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Explanation of the cover: This photo shows spiral galaxy M63 (NGC 5055) taken by Suprime-Cam under condition of seeing size of 0.5 arcsec. It is called as "Sun Flower Galaxy" inferred from its figure.

Postscript

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PREFACE

FY 1999 was the final year of the construction of the **Subaru Telescope**. The nine-year construction project was completed in March 2000, including general adjustments, initial test of observational instruments, and the dedication ceremony held in September 1999. Further preparations for the partial open-use observations in 2000 are being pushed forward. The Subaru Telescope already had achieved excellent observational performance in the course of test observations. Although the significant scientific activities are expected in the coming open-use observation phase, the construction of the telescope was completed with great success. I would like to express my sincere appreciation to all parties concerned in this project.

The high precision VLBI network for geodesic astrometry which has been long-cherished desire of NAOJ since its establishment had finally started its construction under the project name of **VERA**. This is another outstanding progress in the FY 1999. Based on the technical development such as two-beam antenna design achieved in the period of preparation, VERA will make a challenge towards the magnificent goal, which is to figure the three-dimensional structure and gravity distribution of the whole Galactic System by means of direct distance measurement of maser sources. The VERA, as well as the **RISE** project which is a part of a lunar probing project SELENE, aims at new frontier of astronomy based on the academic tradition of the group since the era of Mizusawa Latitude Observatory.

In the field of radio astronomy the open use of **BEARS**, a 85–110 GHZ 25-beam hetherodine receiver for the 45-meter radio telescope of Nobeyama Radio Observatory has started. The test observations of the **RAINBOW** system, a seven elements mm-wave interferometer including the 45-meter Radio Telescope as one of the element antennas were made successfully. Also in VLBI, internationl joint researchs by **VSOP** (**Haruka**) in collaboration with the Institute for Space and Astronautical Science, and collaborative use and works by the domestic VLBI network **JNET** were proceeded. A number of active observational researches with excellent results has been made through the above observations.

Various technical developments, site experiments, and the frame working of international collaboration towards **ALMA** (Atakama Large Millimeter and sub-millimeter Array) have been made. As a forerunner of sub-millimeter wave observations in Chile we forward **ASTE** plan which is to move a 10-meter sub-mm wave antenna to the ALMA site in collaboration with university groups.

To explore new field of astronomy the gravitational-wave detector **TAMA-300** and infrared array were promoted by the group of astrometry and astromechanics in Mitaka. Particularly the TAMA-300 was intensively prepared to achieve the highest performance and long term operations for the first time in the world.

In solar physics, observations by the **Radio Heliograph** in Nobeyama and the X-ray satellite **YOKO** were successfully contiued. Development and production of the new solar observation satellite **SOLAR-B** are in progress.

Number of collaborative researches including international joint works have been carried out and actively extended in the field of theoretical astrophysics.

In the Okayama Astrophysical Observatory, Advanced Technology Center and Astronomical Data Analysis Center new plans towards the future were actively studied as well as the collaborative/open-use researches in each facilities. The Public Relations Center which was settled in 1998, made a great advance in strengthening public services, with expansion of the Public Relations Office.

The old facilities and instruments were converted, renewed or abandoned, on the other hand. Dodaira Astronomical Observatory (with a 90-cm optical telescope) was finally closed in 1999. Also the winter inhabited operation of the Norikura Solar Observatory started in 1998 was continued through 1999.

The above I mentioned are brief outline. Please refer the each text for details.

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Scientific High-lights (1999 Apr. – 2000 Mar.)

Completion of Subaru Telescope

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In 1991, Japan National Large Telescope (nicknamed as Subaru Telescope) project with its diameter 8.2 m was started. It has been completed in March of 2000, during which Subaru telescope received its first light from stars in January of 1999 and its dedication ceremony was held in September of 1999.

In the fiscal year 1999, test observation with astronomical instruments was carried out extensively to make telescope adjustment and to upgrade its performance at the level of its specifications. After assuring the achievement of its specification, Subaru telescope has been handed over to National Astronomical Observatory of Japan (NAOJ). The initial scientific results obtained in this phase was summarized as eleven scientific papers, which was published in Publication of Astronomical Society of Japan (PASJ) (see references).

In the fiscal year 2000, it is eagerly expected that the open-use of Subaru telescope will be started along with the final combination test of telescope and astronomical instruments.

1. Performance of Subaru Telescope

Since the first light of Subaru telescope, telescope performance has been improved by the constant efforts. Here we report its performance achievement at this moment. We have not enough space here. Then concrete numbers at Cassegrain focus is presented as a representative values.

	Specification	Measured values
Telescope		
pointing accuracy:	1.0 (arcsec)	0.87 (arcsec)
tracking accuracy:		
open		
(1 minute)	0.1	0.083
(10 minutes)	0.2	0.197
(30 minutes)	0.6	0.425
Image size (total)	0.2 (FWHM)	0.13 (FWHM)

The measured values tell us a world class telescope. However, owing to the initial defects in control system and the fixed point system, its one fixed point came off during operation. Now the telescope was recovered and the safer control system has been installed.

The improvement of image quality by the suppression of so-called dome seeing is achieved by the temperature control of primary mirror and the mechanical structure, air flow control by ventillation system,

Photo 1. This photo shows spiral galaxy M63 (NGC 5055) taken by Suprime-Cam under condition of seeing size of 0.5 arcsec. It is called as "Sun Flower galaxy" inferred from its figure. M63 is about 2400 light year far from us, and is now active in star formation. In this very sharp image, photo by Suprime-Cam revealed clear tite spiral structure and also distinctive red spherical structure (HII region) due to ionized gas.

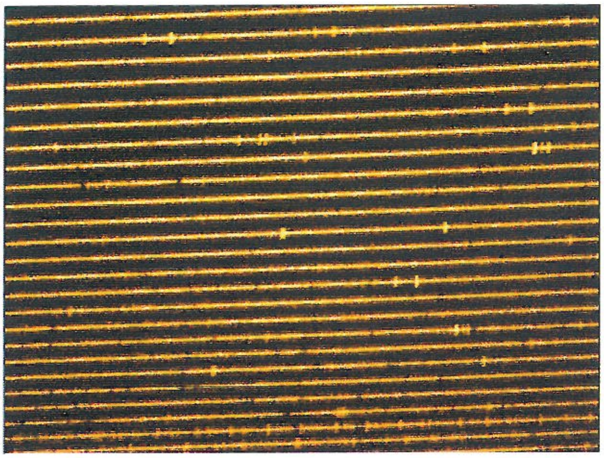

Photo 2. Spectrum of Liner comet taken by HDS (2000. 07.04). Five minute exposure and wave length resolution 30,000 (10 km/s). This photo is on the second CCD image among the two. Wave length coverage is 5100–6500A, and the left bottom is short ward and the right top is longer one. The continuum emission comes from the reflected light of the Sun by the core of the comet. Many emission lines come from the molecules at the diffuse region around the core.

The weak emission lines at the bottom is C2 Swan band. This portion is shown in the figure, in which the very detailed structure of the band is clearly seen.

wind screen system and so forth. At the moment, the measured data is now accumulated to estimate their effects on the image quality. Some good clues to find the solutions is now going to be revealed.

Foci positions are found to change with ambient temperature changes during observing night. By putting the steel structure model into computer and feedbacking monitored temperatures, auto-focusing function has been confirmed to be effective. This system will be applied to the other foci.

Tip and tilt, and chopping functions have been tested for IR secondary mirror. Combination test of this secondary and IR instruments are under way now. In the next fiscal year, the very high resolution imaging, say 0.06 arcsec will be available in near IR region with use of large scale wave front correction by tip-tilt function.

Adaptive optics (AO) system is now in a final phase. But test observation with AO will be realized in a bit more future.

2. Situations of Observational Instruments

After rough adjustment of telescope since its first light event, the seven first generation instruments have been attached sequentially to each focus and received their first light. Now fine adjustments in optics and mechanics performances and also the evaluation of detectors is carried out by data analysis.

Data storage and archive system is developed and their functions has been checked. Data analysis system called DASH is expected to be fully operated. The more detailed information on seven instruments is given below.

FOCAS (Faint Object Camera and Spectrograph): instrument for visible attached to the Cassegrain focus. It is capable of imaging the extremely faint objects and also dispersing the light into 10 to 500 colors. From these information, motions, physical states, and chemical compositions can be obtained. It has also ability to take about spectra of 100 objects at once.

Suprime-Cam (Prime focus wide field Camera): visual instrument attached to the prime focus. Subaru telescope has prime focus only among 8 m class telescopes. So Suprime-Cam is quite unique instrument. Its mosaic large formatted CCD camera ($2 \times 5 = 10$, unit CCD 2 k$\times$4 k) can cover 30 arcmin field of view. Survey observations are expected.

CIAO (Coronagraphic Imager with Adaptive Optics): Attached to Cassegrain focus. With use of Adaptive Optics, very high spatial resolution is achieved. It is capable of detecting very faint objects adjacent to the very bright objects like stars. It is applied to discover the planets around stars and the mother galaxies to the bright QSOs.

IRCS(Infrared Camera and Spectrograph): Attached to Cassegrain focus. With use of AO system, very high spatial resolution imaging and spectroscopy are carried out. Not only star forming region may be observed with high spatial resolution, but also low resolution spectroscopy of cosmological faint galaxies and high resolution spectroscopy of interstellar matters are capable.

COMICS (Cooled Midinfrared Camera and Spectrometer): Attached to Cassegrain focus. It covers the observation for Midinfrared region (8–28 μm). In this region, resolution of 8 m ground based telescopes reaches diffraction limitted resolution. For this reason, observations for planets formation processes and circumstellar dust are expected.

OHS (OH-suppressed Spectrometer): Near infrared instrument attached to IR Nasmyth focus. OH air glow lines may disturb the observation in this region as a noise source. Collecting after dispersing the light in a high resolution and suppressing such line emissions, very faint light of galaxies can be detected free from noise. Primordial galaxies born just after the Big Bang are observed.

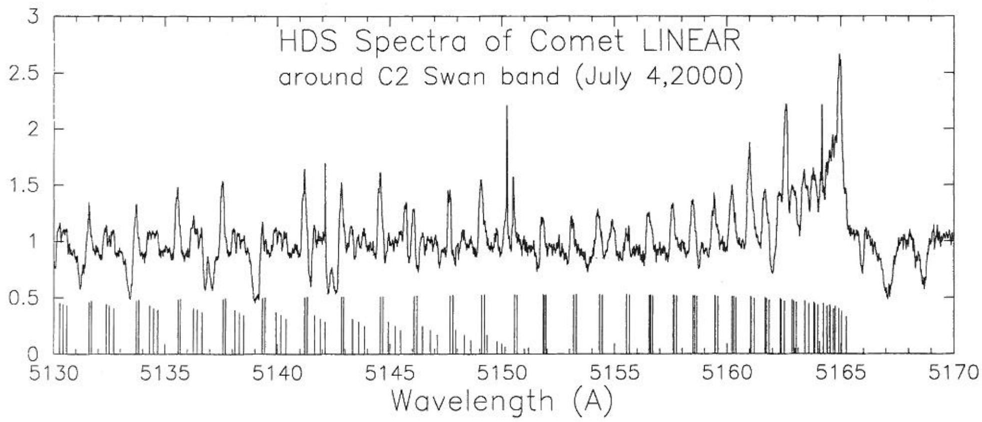

Fig. 1

HDS (High Dispersion Spectrograph): Visual instrument attached to the optical Nasmyth focus. It has a capability of dispersing star light into 100,000 colors. It may reveal the tiny motion of stars, very accurate physical states of stars, and also detailed chemical composition of stars. As a disperse optical element, Echelle grating is adopted and mosaic CCD ($1\times2=2$, unit CCD $2\,k\times4\,k$).

3. To the Regular Operation

In the next fiscal year, Subaru telescope is to be operated for open use, whose demand from astronomical community is extremely strong. Subaru project has been completed in March, 2000. It has been prove that its performance meets with our specification. Our target is to polish up its performance and to maintain it at higher level. To compete with the other 8 m class telescopes, we should continue the constant polish-up of performance and the addition of the new functions.

Concerning the open use instruments, one or two instruments will be provided at first. Then the whole instruments is to be opened to use sequentially.

Coronagraphic Imager with Adaptive Optics (CIAO)

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A near-infrared coronagraphic camera has been built for use with the Subaru 8.2 m telescope and its adaptive optics system.

The purpose of this instrument CIAO (Coronagraphic Imager with Adaptive Optics) is to obtain high-resolution (0.06 arcsec at 2 micron) images of faint objects in close vicinity of bright objects at infrared wavelengths. Such objects are, for example, companion brown dwarfs, extra-solar planets, circumstellar disks around both young stellar objects and main-sequence stars, jets and QSOs. CIAO is a 1–5 micron camera with two focal plate scales: 22 mas/pix and 11 mas/pix.

CIAO utilizes one ALLADIN II (1,024×1,024 InSb) array manufactured by SBRC.

The camera is equipped with the standard broad-band filters, as well as narrow-band filters.

Occulting masks whose diameter ranges from 0.1 to 3 arcsec and several types of pupil masks are selectable.

The first light commissioning test of CIAO on the Subaru telescope was carried out between February 9 and 16, 2000. The obeservations were without the adaptive optics system and with the optical secondary mirror.

Fig. 1. The CIAO at the Cassegrain focus of the telescope.

References

Tamura, M., *et al.*: 1998, *Proc. SPIE,* **3354**, 845
Itoh, Y., *et al.*: 1998, *Publ. Astron. Soc. Japan*, **50**, 55

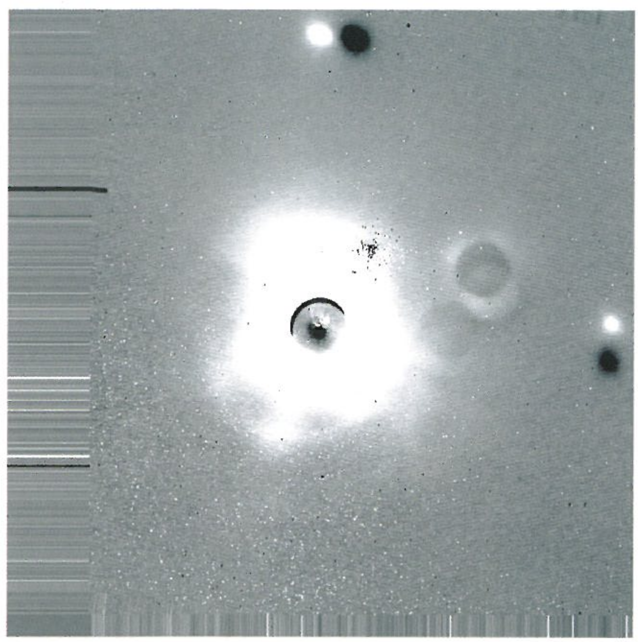

Fig. 2. An H band coronagraph image of IRC 10216. The diameter of the mask is 2 arcsec.

Development of an OH-Airglow Suppressor Spectrograph for the Subaru Telescope

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We have been developing an OH-airglow suppressor spectrograph (OHS), which is one of the first instruments of the Subaru telescope.

In the near-infrared wavelength, especially in the *J*- (1.25 μm) and *H*- (1.65 μm) band, the sensitivity of the observations is determined by non-thermal background emission from the atmosphere. Maihara, *et al.* (1993) showed that most of the emission are attributable to the emission lines of OH (hydroxyl) radicals.

OHS reduces these emission lines by the procedure shown in Fig. 2 and provides the highest sensitivity for imaging and low-resolution spectrograph.

1. Ray from the telescope enters the slit, and then is dispersed by a grism into wavelength-resolution of 5,500.
2. At the focus of the dispersed ray, a mask mirror is placed. This mirror blocks the wavelengths where OH lines exists.
3. The reflected ray goes through the dispersion optics from the reverse end to be converted into white ray again, and refocused on the focal-plane of the back-end camera, CISCO (Motohara, *et al.* 1998).

20% of the wavelength coverage will be lost by the mask mirror, but the width of the individual OH-masks are all very narrow so the macroscopic shape of a spectrum of a object will not be altered. On the other hand, the background emission is expected to be suppressed to 1/30.

Fig. 1 shows OHS mounted on the Infrared Nasmyth focus of the Subaru telescope. Its dimension is 5 m×3 m×1.5 m, and weight is 2.5 tons. After initial

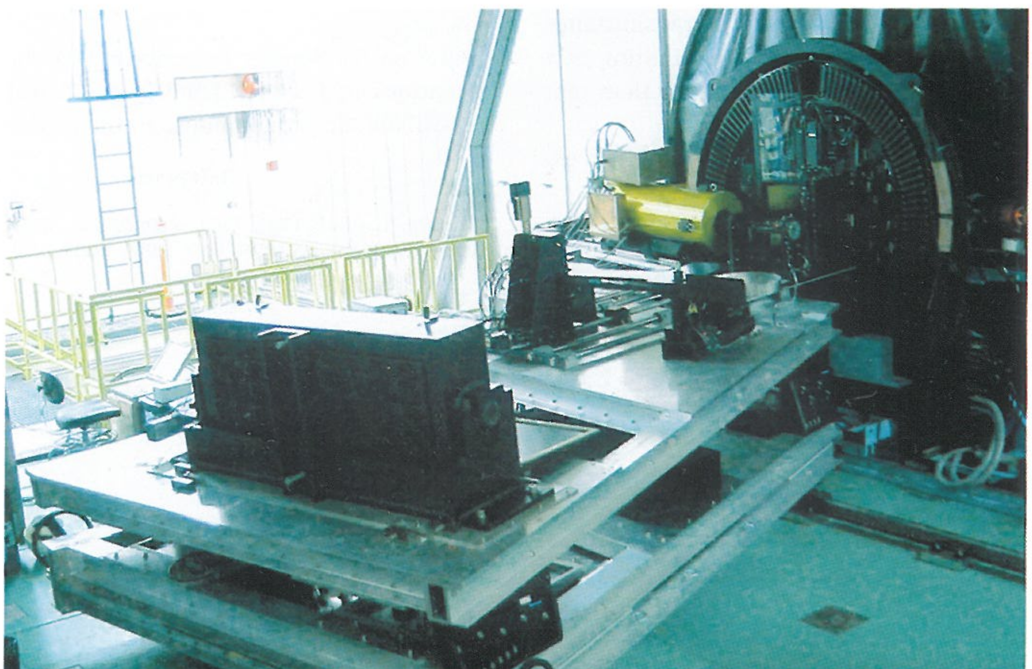

Fig. 1. OHS mounted on the Nasmyth focus of the Subaru telescope.

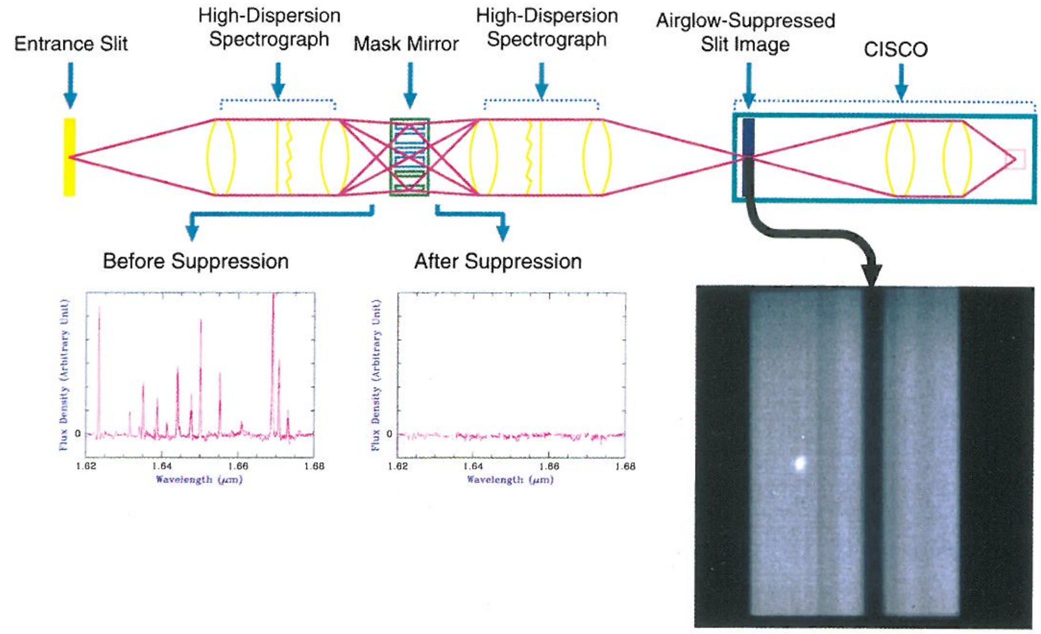

Fig. 2. (Up) Concept of OHS. (Right) One of the images during the first light observations, which shows the field of view of OHS ($30'' \times 20''$). Black lane at the center is the region so called a "dark lane", where the OH-airglow is suppressed by OHS. A star is seen on the left of the dark lane.

test at Mitaka in August of 1999, it was shipped to Hawaii and reassembled on the Nasmyth stage of the telescope in December.

OHS saw first light on February, 2000. Results of the observations showed that the background emission is suppressed to 1/25 (Fig. 2). The transmittance of OHS was measured to be 36%, so the limiting flux will be $\sqrt{0.36 \times 25} = 3$ times (1.2 mag) fainter than that without OHS.

However, we haven't reached the sensitivity expected from above calculation, due to;

- stray light on the Nasmyth stage, which causes additional background emission.
- incomplete shape of the mask, so suppression factor of the background is not so high as expected.

We are now working on these problems, and try the ultimate observations in the next observational run.

OHS on the 8-meter telescope realize the deepest observations in *J*- and *H*-band in the world, which will be available for common-use in the next year.

References

Maihara, T., *et al.*: 1993, *Publ. Astron. Soc. Japan*, **105**, 940

Motohara, K., *et al.*: 1998, *Proc. SPIE*, **3354**, 659

First Light of Subaru IRCS

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After being shipped to Hilo of Hawaii on April 1999, IRCS (Infrared Camera and Spectrograph for the Subaru Telescope) was assembled and evaluated under cryogenic temperature at the base facility of Subaru telescope. On February 2000, IRCS successfully saw the first light on the telescope. We report the outline of IRCS and the results of the first light.

IRCS is a standard near-infrared (1–5 micron) instrument for both imaging and spectroscopy. The optics of IRCS is optimized for high-resolution images with adaptive optics (AO) which is one of the strong points of Subaru telescope. IRCS has two modes of spectroscopy; a "low-to-medium dispersion mode ($R=100$–1,000)" with grism and a "medium-to-high dispersion mode (R=5,000–20,000)" with gratings. As for imaging, there are two cameras of different pixel-scale; "58 mas camera (0.058 arcsec/pixel, field-of-view=1 arcmin)", which is suitable for observing with Tip Tilt and "23 mas camera (0.023 arcsec/pixel, field-of-view =30 arcsec)" for observing with AO. The camera side also serves as a slit viewer for medium-to-high dispersion spectroscopy, so that we can observe efficiently.

Thus, IRCS is a complicated instrument with many functions and has many items to be checked. In the first observing run, we focused on a performance evaluation of IRCS itself without AO. In the following, we show some results from the IRCS first light. Fig. 1 is an image of "BN and IRc2 in Orion nebula" at J (1.25 micron), K (2.2 micron), L′ (3.8 micron) band with 58 mas camera. The brightest object in this image is BN object, and IRc2 is located south-east to BN object. Both objects are young massive infrared sources. Some objects around IRc2 are clearly detected only in L′ band. Deeply embedded sources in molecular cloud can be revealed at 3 micron since extinction by interstellar dust is much less in longer wavelengths. IRCS has an excellent performance of imaging and spectroscopy in 3–5 micron infrared region, which is still an unexplored field in astronomy. Fig. 2 is the K band spectrum with high-dispersion ($R=20{,}000$) of a region which shows the strongest emission of molecular hydrogen near IRc2. Most of the emission lines in Fig. 2 are attributed to shock excited molecular hydrogen by a strong outflow from IRc2. The distorted feature of those emission lines in Fig. 2 clearly shows the kinematics ($v=15$ km/s) of molecular hydrogen in the outflow.

IRCS has been selected as one of the first open use instruments. Now we are checking the details of IRCS for the open use which will start fom December 2000.

Reference

Kobayashi, N., *et al.*: 2000, *SPIE, Proc.*

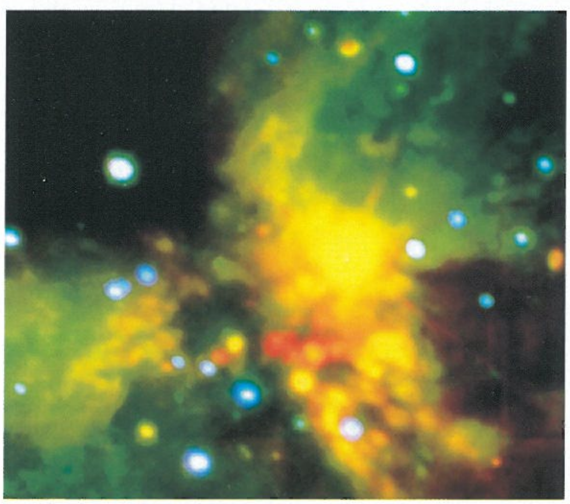

Fig. 1. J, K, L′ band image of BN and IRc2 (field of view= 40 arcsec×46 arcsec).
[Blue: J band (1.25 μm), Green: K band (2.2 μm), Red: L′ band (3.8 μm)]

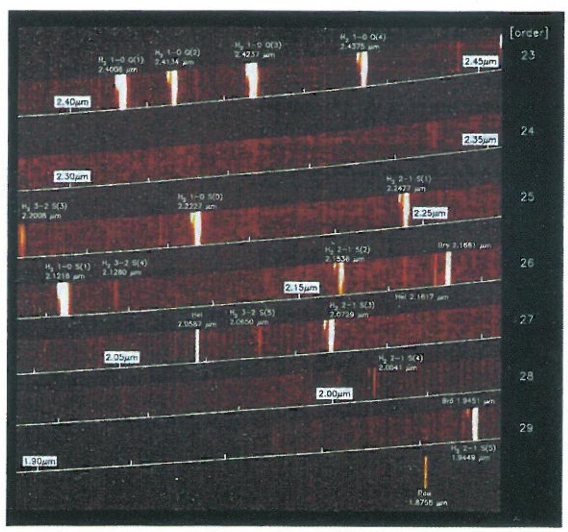

Fig. 2. K band spectrum of Orion nebula with high-dispersion ($R=20{,}000$).

Subaru Telescope FOCAS First Light

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We have been developing the Faint Object Camera And Spectrograph (FOCAS), which is one of the first common-uses instruments for Subaru Telescope. It is the main Cassegrain instrument at optical wavelength, and was constructed especially for observing the faintest and the most distant objects observable only with Subaru Telescope. FOCAS provides various observing modes, including imaging, (multi-object) spectroscopy, and polarimetry. Although the conceptual design study was started back in late 1980's, the final design was fixed in 1997 and the actual fabrication of FOCAS began in full gear.

The main body of FOCAS was delivered at Mitaka in April 1999. It was then furnished with its focal plane unit providing multi-object sampling capability and the CCD camera. Soon after the integration, it was attached to the optical simulator at Mitaka, and extensive tests of the optical properties, flexures, and the functionalities of movable parts were performed at its inclined positions. After passing all these tests, it was shipped to Hawaii in October and arrived at Hilo base facility safely after two months. Extensive tests with the optical simulator there were conducted again to check all functions after long journey on the ship, and the final adjustments of both hardware and software, including the communication through the network, were made. In middle of January 2000, FOCAS was transported to the summit and was finally attached to the Cassegrain focus of Subaru in late January. The first test observation was started on February 1 and FOCAS finally saw its first light very successfully. An image of nearby galaxy M82 taken during this observing run was made public at the press conference held at Mitaka, and was shown

Fig. 1. FOCAS attached to the Subaru Telescope.

Fig. 2. The first-light image (M82).

in many newspapers on March 24.

Although FOCAS achieved its first light very successfully in its imaging mode, spectroscopy and polarimetry modes are not yet fully tested. We also identified many items for improvement during these test observations. It will take some more time before it works fully as a common-use instrument of Subaru Telescope. We will devote ourselves to improve FOCAS and to obtain some scientific outputs with it.

References

Kashikawa, N., *et al.*: 2000, *SPIE Symp.*, "Astronomical Telescopes and Instrumentation 2000", **4008-11**, in press

Yoshida, M., *et al.*: 2000, *SPIE Symp.*, "Astronomical Telescopes and Instrumentation 2000", **4009-24**, in press

Submillimeter Polarimetry of Star-Forming Regions with the SCUBA Polarimeter 2: First Detection of Submillimeter Polarization from T Tauri Stars

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We report a first detection of polarization of the 850 micron continuum emission from two T Tauri stars (TTSs), GM Aur and DG Tau, with the polarimeter for SCUBA jointly developed under UK-Japan collaboration. These are both single and classical TTSs. The emission mostly comes from the compact ($r<100$ AU) accretion disks. The polarization (at about 3% level at 3 sigma) is interpreted in terms of thermal emission by magnetically aligned dust grains in the disk. Thus these submillimeter polarizations probe the magnetic field structure in the disk, while the previously reported millimeter/submillimeter polarizations of protostars and the transitional objects from the protostars to TTSs trace the magnetic fields in the larger envelope region. In both TTSs, the direction of the magnetic field inferred from our submillimeter polarizations is parallel to the plane of the compact dust disk measured by interferometric observations, suggesting the dominance of a toroidal magnetic field component in the disk. The magnetic evolution of the circumstellar environments is discussed, as well as the constraints on the MHD models of the jets and outflows from young stellar objects.

Reference

Tamura, M., *et al.*: 1999, *Astrophys.* J., **525**, 832–836

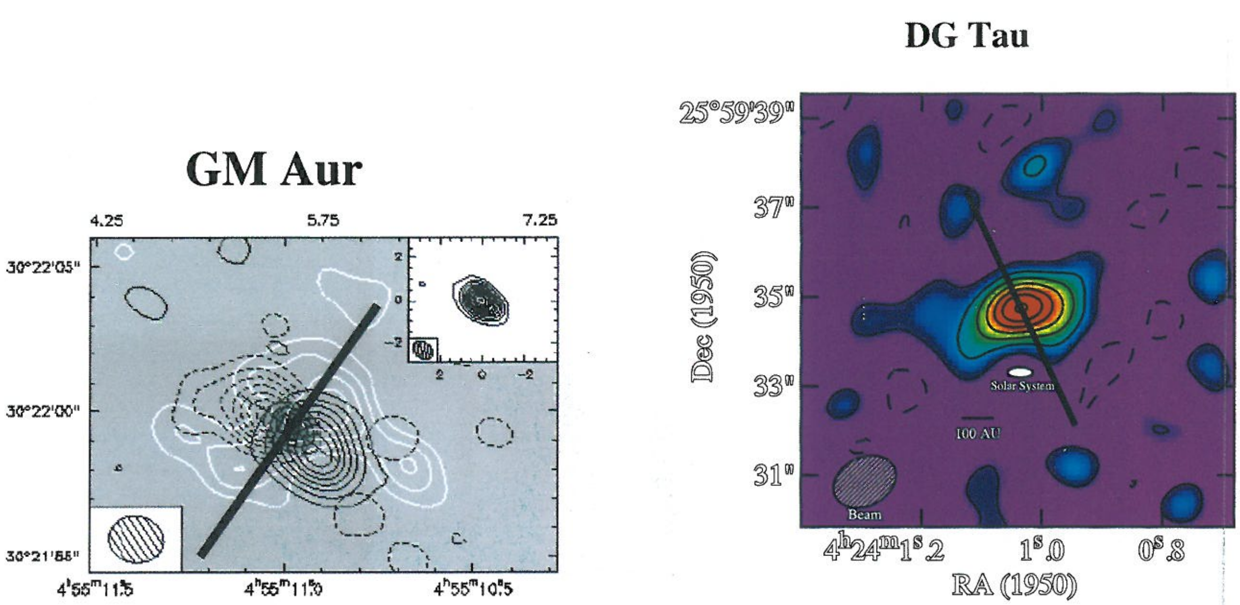

Fig. 1. 850 μm polarization vector superposed on the CO2-1 and 1.3 mm continuum maps. Inset is a higher resolution continuum map. (Dutrey *et al.* 1998)
850 μm polarization vector superposed on the 2 mm continuum map by Kitamura *et al.* (1996)

Suprime-Cam: Observations at the Cassegrain Focus of the Subaru Telescope

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Following the successful first light of the Subaru telescope, observations with Suprime-Cam at the cassegrain focus had been carried out for six month. During this first-light phase, Suprime-Cam had been attached to the cassegrain focus and used as a test instrument for commissioning of the telescope, though Suprime-Cam is designed for use at the prime focus. Main results are observations of the cluster of galaxies A851 and the Ring Nebula (M57).

The cluster of galaxies A851, which is located at $z=0.4$, is thought to be one of the best targets to check the imaging capability of the Subaru telescope since Hubble Space Telescope (HST) also observed this cluster. The observation[1] proved that the Subaru telescope can obtain deeper images than HST though the angular resolution is not high (Fig. 1). In addition, it is also revealed that image quality is not so bad compared with HST from the morphological classification of galaxies and the gravitational lensing analysis.

The observation of the Ring Nebula (M57)[2], which was carried out as a test of the Hα filter, revealed the fine structure of the inner and outer halos in unprecedented detail (Fig. 2). This image also shows the fine structures of the other parts with a resolution comparable to the image taken with HST. The features newly found in this image are thought to give more challenges to the current strucutural model of the Ring Nebula.

These two observations show the high imaging capability of the Subaru telescope. The commissioning of the prime focus started from July of 1999 and we are now preparing for the open use from this December. Suprime-Cam, which has the widest field of view (3′× 24′) among 8-m class telescopes, is expected to produce many scientific results in the various fields from the solar system to the cosmology.

References

1) Iye, M., *et al.*: 2000, *Publ. Astron. Soc. Japan*, **52**, 9
2) Komiyama, Y., *et al.*: 2000, *Publ. Astron. Soc. Japan*, **52**, 93

Fig. 1. A851 in the R band.

Fig. 2. Ring Nebula (M57) in the Hα band.

Commencement of Operation of the TAMA300 Gravitational-Wave Detector

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Masaki ANDO, Daisuke TATSUMI, Shigeo NAGANO
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(Osaka University)

TAMA300 is the 300 m interferometric gravitational wave detector located on the Mitaka campus of National Astronomical Observatory. It aims at establishing techniques for sensitive and stable operation of a long baseline interferometer, as well as at possible detection of gravitational waves from coalescing compact binaries or supernovae which happen to occur within or nearby our Galaxy.

We have developed a high-power and ultra-stable laser, very high quality mirrors and so on, which are essential to the high sensitive interferometer, and finished the construction of the detector. In the summer of 1999, we performed the first observational run successfully in advance of the other large-scale or medium-scale laser interferometers in the world, LIGO (4 km), VIRGO (3 km) and GEO (600 m). The operation of the interferometer was very stable. During the three nights' data-taking run (September 17 to 20, 1999), the interferometer was in a locked state for about 30 hours, 94% of the total observation time. Figure 1 shows the power fluctuation of the interferometer during the run. The longest time of con-

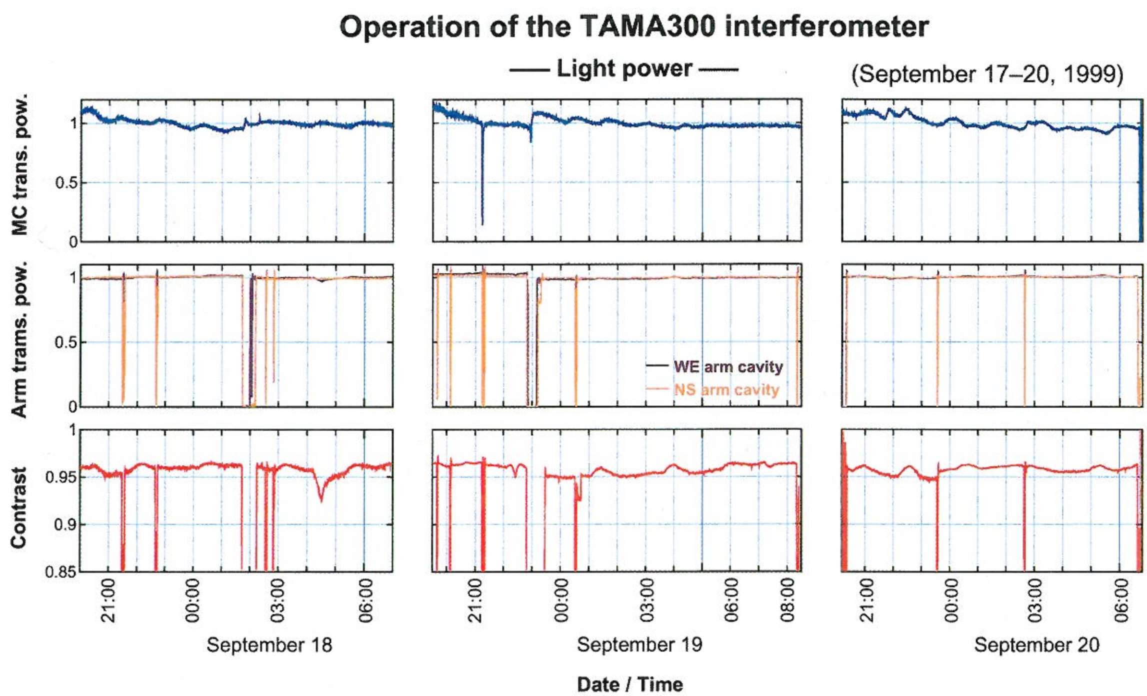

Fig. 1. Power fluctuation of the TAMA300 interferometer during the data-taking run performed in September, 1999. The interferometer was operated stably for about 30 hours, 94% of the total time.

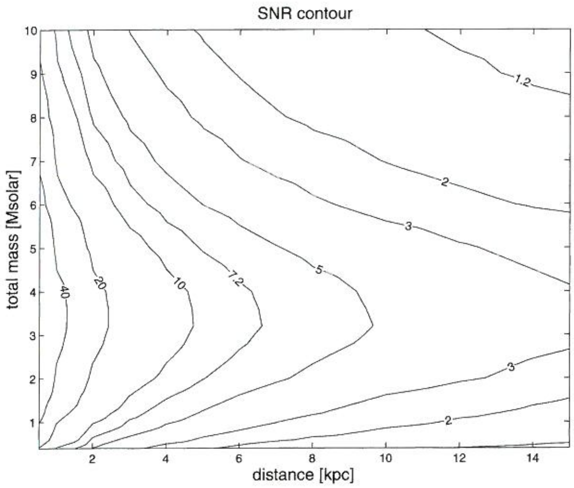

Fig. 2. A contour plot of SNR as a function of distance and total mass of equal mass binaries in the case when the position of the source on the sky and the inclination angle of the binaries are optimal.

tinuous locked operation was more than 7 hours.

The detector output was converted to the strain equivalent amplitude with 1% accuracy by using a transfer function which is estimated from the calibration signal. The observation was done with the strain sensitivity of $3\times10^{-20}/\sqrt{\mathrm{Hz}}$ around 900 Hz. We analyzed the data by using the matched filtering, searching for the gravitational waves from inspiraling compact binaries. Fig. 2 shows a contour plot of the signal-to-noise ratio as a function of the distance to the source and the total mass for equal mass binaries. Gravitational waves from inspiraling binary neutron stars with 1.4 solar mass at 6.2 kpc distance could be detected with signal-to-noise ratio 7.2.

The sensitivity of the interferometer was limited by the alignment control noise from 10 Hz to 700 Hz. The noise in the alignment control error signal causes displacement noise through coupling with miss-centering of the beam on the mirrors, and efficiency asymmetries of the coil-magnet actuators. Reduction of the electric noise in the alignment error sensor, fine adjustment of the beam centering on the mirrors, and a change in the alignment control servo filter have improved the sensitivity drastically as shown in Figure 3. The noise source limiting the floor level (around 800 Hz to 3 kHz) has not yet been identified. The scattered light inside the beamsplitter tank seems one of the origin of the floor level noise.

TAMA300 is the first to start operation in the world and has an important role to make a search for gravitational waves at the highest sensitivity so far attained, and also has another important role to find out the technical problems which limit the stability and the sensitivity of the interferometer and to give an outlook for further improvement.

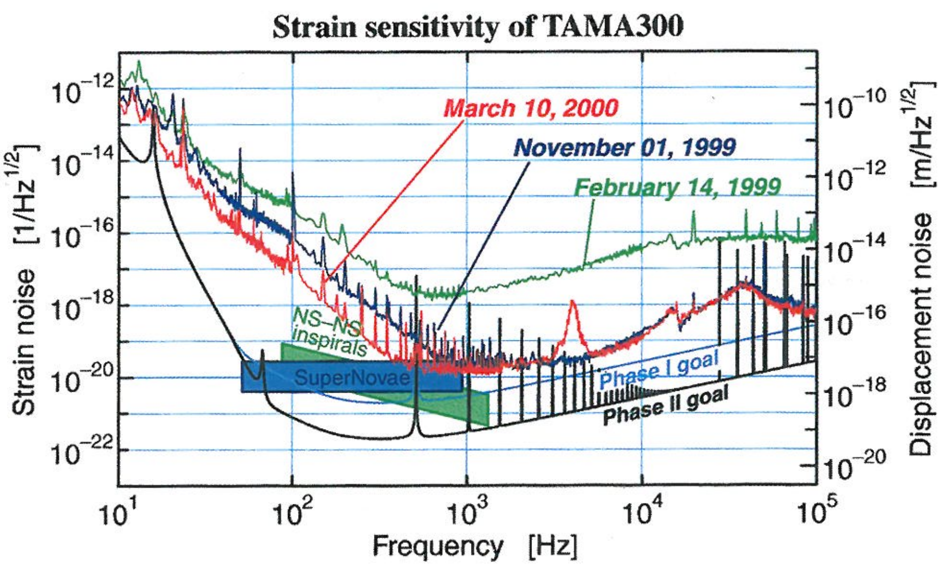

Fig. 3. Increasing strain sensitivities of the TAMA300 interferometer in unit of $1/\sqrt{\mathrm{Hz}}$. The target sensitivities in Phase I and Phase II, and expected gravitational wave sources in our Galaxy are shown together.

Galactic-Plane Survey of VLBI Radio Sources for VERA

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VERA (VLBI Exploration of Radio Astrometry) is a new VLBI array dedicated to phase referencing VLBI. VERA aims at measuring the position of galactic maser sources relative to reference extra-galactic sources with an accuracy of 10 micro-arcsec level. In order for VERA to observe the target maser and the reference source simultaneously with its dual beam system, the two objects are located within 2 degree from each other, which requires a large number of reference sources spread over the whole sky area. While nearly 2000 VLBI radio sources are already known and can be used as reference sources for VERA, the number of VLBI sources in the galactic plane was much less than in other sky region, which makes it impossible to observe many maser sources in the galactic plane using VERA.

In order to search for new VLBI sources in the galactic plane that can be used as reference sources for VERA, we have conducted 22 GHz survey of compact radio sources using the Japanese VLBI Network (J-Net). We have detected 51 new VLBI sources within ±5 degree of galactic plane. The detection of 51 new sources has increased the number of H_2O maser-reference source pairs within 2 degrees by 130. Combining other VLBI source surveys, about half of 700 H_2O masers in the northern sky area become observable with VERA. Although there are still many maser sources which do not have reference sources within 2 degree, we will hopefully find all reference sources that are necessary for VERA by continuing the survey of VLBI sources like the present study.

Reference

Honma, M., *et al.*: 2000, *Publ. Astron. Soc. Japan*, **52-4**, in press

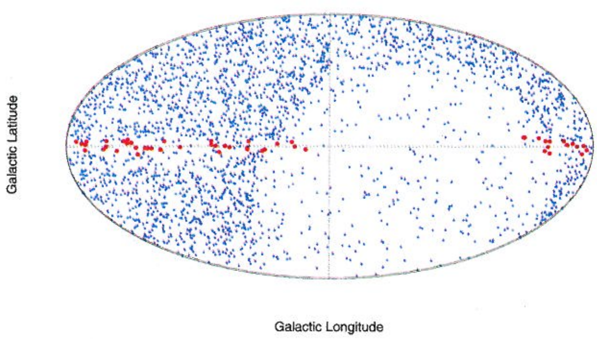

Fig. 1. Distribution of newly discovered VLBI sources in the galactic coordinate (red circles). VLBI sources that are already known are also plotted (sky-blue circles).

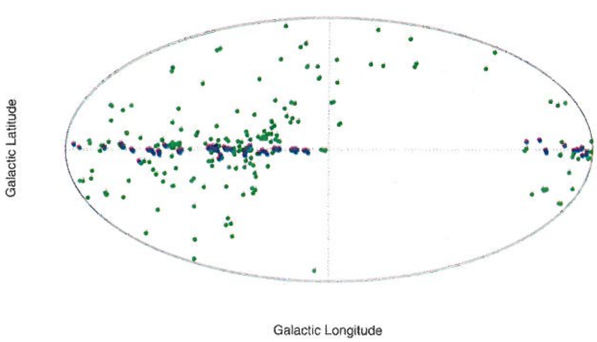

Fig. 2. Distribution of H_2O masers that have reference sources within 2 degree. Blue spots indicate the masers which reference sources have been found in the present study, and green spots indicate the masers which references are previously known.

Solar-B

Saku TSUNETA
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The National Astronomical Observatory is developing the Solar-B (Fig. 1) onboard-instruments in collaboration with the Institute of Space and Astronautical Science (ISAS), NASA and UK PPACK. Solar-B is ISAS's 22 nd scientific satellite, and Japan's 3rd solar observing satellite. The onboard instruments are Solar Optical Telescope (Fig. 2), X-Ray Telescope, and EUV Imaging Spectrometer. The primary mission of Solar-B is to understand the heating of the solar corona and the solar dynamo mechanism.

The optical telescope is able to obtain vector magnetic fields with unprecedent spatial resolution of 0.2–0.3 arcsec by precision polarization measurements. The X-ray telescope has 1 arcsecond resolution, approximately 3 times higher than the Yohkoh resolution. The observing temperature range is wider than Yohkoh, and thus permits us to simultaneously observe multi-temperature components of the solar corona. EUV imaging spectrometer will obtain the information on the dynamics of the solar corona such as bipolar inflows and outflows associated with magnetic reconnection. The suite of instruments allows us for the first time to simultaneously observe both the magnetic fields as the source of energy and its dissipation. Furthermore, we anticipate to understand internal dynamo mechanism by observing buoyant magnetic fields coming from deep inside the Sun with the optical telescope.

These three telescopes are jointly built by NAO, NASA and UK. The optical telescope is designed, built, and tested by NAO with industry partners. The focal plane package for the optical telescope is fabricated by NASA, and is integrated to the main telescope. The X-ray CCD camera is built and tested by NAO with ISAS, and is integrated to the main telescope fabricated by NASA.

Multiple key technologies has been developed for the optical telescope. The fabrication and opto-mechanical testing of the 50 cm-diameter primary mirror with sophisticated kinematic mounting is based on the heritage from the Subaru telescope project. The full-scale telescope will be tested in FY 13, and the 60 cm-diameter plain mirror (Fig. 3) for the interferometric testing wascompleted. Its surface figure reaches 5.9 nm RMS ($\sim\lambda/100$).

The primary and secondary mirrors has to be maintained with an accuracy of a micron against launch and in orbit. To realize this difficult requirement we extensively use the newly-developed graphite-cyanate composite structure without any metal connection flanges (Fig. 4). The composite material is demonstrated to have an exceptional performance. In particular, the coefficient of thermal expansion is better than 0.1

Fig. 2. Solar Optical Telescope.

Fig. 1. Solar-B outlook.

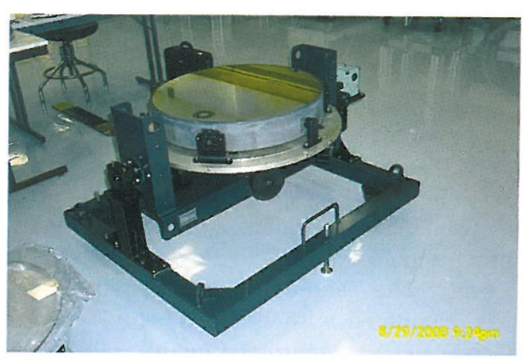

Fig. 3. 60 cm diameter precision plain mirror.

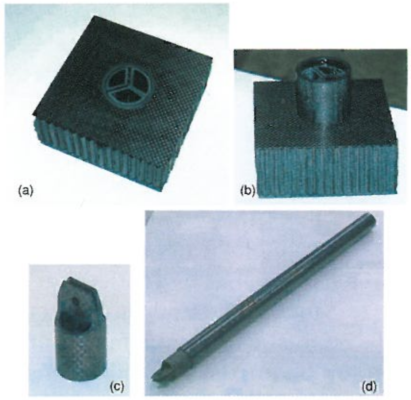

Fig. 4. Ultra low CTE composite material for the optical telescope.

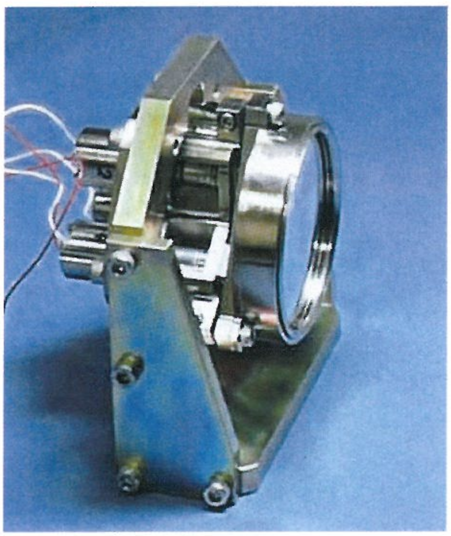

Fig. 5. Tip-tilt mirror for the optical telescope.

ppm/C, and exceeds that of Invar.

The requirement for image stabilization at the focal plane is far more stringent than the spacecraft attitude stability. The stability is realized with the onboard tip-tilt mirror with piezoelectric actuator (Fig. 5). The image stabilization system is based on the tip-tilt mirror developed for the NAO XUV Doppler Telescope aboard ISAS sounding rocket launched in 1998. The high-bandwidth tip-tilt mirror for Solar-B is being developed, and the extensive space-qualification of the commercial piezoelectric actuators is going on. The control computer is space-qualified 64 bit CPU developed by NASDA.

The development of the X-ray CCD camera proceeds well. 2 k×2 k back-illuminated CCD are cooled down to −50 to −60 C passively with a dedicated radiator in orbit. The camera has a capability to mechanically move the cooled CCD to position the CCD at the best focus. The candidate CCDs for flight are extensively evaluated with the NAO soft X-ray source and UVSOR/KEK synchrotron facilities (Fig. 6).

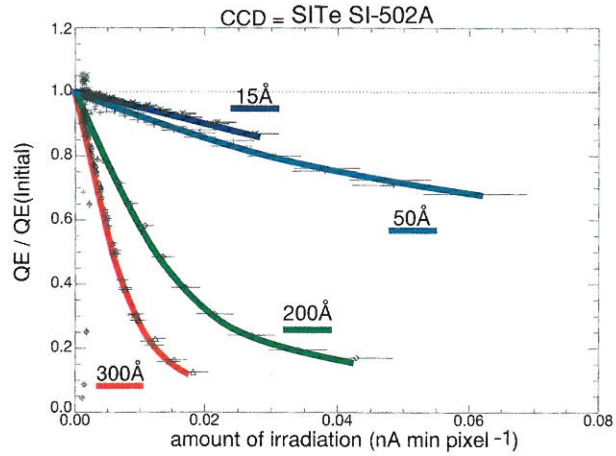

Fig. 6. Quantum efficiency and dark-current due to X-ray dose.

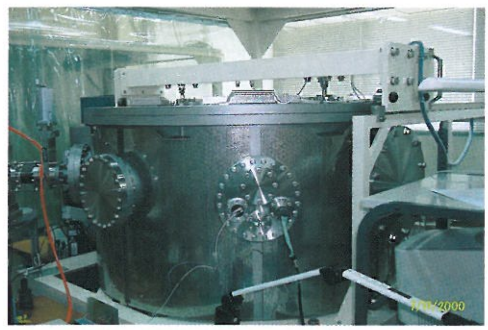

Fig. 7. Space chamber.

Fig. 8. X-Ray light source.

In order to perform various critical tests for the onboard instruments and components, oil-free 1.2 mϕ× 0.7 m vacuum chamber was introduced at the NAO advanced technology center (Fig. 7). The chamber is equipped with the shroud with controlled temperature from −70 C to 70 C, the contamination monitor (TQCM), the residual gas analyzer, and the soft X-ray monochrometer (Fig. 8). The facility is widely used for the Solar-B development and other purposes.

Reference

Kano, R., *et al.*: 2000, *NAO reports*, in press

Detection of Circumstellar C_2 Swan (0,0) Band in Carbon Stars

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A new High Dispersion Echelle Spectrograph (hereafter HIDES) installed at the coude focus of the 188 cm reflector of Okayama Astrophysical Observatory, saw the astronomical first light in the spring of 1999. HIDES can now observe more than 1000 Å in wavelength range at one time and achieve a maximum spectral resolution ($\lambda/\Delta\lambda$) of 110,000.

We have been observing blue-green spectra of bright optical carbon stars with HIDES, achieving a resolution of 95,000, in order to investigate their mass loss phenomena. Recently we succeeded in detecting definite circumstellar C_2 and its isotopomers' Swan (0,0) bands in several stars.

Circumstellar molecular absorption lines have been well studied in the optical spectra of post-AGB stars, while only an example, IRC+10216, is known to show evidence of circumstellar molecular absorption lines amongst carbon-rich as well as oxygen-rich red giant stars. Because optical spectra of cool red giant stars are very complicated due to atmospheric molecular absorption bands, detecting such circumstellar absorption lines is a very difficult task intrinsically.

Our detection of circumstellar C_2 Swan (0,0) bands has been achieved by observing the C_2 Swan (0,0)

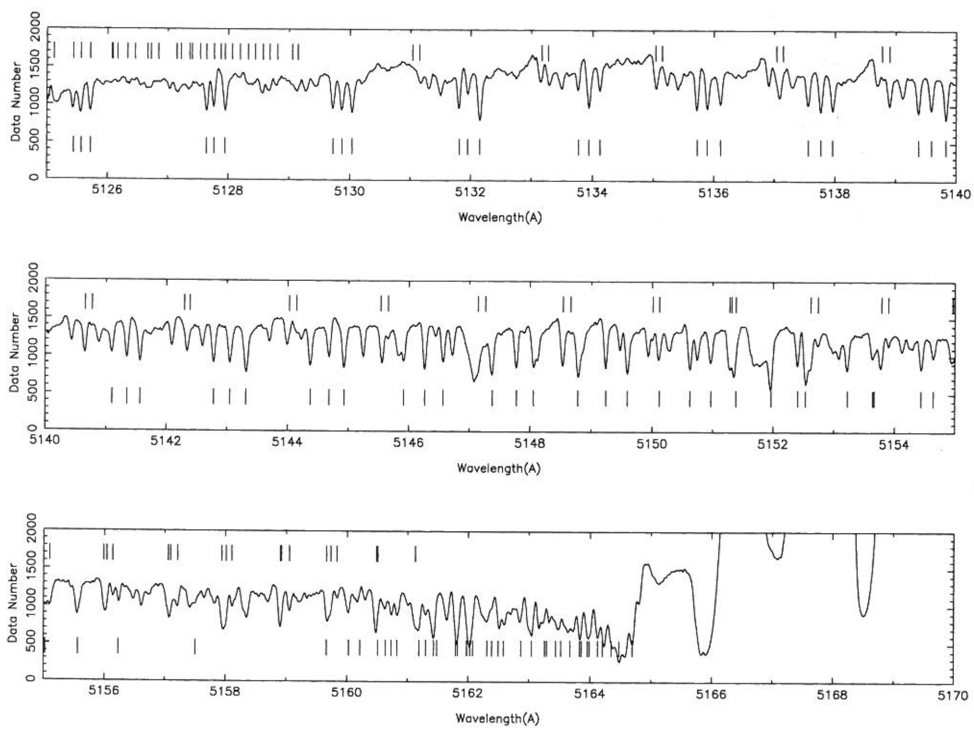

Fig. 1. The spectrum around C_2 Swan (0,0) band head of the ^{13}C-rich carbon star RY Dra observed with HIDES at Okayama Astrophysical Observatory. The abscissa is wavelength in Å and the ordinate is relative intensity of the light. A region from 5125Å to 5170Å is shown. Vertical ticks show the positions of $^{12}C^{12}C$ lines for a line of sight velocity with respect to LSR (Vlsr) of −15 km/s. Lower ticks show the lines with lower excitation potential less than 1,000 K, while upper ticks do those with lower excitation potential more than 1,000 K. The systemic and outflow velocities from mm-wave CO $J=1-0$ line are −5 km/s and 13 km/s, respectively. Most of remaining strong lines which were not associated with $^{12}C^{12}C$ lines are successfully assigned to isotopomers' ($^{12}C^{13}C$ and $^{13}C^{13}C$) Swan (0,0) band lines.

band head (λ5165) region, exploiting the high spectral resolution as well as high sensitivity of HIDES. In this wavelength region atmospheric C_2 absorption lines are so crowded and strong that the bottoms of the lines connect with one another and form a pseudo continuum which lies at a very low level compared to the true continuum. We have detected very narrow absorption lines in the pseudo continuum region (Fig. 1). The lines are assigned to Swan (0,0) bands of C_2 and its isotopomers. C_2 molecules at rotational levels of which excitation potentials are lower than 1000 K are found to be responsible for the strongest lines. The line of sight velocities of the lines are found blue-shifted with respect to the center of mass velocity of the star determined by the mm-wave CO emission lines. In each star the amount of the shift is found to be almost equal to the expansion velocity of the circumstellar envelope. Observed line widths are around 4 km/s, while instrumental width is 3.2 km/s, which suggests that the intrinsic line widths are smaller than 3 km/s. With these results we have concluded that the absorption lines detected in our observations are due to C_2 molecular gas in the circumstellar envelope. We have already detected this kind of absorption lines in several stars. It would provide new methods to examine systematically carbon isotopic abundance, molecular excitation temperature, and turbulent velocity of the circumstellar envelopes of carbon stars.

Reference

Izumiura, H.: 1999, *Proc. Fourth East-Asian Meeting on Astronomy*, ed. P. S. Chen (Yunnan Observatory, China), 77–81

Development of the 230 GHz Receivers for the Nobeyama Millimeter Array and the RAINBOW Interferometer

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Toshihito SHIBATSUKA, Kotaro KOHNO, Ryohei KAWABE
(Division of Radio Astronomy・NAOJ)

We describe the development of the 230 GHz receiver systems for the Nobeyama Millimeter Array (consists of six 10 m dishes) and the RAINBOW interferometer, which is the combined interferometer between the NMA and 45 m telescope at Nobeyama Radio Observatory.

In 230 GHz band, important information can be obtained through observations of CO (J=2−1) line, thermal emission from dust, and so on. However, flux densities of quasars, which are used as visibility calibrators at interferometric observations, decrease with increasing frequency. Therefore it is essential to develop low noise receivers and high precision observing systems to make synthesis observations at 230 GHz band.

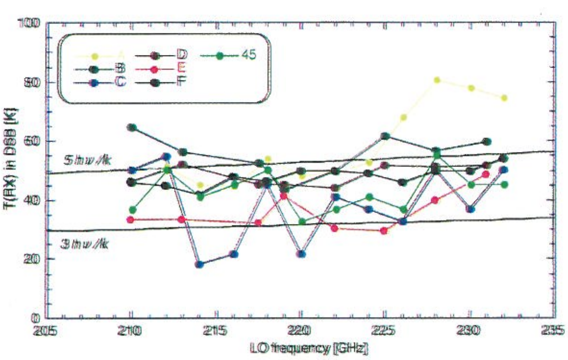

Fig. 1. DSB Receiver noise temperatures of the 230 GHz SIS receivers, which were developed at the Nobeyama Radio Observatory for the NMA and the RAINBOW interferometer, as a function of LO frequency. The center of IF frequency is 6 GHz.

The mixer of each 230 GHz receiver is the parallel-connected twin junction (PCTJ), developed at Nobeyama Radio Observatory (Shi, *et al.*, 1997). Crossguide coupler (25 dB coupling) was employed for LO injection. The LO source is composed of a frequency tripler and a Gunn oscillator at 70 GHz band. The vacuum window is made from a polyester film with a thickness of 50 μm, which is transparent and therefore is enable us to make alignments between beam optics mirrors and a feed horn attached with the mixer using a laser beam. Sideband separation is achieved by 90 degrees phase switching of LO signal. The IF frequency can be adjusted in the frequency range of 4.5 GHz to 7 GHz. We can therefore make simultaneous observations of ^{12}CO (J=2–1) line (230.538 GHz) and ^{13}CO (J=2–1) line (220.399 GHz) by setting the IF frequency of about 5.1 GHz. This is the unique

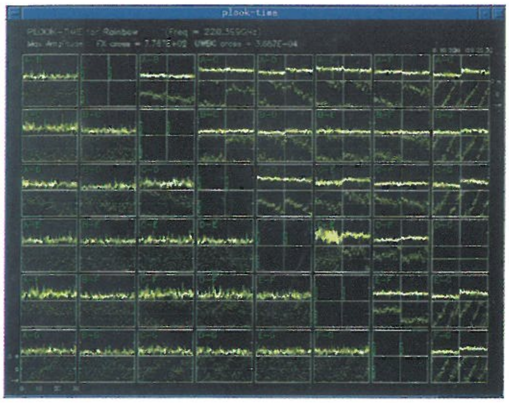

Fig. 2. The first fringe obtained from the 7 elements RAINBOW interferometer. The observing frequency was 220 GHz, and 21 cross correlations from each baseline are plotted; the upper panel of each box is the visibility amplitude, and the lower panel is the visibility phase as a function of correlator channel number. The upper right part displays the visibilities from the Ultra Wide-Band Correlator (UWBC) with a 1,024 MHz bandwidth, and the lower left group shows the 32 MHz bandwidth FX correlator. The visibilities labeled as "*−G" are from the 10–45 m baselines.

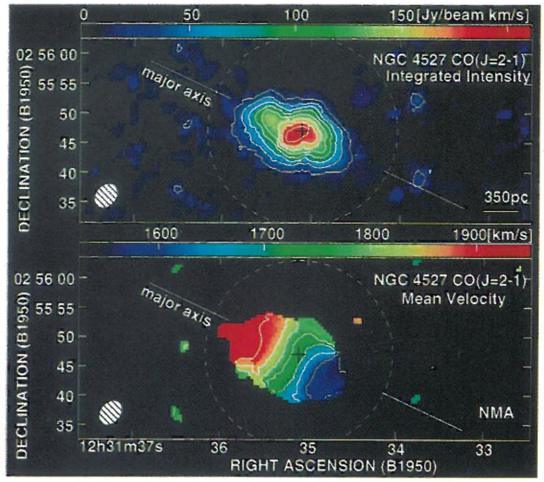

Fig. 3. The CO (J=2–1) maps of the starburst galaxy NGC 4527 observed with the 230 GHz receivers installed to the Nobeyama Millimeter Array. The integrated intensity map (top) and the intensity-weighted mean velocity map (bottom) are displayed. The dashed circle denotes the NMA field of view at 230 GHz (30″), and the left bottom ellipse shows the synthesized beam (4″.7×3″.6). The cross marks the center of the galaxy.

capability for the 230 GHz system of Nobeyama Millimeter Array and RAINBOW interferometer. The receiver noise temperatures of 230 GHz receivers for the NMA and the 45 m telescope are less than 60 K in DSB over the tunable frequency range, and mostly fall between 30 K and 50 K. These noise temperatures correspond to about $3\,h\nu/k$ and $5\,h\nu/k$, where $h\nu/k$ is the quantum limit of the heterodyne mixer receivers. The lowest noise temperature is about 20 K ($2\,h\nu/k$).

The aperture efficiencies of 10 m dishes and 45 m telescopes at 230 GHz band were determined to be about 0.3 and 0.1, respectively, by observations of Planets. In order to improve the efficiencies, further panel adjustments of reflector panels based on radio holography measurements will be performed in the autumn of 2000. It is also planned to replace mirrors and the sub-reflector of the 45 m telescope to improve the efficiency.

We have successfully made synthesis observations of CO (J=2–1) emission from three nearby starburst galaxies (NGC 3627, NGC 3628, and NGC 4527) in the course of test synthesis observations of the NMA at 230 GHz band. The first fringe with the RAINBOW interferometer was also obtained from the observations of the quasar 3C273. The open use observations of the NMA 230 GHz band will start in the observing period from November 2000.

Improvements of receiver performance, aperture efficiency, and pointing accuracy should be made, as well as the development of adoptive phase compensation method, to make more efficient operations of the array at 230 GHz band.

Reference

Shi, S. C., Noguchi, T., and Inatani, J.: 1997, *IEEE Trans. Appl. Superconductivity*, 7, 2587

Development of Thermal Model of ILOM Telescope

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Takaaki YOKOYAMA, Takahiro IWATA
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Table 1. Specifications of the ILOM telescope

Caliber	0.2 m
Focal length	2 m
Type	PZT
Resolving power	1″ (λ=500 nm)
Detector	CCD
Dimension of a pixel	9 μm×9 μm (0.8″×0.8″)
Number of pixels in array	4,096×4,096
Field of view	1o×1o
Integration time	<100 s
Magnitude of target stars	M<13
Final expected accuracy	0.001 of a pixel size (1 mas)

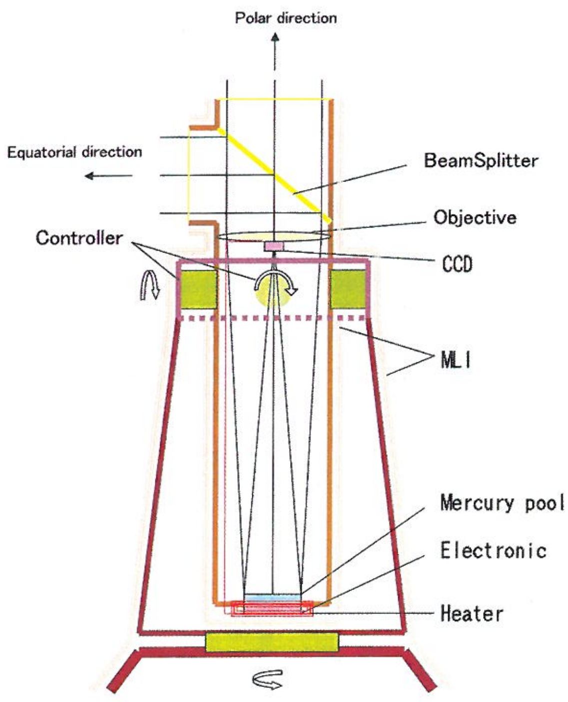


Fig. 1. Schematics of ILOM telescope.

We are proposing a selenodetic mission, *in-situ* Lunar Orientation Measurement (ILOM) in a post-SELENE project in order to study lunar rotational dynamics by direct observations of the lunar physical librations and the free librations from the lunar surface with an order of 1 milli-arc-second (1 mas) accuracy. The main component is a compact PZT (Photographic Zenith Tube), which is suitable for a positioning telescope on the moon since a mercury pool set at the middle point of the focal length compensates the tilt of the telescope caused by thermal expansion. It bears characteristics of a beam splitter for equatorial stars, a CCD camera, a deep mercury pool without copper amalgam, thermal control, three axes driving mechanism.

PZT has a horizontal reflection surface at the

Fig. 2. Thermal model of ILOM telescope.

middle point of its focal length in order to compensate a shift of focal point due to a tilt of the tube. It is anticipated that the compensation will not be perfect due to thermal expansion of the objectives, the tube and the mercury pool when the telescope is set on the lunar surface. We developed a thermal model in order to demonstrate the feasibility of the ILOM telescope with 1 mas accuracy under the critical environment of the lunar surface in cooperation with Iwate University and National Space Development Agency of Japan. The thermal model is composed of a CFRP tube of 200 mm diameter and 1,100 mm long, a slanting mirror, an optical parallel as objectives and a mirror as a mercury pool and thermal expansion and tilt generated by heaters put on the surface of the tube are measured by a laser interferometer and tiltmeters. Specifications of the ILOM telescope, Schematics of the telescope and a photograph of the thermal model are shown in Table 1, Figs. 1 and 2, respectively.

References

Takanezawa, T., Hanada, H., Tsuruta, S., Tsubokawa, T., Kono, Y., and ILOM research group: 1999, *22nd Int. Symp.*, "Space Technology and Science", **J-12**, 1–6

Kawachi, M., Funazaki, K., Takanezawa, T., Hanada, H., and ILOM group: 1999, *22nd Int. Symp.*, "Space Technology and Science", **J-26**, 1–6

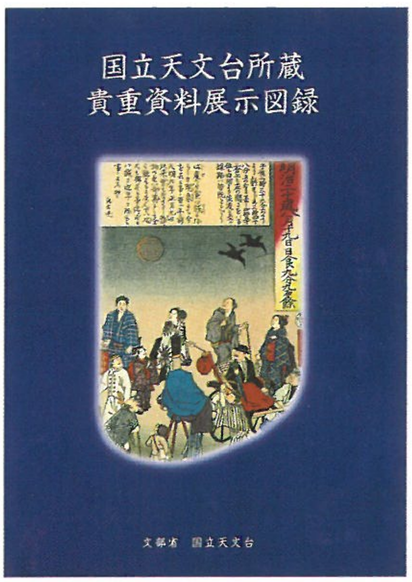
Yokoyama, T., Iwata, T., Hanada, H., Kawano, N., and Karoji, H.: 1999, *22nd Int. Symp.*, "Space Technology and Science", **J-10**, 1–6

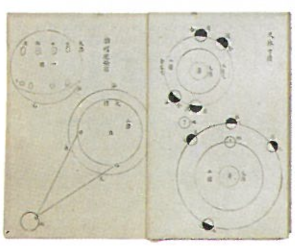
Hanada, H., Heki, H., Ooe, M., Matsumoto, H., Araki, H., Iwata, T., and ILOM research group: 1999, *22nd Int. Symp.*, "Space Technology and Science", **J-11**, 1–6

Publication of “Figures in Classics at the National Astronomical Observatory”

Setsuko ITO
(Public Relations Center·NAOJ)
Sakurako ICHIMURA
(The Library·NAOJ)

NAOJ has kept a number of volumes of precious and classic books collected by Astronomical Officer of the Tokugawa shogunate, which are called NAOJ classics. We copied some of them into microfilms so that researchers can refer them frequently and easily. The list of Classics is available through the Internet from the Library of NAOJ homepage (http://library.nao.ac.jp/). Since Nov. 16, 1991, we started their display one by one at the lobby of NAOJ MITAKA Administrative Building. The number of displays has amounted to 22. This time, we have arranged these 22 displays into a color monograph titled as above. The book contains 61 figures, their supplementary expanations, and their index as well as the index of the whole Classics.





Subaru First-Light Deep Photometry of Galaxies in A 851 Field

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Fumihide Iwamuro, Toshinori Maihara
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Satoshi Miyazaki
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Sadanori Okamura, Kazuhiro Shimasaku
(University of Tokyo)
Chris Simpson
(Subaru Telescope・NAOJ)

We report on the results of optical and near-infrared photometry of the cluster of galaxies A 851 (=Cl 0939+4713) carried out as one of the first-light observations of the 8.2 m Subaru telescope on Mauna Kea[1]. Images as sharp as 0.″3 FWHM in K' and 0.″45 in R were obtained in these observations. The 3σ limiting magnitudes for points sources in 0.″3 seeing with a 0.″6 software aperture were shown to go down to $R=28.1$, $J=25.1$, and $K'=24.0$, respectively, for about 1 hour integration. Subaru photometry of the galaxies in this cluster has shown in its color-magnitude diagrams a well-defined sequence of the early-type galaxy population that is consistent with the track predicted for a single-burst passive-evolution model of galaxies at $z=0.4$. We attempted a morphological classification of galaxies in the Subaru R-band image using the $C_{\rm in}$ method[2], and found that discrimination between ellipticals and spirals can be achieved fairly consistently with the types assigned by MORPHs on the HST F702W image down to $R<23$. A weak lensing analysis made on the Subaru R-band image yielded a reconstructed surface mass-density distribution that shows a significant maximum corresponding to the peaks of the smoothed luminosity distribution of cluster galaxies and of the X-ray distribution. We found no significant excess of faint and/or small galaxies in

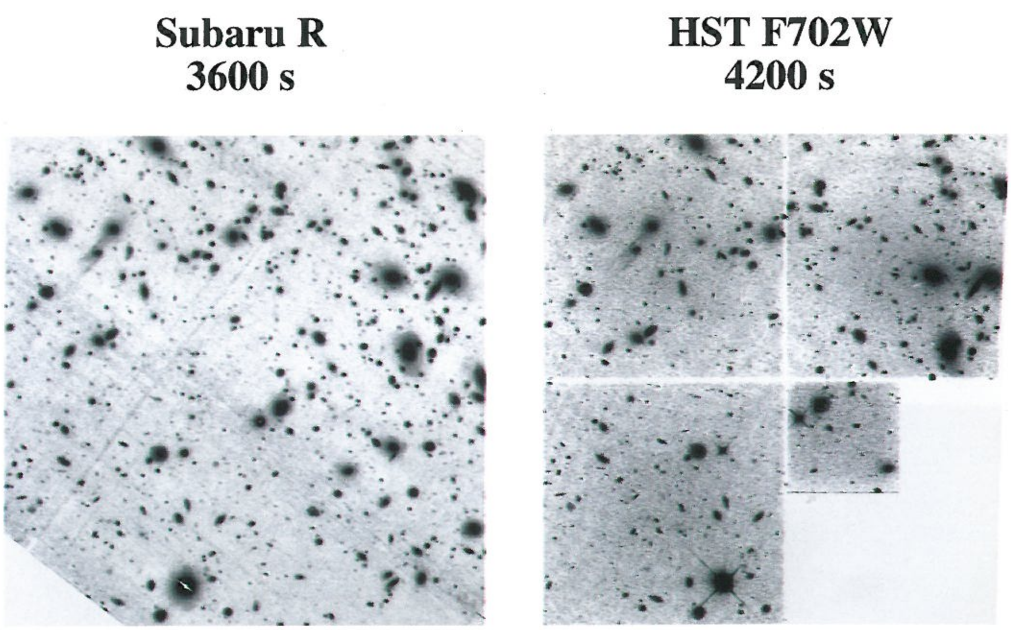

Fig. 1. Deep images of A851 obtained by Subaru (left) and by HST (right).

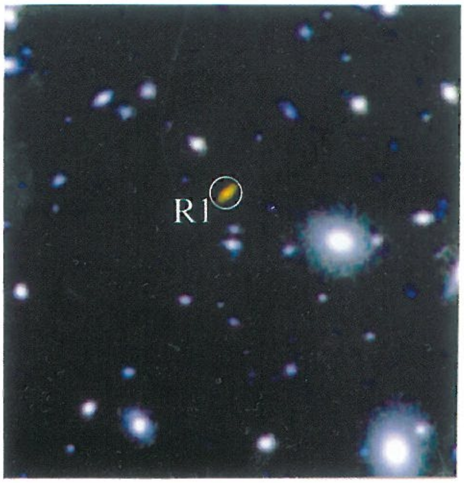

Fig. 2 Extremely red objbct R1 discovered in the A851 field.

the putative cluster area around the $z=2$ quasar and no difference in the colors for galaxies in this area from those in the main cluster either. Two extremely red objects (ERO) with $R-K>6$ are newly identified in the field. The colors of the reddest, disk-shaped galaxy R1 are found compatible with those of an unreddened E/S0 galaxy at $z=1.6$

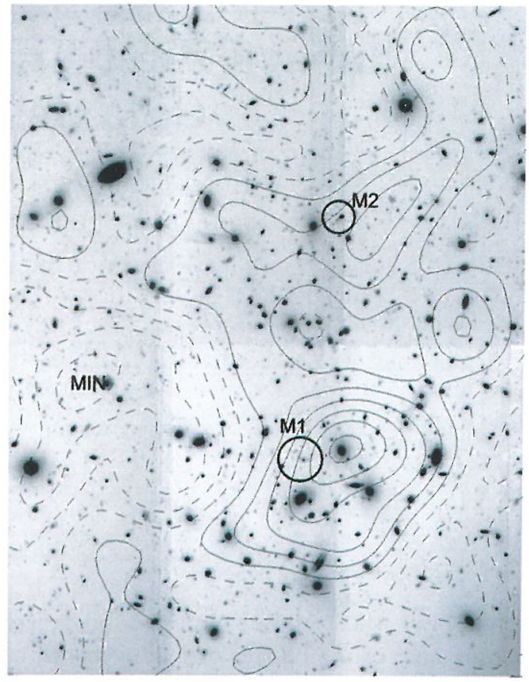

Fig. 3. Surface mass density contour reconstructed from weak lensing analysis of Subaru R-band image. M1 and M2 correspond to the X-ray peaks observed by ROSAT.

References

1) Iye, M., *et al.*: 2000, *Publ. Astron. Soc. Japan*, **52**, 9–23
2) Doi, M., Fukugita, M., and Okamura, S.: 1993, *Mon. Not. R. Astron. Soc.*, **264**, 832

Optical Identification of the ASCA Large Sky Survey

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Masaaki SAKANO (NASDA)
I. LEHMANN (Penn State University)
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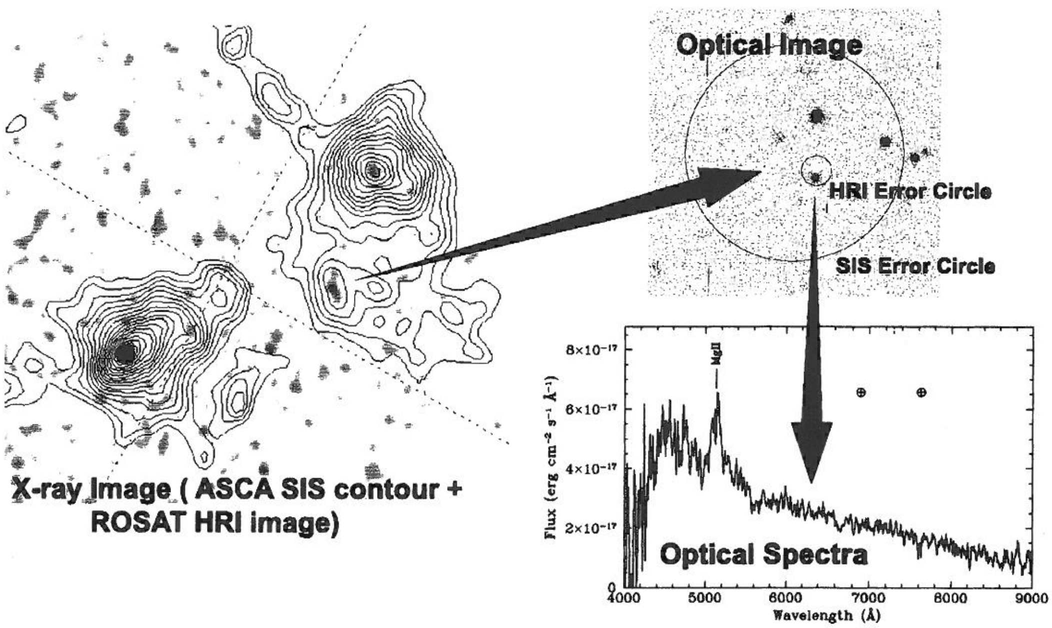

Fig. 1. An example of an identification of an X-ray source identified with a broad-line AGN at redshift of 0.834.

In order to reveal the origin of the cosmic X-ray background (CXB) in the hard X-ray band, we conducted a wide-area hard X-ray source survey with an X-ray satellite, ASCA (the ASCA Large Sky Survey, hereafter LSS). In a 5 square degree field near the north galactic pole, 34 X-ray sources were found in the hard 2–7 keV X-ray band. The flux limit of the survey is 100 times deeper than X-ray surveys before ASCA in the X-ray band, and 20–30% of the CXB in the hard band is resolved into a discrete sources.

To reveal nature and redshifts of these X-ray sources, we made optical photometric and spectroscopic observations at University of Hawaii 2 m telescope on Mauna Kea, Calar Alto 3.5 m telescope, and Mayall 4 m telescope on Kitt Peak National Observatory. The sources were identified with 30 active galactic nuclei (AGNs), two clusters of galaxies, and a galactic star (an example of an object identified with a broad-line AGN at redshift of 0.834 is shown in Fig. 1). Only one source is still unidentified. All of the X-ray sources that have a hard X-ray spectrum, were identified with narrow-line AGNs. It is a big mystery that the spectrum of the CXB is significantly harder than the typical spectra of non-absorbed broad-line AGNs, which dominate the flux of the CXB in the soft X-ray band. The identification of hard X-ray sources with narrow-line AGNs suggests that the hardness of the CXB is originate from the absorbed hard X-ray spectra of narrow-line AGNs.

The redshift-luminosity distribution of the ASCA LSS AGNs is shown in Figure 2. Although we found 15 non-absorbed broad-line AGNs in the high-redshift and high-luminosity region, we detect no absorbed narrow-line AGN in the region. Assuming that the number ratio of non-absorbed to absorbed AGNs do not depend on their intrinsic luminosity and red-

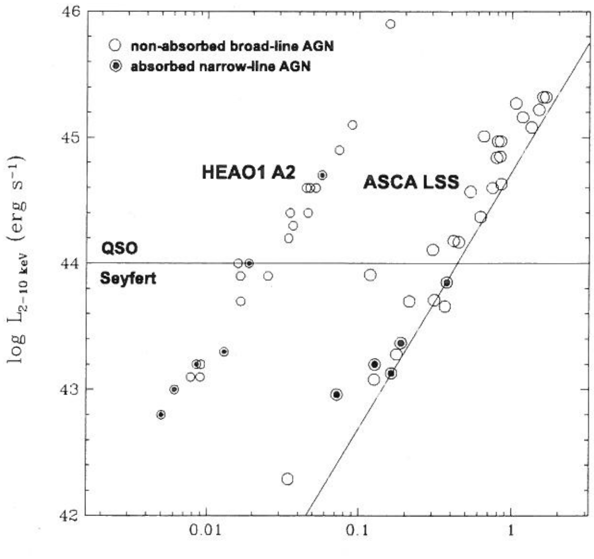

Fig. 2. Hard X-ray luminosity and redshift distribution of ASCA LSS AGNs (large marks). Absorbed AGNs are indicated with black dots. The solid line represent the detection limit of the ASCA Large Sky Survey for broad-line AGNs.
Small marks indicate the distribution of AGNs found in the HEAO1 A2 survey.

shifts, we expect to detect 10 absorbed narrow-line AGNs in the high-redshift and high-luminosity range, even if we consider the effect of absorption. Therefore, the non-detection of an high-redshift and high-luminous absorbed narrow-line AGN suggests that the number ratio changes with intrinsic luminosity and/or redshift. Comparison with the redshift-luminosity distribution of the shallower HEAO1 A2 AGN sample (see the small marks in Fig. 2) supports the luminosity dependence of the number ratio. The deficiency of absorbed luminous AGNs is explained by scenarios, such as absorbing matter around luminous AGN is destroyed by its radiation, or swept away by its radiation pressure.

We are now conducting optical follow-up observations for a shallower but much wider area survey with ASCA (ASCA Medium Sensitivity Survey). We also have plans to do deeper surveys with Chandra and XMM-Newton satellites and optical follow-up observations with Subaru telescope. Combining these results, we will reveal the cosmological evolution of the non-absorbed broad-line AGNs and absorbed narrow-line AGNs, separately, which should reflect the evolution of the internal structures of AGNs from their appearance to the nearby universe.

Reference

Akiyama, M. et al.: 2000, *Astrophys. J.*, **532**, 700–727

Analysis of Galaxy Counts in the Subaru Deep Field

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The Subaru Deep Field (SDF, Maihara et al. 2000) is one of the deepest image of the universe in the near-infrared wavebands, and we have performed a detailed analysis on the galaxy counts observed in this field in comparison with theoretical models. Here we report the summary of this study as well as the result of the analysis on the deepest image in the optical bands, i.e., the Hubble Deep Field (HDF).

It is well known that the galaxy counts include the information of the most distant galaxies and it is one of the most important data to study the geometry of the universe and galaxy formation or evolution processes. Especially, the K band where the SDF image has been obtained is known as a useful band because uncertainty of galaxy evolution is smaller than that in the optical bands. On the other hand, there are many processes which affect the galaxy counts, and selection effects by the cosmological dimming of surface brightness against high-redshift galaxies is very important. Therefore, a very careful and comprehensive analysis is required. We have performed a high precision analysis keeping these affairs in mind.

The standard cosmological model is now a Λ-dominated flat universe. In fact, our analysis on HDF galaxy counts and redshift distributions strongly favors this cosmological model (Totani & Yoshii 2000). In this universe, we found that the SDF counts, size and color distributions are well explained by a simple pure-luminosity-evolution model without number evolution of galaxies. Therefore, the combination of HDF and SDF data gives a strong constraint on the number evolution of elliptical galaxies which dominate the SDF galaxies in number. It is in contrast that the HDF galaxies which are dominated by late-type galaxies require some level of number evolution.

One very interesting result is an implication on the extragalactic background light (EBL). Generally the integration of galaxy counts gives a lower limit for the EBL, but when the slope of the N-m relation is flat, the extrapolation of count integration is convergent and it can be considered as a measurement rather than a lower limit. The previous reports of K-band counts have shown considerable dispersion, but the SDF most clearly shows this convergent trend. We also carefully checked the possible contribution of galaxies which may have been missed in the survey because of the selection effects, and found that such missing galaxies are unlikely to change the above conclusion. Therefore, it can be said that the Subaru already resolved the bulk of K-band EBL into discrete galaxies. On the other hand, recent direct measurements of the K-band EBL suggest that the EBL flux is higher than the SDF count integration by a factor of several, and it has raised an interesting mystery about the origin of EBL.

In the future, various follow-up observations will

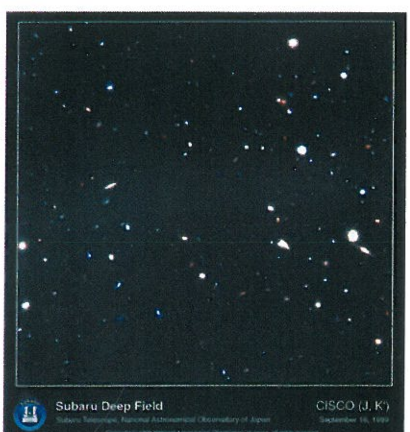

Fig. 1. Image of the Subaru Deep Field.

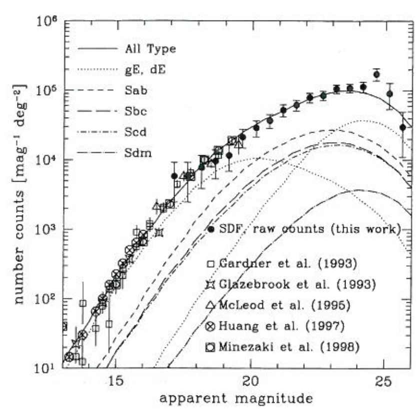

Fig. 2. K-band galaxy counts observed in the Subaru Deep Field and fitting by a theoretical model.

be done in the SDF, and especially redshift distributions and morphological information by adaptive optics are desirable. We have made some predictions for such future observations, and hope to derive further strong scientific results in the future.

References

Maihara et al.: 2000, *Puble. Astran. Soc. Japan,* submitted

Totani, T., and Yoshii, Y.: 2000, *Astrophys. J.,* in press (Sep. issue)

VSOP Revealed the Plasma Cocoon around a Radio Galaxy OQ 208

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The Seyfert galaxy Mkn 668 at $z=0.0768$ hosts a strong radio source OQ 208, to be also classified as a radio galaxy. The small separation (~10 pc) of the double lobe implies that OQ 208 is at a young stage (~10^{-3} yr) of evolution. This object can be a important probe to clarify how does a radio galaxy evolve at the initial stage. It shows a convex radio spectrum peaked at ~3 GHz. So far, the low-frequency cut off has been considered to be due to synchrotron self-absorption (SSA).

We have observed OQ 208 with the VSOP (VLBI Space Observatory Programme) at 1.6 GHz. The image (Fig. 1) shows a double lobe separated in the north-east to south-west direction by 7 mas (10 pc). The radio spectra for the lobes (Fig. 2) indicate that the double lobe becomes more asymmetric at lower frequencies. The cut off below 3 GHz in the SW lobe is too steep to be attained by SSA. A possible explanation is that cold (T_e~10^5 K) dense (N_e~10^5 cm^{-3}) plasma around the lobe like a cocoon causes free-free absorption (FFA). The asymmetry between two lobes is due to the slant jet axis from the line of sight, which results in difference of path lengths in the FFA absorber.

Our result showed that the lobe of OQ 208 may be smothered in the cocoon. We have later observed another 9 young radio sources, for the purpose of verification, to obtain in supporting results.

References

Kameno, S., Horiuchi, S., Shen, Z.-Q., Inoue, M., Kobayashi, H., Hirabayashi, H., and Murata, Y.: 2000, *Publ. Astron. Soc. Japan,* **52**, 209–216

Kameno, S., Horiuchi, S., Inoue, M., and Hirabayashi, H.: 2000, *Adv. Space Res.,* **26**, 705–708

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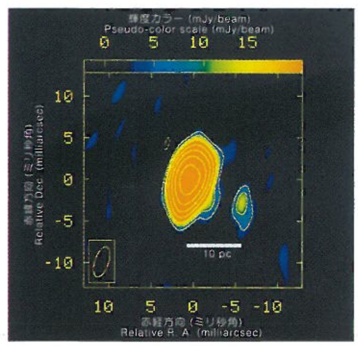

Fig. 1. A radio image of OQ 208 taken b: the VSOP. Two lobes are separated in the NE–SW direction by 10 pc. The SW lobe is ~1/60 times as faint as the NE lobe.

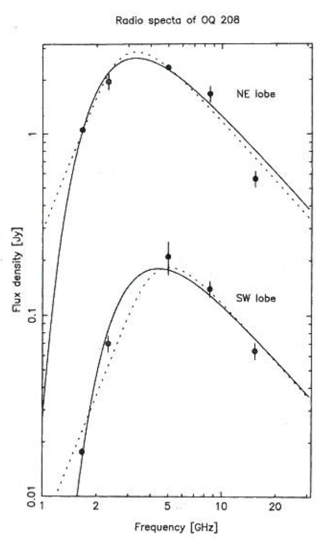

Fig. 2. Radio spectra of two lobes in OQ 208. Free-free absorption model (solid line) better fits to the observed flux densities than synchrotron self-absorption model (dashed line) does, especially at low-frequencies for the SW lobe.

Measurement of Galaxy Distance by Observing a Maser Disk around a Massive Black Hole

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The accurate measurement of extragalactic distances is a central challenge of modern astronomy, being required for any realistic description of the age, geometry and fate of the Universe. The measurement of relative extragalactic distances has become fairly routine, but estimates of absolute distances are rare. In the vicinity of the Sun, direct geometric techniques for obtaining absolute distances, such as orbital parallax, are feasible, but such techniques have hitherto been difficult to apply to other galaxies. As a result, uncertainties in the expansion rate and age of the Universe are dominated by uncertainties in the absolute calibration of the extragalactic distance ladder. We directly determined the distance to a LINER/Seyfert 2 NGC4258 by observing a H_2O-masering compact ($r_{in}=0.16$ pc) disk circulary rotating around a massive (3.9×10^7 Mo) black hole with a rotating speed of 1080 km/s (Miyoshi et al. 1995). The observations of the maser emission were made from 1994 to 1997 with VLBA. We determined the distance by two methods; 1) comparing the apparent (4.7 mas) and linear (0.16 pc) size of the inner radius of the disk (0.16 pc) determined from the measured secular drift (9.3 ± 0.3 km/s) of the line of sight velocity, and 2) measuring the proper motion of the maser spots ($31.5\pm1\,\mu$as). The two distances well conincides each other and we get 7.2 ± 0.3 Mpc which is the most precise absolute extragalactic distance yet measured and is likely to play an important role in future distance-scale calibrations.

Reference

Herrnstein, J. R., Moran, J. M., Greenhill, L. J., Diamond, P. J., Inoue, M., Nakai, N., Miyoshi, M., Henkel, C., and Riess A.: 1999, *Nature*, **400**, 539

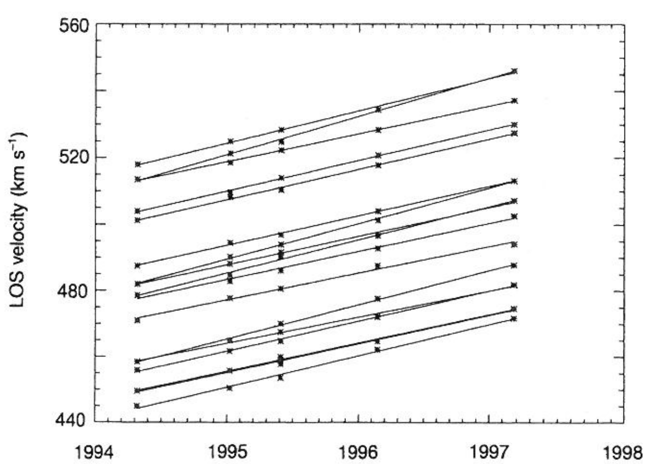

Fig. 1. Secular drift of the systemic maser fatures.

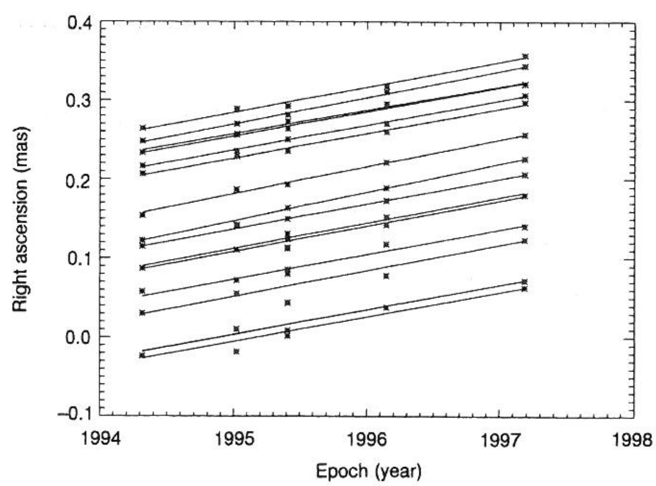

Fig. 2. Proper motion of the maser spots.

Statistical Study of Gas-transport in Spiral Galaxies

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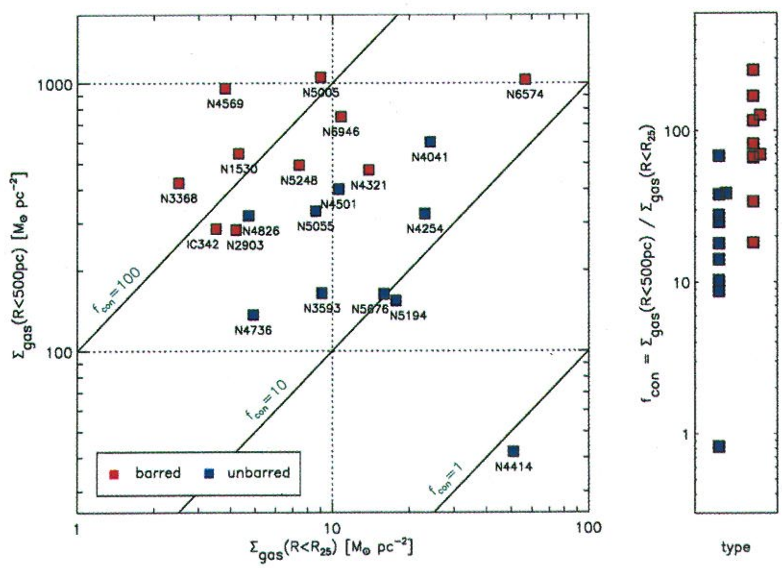
Stellar bars in spiral galaxies have long been believed to transport interstellar gas to galactic center [1]. This gas-transport has been regarded as a trigger to active phenomena in galactic centers such as starburst [2]. Furthermore, recent theoretical studies predict that the gas transport, which redistributes mass within galaxies, would cause secular morphological evolution of disk galaxies through distraction of bars and growth of bulges [3]. We need to statistically study the relation between stellar bars and gas distribution in disk galaxies in order to shed more light on these predictions on the gas transport and evolution of galaxies.

We used Nobeyama and Owens-Valley millimeter-wave interferometers to observe molecular gas in the central regions of 20 nearby spiral galaxies [4]. We measured the degree of gas concentration in each galaxy by combining our data with single-dish observations of the disks of the galaxies. The degree of gas concentration is then compared to the bar property of each galaxy. We discovered that molecular gas is more highly concentrated to the center in galaxies with prominent bars than in galaxies without such bars (see Figure below). This means that bars are indeed effective in radially transporting gas in spiral galaxies, and that more than half of the gas at the center of barred galaxies were transported there from outside by bars. The correlation, along with the estimated rates of gas consumption due to star formation, also sets a limit on the timescale of possible bar dissolution.

The present study is the first one that statistically proved a correlation between global gas distribution in galaxies with their bar properties. It is getting clearer from such studies that disk galaxies are evolving systems with large amount of gas being transported within them by the action of bars. Although it took us almost 10 years to collect the data of 20 galaxies, recent progress of radio telescopes and forthcoming powerful instruments such as LMSA/ALMA will soon enable us extensive statistical study with a much larger sample.

References

[1] Matsuda, T. & Nelson, A. H. 1977, *Nature*, **266**, 608
[2] Ishizuki, S. et al. 1990, *Nature*, **344**, 224
[3] Norman, C., Hasan, H. & Sellwood, J. A. 1996, *Astrophys. J.*, **462**, 114
[4] Sakamoto, K., Okumura, S. K., Ishizuki, S., and Scoville, N. Z. 1999, *Astrophys. J. Suppl.*, **124**, 403
[5] Sakamoto, K., Okumura, S. K., Ishizuki, S., and Scoville, N. Z. 1999, *Astrophys. J.*, **525**, 691



Degree of gas concentration is measured in barred (red) and unbarred (blue) galaxies.
(left) Mean surface density of molecular gas in galactic disk (abscissa) is compared to the mean surface density of molecular gas in the central kiloparsec (ordinate). Gas is more concentrated toward the center in galaxies to the upper-left of the plot.
(right) Ratio of the two surface densities. Galaxies with higher gas concentration are on the upper part of the plot.
It is evident that barred galaxies have higher degrees of gas con- centration than unbarred galaxies.
A Kolmogorov-Smirnov test pro- ved that the difference is stati- stically significant.

Spectroscopic Observation of NGC 6240 with CISCO and Subaru Telescope

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NGC 6240 is a luminous infrared galaxy (LIG) at a distance of 98 Mpc. It consists of two merging galaxies (northern and southern nuclei), and is very famous for its unusually luminous molecular hydrogen (H_2) emission at 2.1 μm. LIGs often show strong H_2 emission as a result of AGNs (Active Galactic Nuclei) and/or the burst of star formation. However, in the case of NGC 6240, such mechanisms cannot explain the huge H_2 luminosity, and the global shock driven by the galaxy-galaxy collision between the two nuclei is believed to be a main energy source.

We performed K-band spectroscopic observation of NGC 6240 with CISCO attached to the Cassegrain focus of Subaru Telescope. The strong H_2 emission is detected over about 3.3 kpc region around the two nuclei. We found the following properties: The peak position of H_2 emission is located at slightly south of the midpoint between the two nuclei, and this position corresponds spatially to the midpoint between the molecular gas concentration and the southern nucleus. Based on the line-ratio analyses, the excitation mechanism of H_2 is found to be pure thermal at most positions. The H_2 velocity field shows the following three components: a blue-shifted component (~ -250 km s with respect to V_{sys}), which is recognized as a distinct "C"-shape distortion in the velocity field around the southern nucleus; a high-velocity blue-shifted "wing" component (~ -1000 km s^{-1} with respect to V_{sys}); and a component indicating possible line splitting of ~ 500 km s^{-1}. These complex velocity structures are difficult to be explained by a simple galaxy rotation curve. Rather, we show that these properties can be reproduced by the strong shock between the interstellar medium and the expanding shell-like structure around the southern nucleus. In this model, the "C"-like feature forms because the red-shifted part of the emission suffers from heavy dust extinction around the southern nucleus. However, around the southern part of the southern nucleus, we can see both blue- and red-shifted emission components because of the smaller extinction. This kind of large-scale expanding structure with strong shocks can be naturally explained

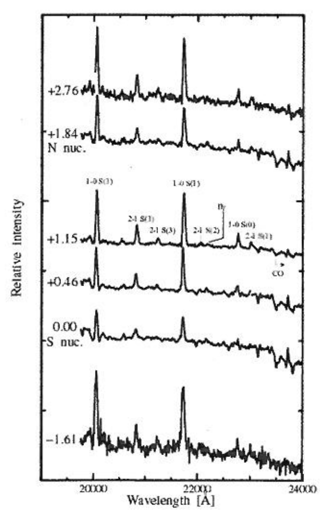

Fig. 1. K-band spectra around the two nuclei (S nuc. and N nuc.). Relative positions along the slit are shown at each spectrum in units of arcsec.

by the "superwind", which is the galaxy-scale outflow of the ionized gas driven by kinetic energy released from numerous supernova explosions at the nucleus. Since a large amount of molecular gas is located between the two nuclei as a result of the dynamical effect of the merging, the superwind expands non-symmetrically, and the strong shock-excited H_2 emission with higher-than-usual efficiency is emitted at the interface between the superwind and the intergalactic gas.

Our new superwind model is essentially different from the current standard model of the global shock driven by galaxy-galaxy collision. It is now clear that the superwind activity plays an important role to produce unusually strong H_2 emission. These findings were made possible with the much higher sensitivity and the spatial resolution of CISCO and Subaru Telescope.

Reference

Ohyama, Y. et al.; 2000, *Publ. Astron. Soc. Japan,* **52**, 1

Evolution of Beryllium and Boron in the Inhomogeneous Early Galaxy

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A model of supernova-driven chemical evolution of the Galactic halo, recently proposed by Tsujimoto, Shigeyama, & Yoshii (1999, ApJL, 519, 63), is extended in order to investigate the evolution of light elements such as Be and B (BeB), which are produced mainly through spallative reactions with Galactic cosmic rays (GCRs). In this model each supernova (SN) sweeps up the surrounding interstellar gas into a dense shell and directly enriches it with ejecta which consist of heavy elements produced in each Type II supernova with different progenitor masses. We propose a two-component source for GCRs such that {\it both} interstellar gas and fresh SN ejecta engulfed in the shell are accelerated by the shock wave. The released GCRs travel much faster than the expansion of the shell, and thus produce the BeB elements far outside the shell which will be incorporated in subsequent formation of shells arising from later SNe. As a result, stars formed from coeval shells are predicted to show a large scatter in the abundance of heavy elements, while exhibiting BeB abundances similar to that in the gas, with no appreciable scatter. This indicates that, contrary to heavy elements, stellar BeB abundances might be used as a good age indicator in the inhomogeneous Galactic halo.

The production of BeB at early epochs is dominated by the primary process through spallation of heavy GCRs, though being a minor component in the bulk of the GCR composition at present. We have calculated the frequency distribution of long-lived stars in the log (BeB/H)-[Fe/H] plane and find that the contour of constant frequency covering a range of $-3<[Fe/H]<-1$ in this plane is consistent with the observed linear trend between BeB and Fe. We show from our calculations that there is an intri guing possibility of distinguishing between standard and non-standard Big-Bang nucleosynthesis models if BeB abundances in several hundred halo stars are observed in the future.

Reference

Suzuki, T. K., Yoshii, Y., and Kajino, T.: 1999, *Astrophys. J. Lett.* **522**, L125–128

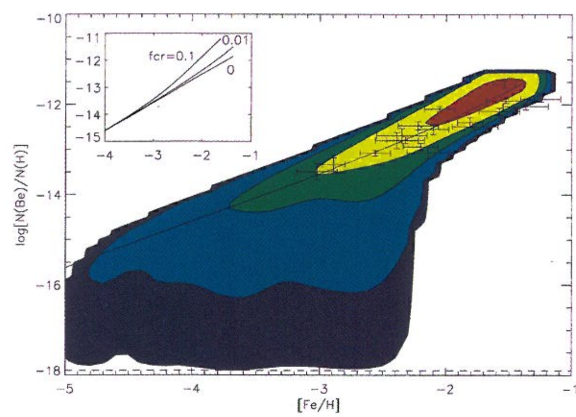

Fig. Color-coded frequency distribution of long-lived stars in the log (Be/H)−[Fe/H] plane, convolved with a Gaussian having\sigma=0.15 dex for both log(Be/H) and [Fe/H]. The primorial Be abundance is taken from the SBBN model, and is indicated by the dashed line. The five contour lines, from the inside to the outside, correspond to those of constant probability density 10^{-2}, 10^{-3}, 10^{-4}, 10^{-6}, and 10^{-8} in unit area of\Delta [Fe/H]=0.1\times\Deltalog (Be/H)=0.1. The thick line shows the log(Be/H)−[Fe/H] relation for the gas for our standard choice of fcr=0.01; the lines in the inset show those for various values of fcr. The crosses represent the data with observational errors taken from Boesgaard *et al.* (1999).

Structure and Evolution of the Galactic Halo

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The chemical compositions of long-lived stars provide us clues for the enrichment history of our Galaxy. Recent observations of metal-poor halo stars show intrinsic large dispersions in chemical abundances, especially for neutron-capture elements (Fig. 1). These dispersions may indicate that the interstellar medium (ISM) was not mixed well at the very early epoch. These facts imply that the heavy elements in metal-poor stars come from a few supernovae. If star formations are induced by supernova explosions, newly formed stars should contain the supernova products as well as metals in the ISM. With this assumption, we construct a new chemical evolution model of our Galaxy, and aim to understand the star formation history of our Galaxy at the beginning.

We assume star formations are induced by each supernova. Chemical compositions of newly formed stars are obtained by mass average of the 'snow-plowed' ISM and the supernova products. The chemical evolution of the ISM is calculated by a 1-zone model, losing gas through accretion onto the disk. We set the mass range of SNII progenitors as 8–$60M_\odot$, but stars of 8–$10M_\odot$ are assumed to produce no iron. Neutron-capture elements are produced by r-, main s-, or weak s-processes. R-elements are primary and are supposed to be produced by SNII, whereas s-elements are produced in AGB stars or SNII as secondary. The stellar mass ranges for the sites of each process are regarded as parameters. The masses of produced r-elements are assumed to be constant, regardless of progenitor mass.

Eu is regarded as a representative of r-process. Major candidates for r-process sites are 1) prompt shock of SNII of 8–$10M_\odot$ with O-Ne-Mg cores and 2) neutrino winds of SNII by massive stars$>10M_\odot$. Thus in models, masses of r-process sites are assumed as SNII of a) 8–$10M_\odot$, b) $\geq 30M_\odot$ and c) $\geq 10M_\odot$. As shown in Fig. 2, the case a) can explain well the enhancement of Eu. This trend can be also seen in the case b). In case of lower mass SNII, increases of [Eu/Fe] with [Fe/H] also appears. In future observations, if such low [Eu/Fe] stars are detected, we can determine the r-process site. On the other hand, all SNII produce Eu with similar yields as in the case c), high [Eu/Fe] cannot be reproduced. In conclusion, the observed dispersions indicate that star formations are induced by SN explosions. In this case, the r-process site should be in SNII 1) which produces less Fe (a), or 2) whose number fraction is enough small (b).

To summarize, we have constructed an inhomogeneous enrichment model ofthe Galactic Halo. The observed ~300-fold dispersions in chemical abundances of metal-poor stars are explained by star formations inducedby supernova explosions. Comparing the model predictions with observations, we have shown that r-elements must be produced by supernova of 8–$10M_\odot$ or $\geq 30M_\odot$ stars.

* Present position: Sophia University

Reference

Ishimaru, Y., and Wanajo, S.: 1999, *Astrophys. J.*, **511**, L33

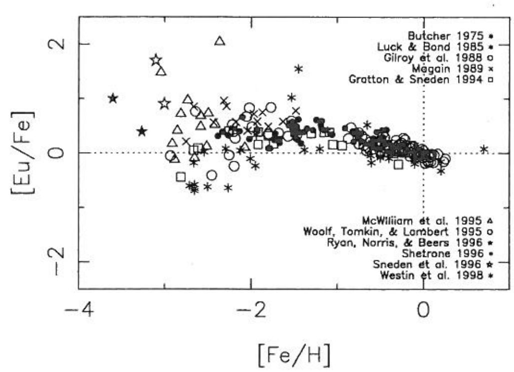

Fig. 1. Observational Data of [Eu/Fe] vs. [Fe/H] Relation.

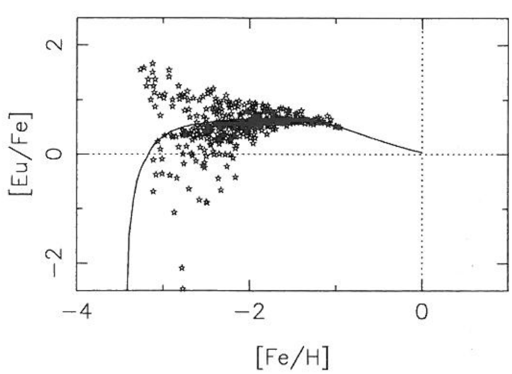

Fig. 2. Predicted [Eu/Fe] vs. [Fe/H] Relation.

Detection of Lead in an s-Process-rich Very Metal Poor Star

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We report the detection of the Pb I 4057.8Å line in the very metal-poor ([Fe/H]$=-2.7$), carbon-rich star, LP 625-44. We determine the abundance of Pb ([Pb/Fe]$=2.65$) and 15 other neutron-capture elements. The abundance pattern between Ba and Pb agrees well with a scaled solar system *s*-process component, while the lighter elements (Sr–Zr) are less abundant than Ba. The enhancement of *s*-process elements is interpreted as a result of mass transfer in a binary system from a previous AGB companion, an interpretation strongly supported by radial velocity variations of this system.

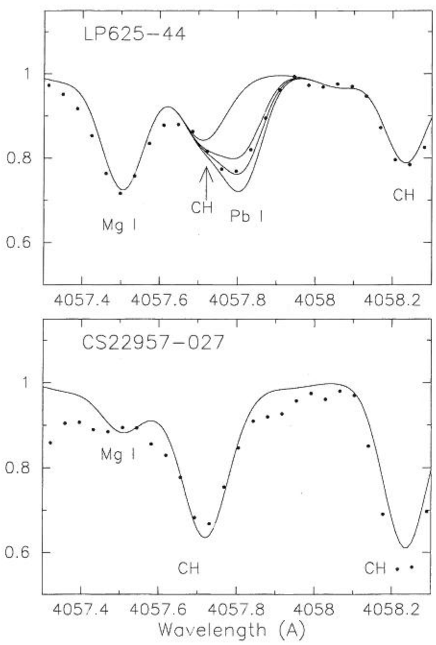

Fig. 1. Comparison of the observed (dots) and synthetic (lines) spectra near Pb I 4057.8Å. In the upper panel, LP 625–44 is shown along with the four synthetic spectra for [Pb/Fe]$=0.0$, 2.35, 2.65 and 2.95. The atomic and molecular species that strongly contribute to the absorption are also labelled. For comparison, and for a check on possible contamination from molecular lines, the spectrum of CS 22957–027, and the synthetic spectrum for [Pb/Fe]$=0.0$ are shown in the lower panel.

The detection of Pb makes it possible, for the first time, to compare model predictions of *s*-process nucleosynthesis in AGB stars with observations of elements between Sr and Pb. The Pb abundance is significantly *lower* than the prediction of recent models (Gallino *et al.*), which succeeded in explaining the metallicity dependence of the abundance ratios of light *s*-elements (Sr-Zr) to heavy ones (Ba-Dy) found in previously observed *s*-process-enhanced stars. This suggests that one should either (a) reconsider the underlying assumptions concerning the ^{13}C-rich *s*-processing site (^{13}C-pocket) in the present models, or (b) investigate alternative sites of *s*-process nucleosynthesis in very metal-poor AGB stars.

References

1) Aoki, W., Norris, J. E., Ryan, S. G., Beers, T. C., Ando H.: 2000, *Astrophys. J.*, **536**, L97
2) Gallino R., Arlandini, C., Busso, M., Lugaro, M., Travaglio, C., Straniero, O., Chieffi, A., Limongi, M.: 1998, *Astrophys. J.*, **497**, 388

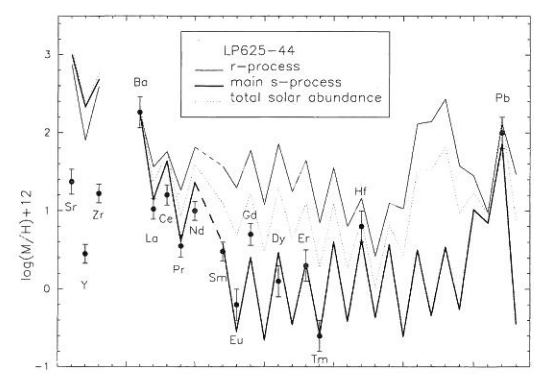

Fig. 2. The abundances of heavy elements as a function of atomic species for LP 625-44. The thick solid line indicates the main *s*-process component, while the thin line indicates the r-process component. The dotted line represents the total solar abundance. All abundance patterns are normalized to the observed Ba abundance of LP 625–44.

New Nuclear Reaction Flow towards r-Process Nucleosynthesis in Supernovae: A Critical Role of the Light Neutron-Rich Nuclei $1 \leq Z \leq 10$

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G. MATHEWS
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We study the role of light neutron rich nuclei in r-process nucleosynthesis in supernovae. Most previous studies of the r-process elements have concentrated on heavy unstable nuclei. Although the nuclear reaction network included a few thousand heavy nuclei, only limited reaction flow through low-mass nuclei near stability has been used. However, in neutrino-driven winds, the initial condition is a high-entropy hot plasma consisting of neutrons, protons, and electron-positron pairs experiencing an intense flux of neutrinos. Light-mass nuclei as well as heavy nuclei are expected to play important roles in the production of seed nuclei and r-process elements. Thus, we have extend the nuclear reaction network up to the neutron drip line for $Z \leq 10$, and connected it with the larger network for $Z \geq 10$. In the present nucleosynthesis study, we adopt a wind model of massive SNeII explosion to study the effects of this extended network. We find that a new nuclear-reaction flow path opens in the very light neutron-rich region. This new nuclear reaction flow can change the final heavy-element abundances by as much as one order of magnitude. (This is the abstract of a refrence [3].)

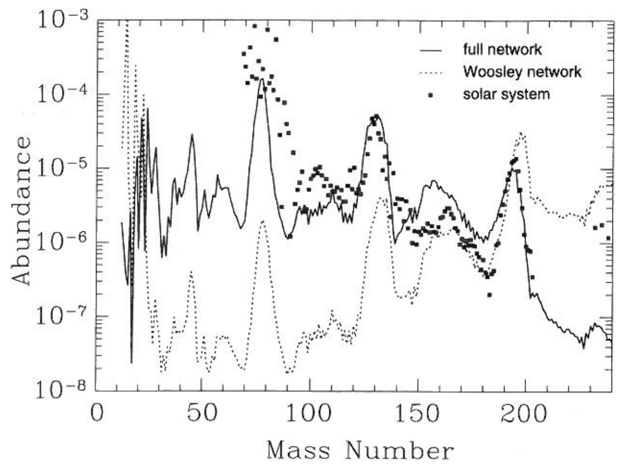

Fig. 1. Final abundances as a function of mass number in the present r-process calculations. The solid line is the result obtained by using "full network" and the dotted line comes from using the "small network". Data points are solar systems r-process abundances in arbitrary unit from Käppeler *et al.* (1989).

References

1) Woosley, S. E., Wilson, J. R., Mathews, G. J., Hoffman, R. D., and Meyer, B. S.: 1994 *Astrophys. J.* **433**, 229
2) Qian, Y.-Z., Haxton, W. C., Langanke, K., and Vogel, P.: 1997 *Phys. Rev.* **C55**, 1533
3) Terasawa, M., Sumiyoshi, K., Kajino, T., Tanihata, I., and Mathews, G. J: in preparation
4) Sumiyoshi, K., Suzuki, H., Otshuki, K., Terasawa, M., and Yamada, S.: 2000 *Publ. Astron. Soc. Japan,* **52-4.**
5) Käppeler, F., Beer, H., and Wisshak, K.: 1989, *Rep. Prog. Phys.,* **52**, 945

High-Energy Neutrinos from Gamma-Ray Bursts and Magnetars

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Gamma-ray bursts (GRBs) are presumed to be powered by still unknown central engines for the time-scales in the range 1 ms~a few seconds. We propose that the GRB central engines would be a viable site for strong meson synchrotron emission if they were the compact astrophysical objects such as neutron stars or rotating black holes with extremely strong magnetic fields $H \sim 10^{12}$–10^{17} G and if protons or heavy nuclei were accelerated to ultra-relativistic energies of order $\sim 10^{12}$–10^{22} eV. We show that the charged scalar mesons like $\pi^{\pm}$ and heavy vector mesons-like ρ, which have several decay modes onto $\pi^{\pm}$, could be emitted with high intensity a thousand times larger than photons through strong couplings to ultra-relativistic nucleons. These meson synchrotron emission processes eventually produce a burst of very high-energy cosmic neutrinos with $10^{12}\,\mathrm{eV} \leq E_\nu$. These neutrinos are to be detected during the early time duration of short GRBs.

A heavy meson, Υ which consists of $b\bar{b}$ quarks, could be also produced by meson synchrotron radiation. Υ has a considerable decay branching ratio into $\tau^{\pm}$, which subsequently decays into neutrinos. We calculated the spectra of τ and μ neutrinos, taking into account the effect of energy loss of parent charged leptons ($\tau^{\pm}$, $\mu^{\pm}$). The spectrum of τ neutrinos was found to be harder than that of μ neutrinos, reflecting the shorter decay life of τ. We proposed that the difference in the spectra between τ and μ neutrinos could be a signature that the meson synchrotron radiation actually takes place.

We have also estimated the intensity of high energy neutrinos from giant bursts of SGR based on some assumptions for simplification, and showed that if the burster is located at $\sim$1 kpc from the Earth, a few tens of high energy neutrinos per burst might be observed by a typical ground based neutrino detector with the detection probability being taken into account.

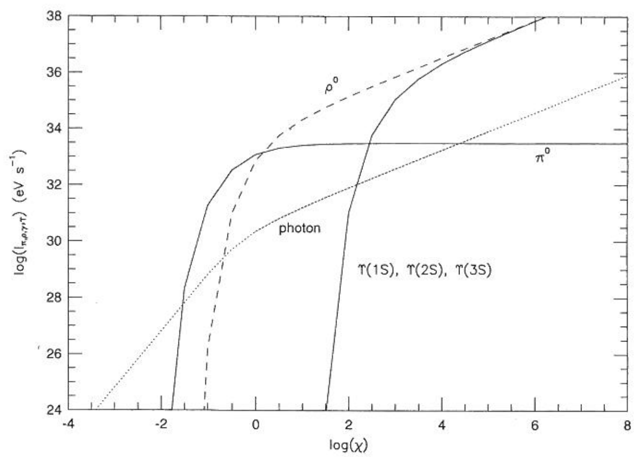

Fig. 1. Calculated total intensities, I, of the synchrotron emission of vector photon (dot), scalar π^0 meson (solid), vector ρ^0 meson (dash), and vector Υ (thick solid) as a function of the synchrotron parameter x. $x = H/H_0 E/M_p$, where H is the field strength of the magnetic field in units of $H_0 = 1.5 \times 10^{20}\,G$, and E is the proton energy in units of $M_p c^2 = 938\,MeV$.

We conclude that the meson synchrotron radiation is an important process in astrophysical sites where strong magnetic fields and high energy hadrons coexist.

References

Tokuhisa, A., and Kajino, T.: 1999, *Astrophys. J.*, **525**, L117–L120

Tokuhisa, A., and Kajino, T.: 2000, *Astrophys. J.*, submitted

r-Process Nucleosynthesis and Neutrino Process in Supernovae

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The r-process is a neutron-capture process to produce elements heavier than iron. The r-process elements are presumed to be produced in an explosive environment. Unfortunately, however, astrophysical site of the r-process nucleosynthesis has been poorly known, although several candidate sites are proposed and being investigated theoretically. Neutrino-driven wind from young hot neutron star, which is formed by supernova explosion, is one of promising candidate for r-process nucleosynthesis.

Although there are several numerical simulations of the neutrino-driven wind, results are very different from one another, depending on models and methods adopted in literature. A numerical simulation by Woosley *et al.* can successfully explain the solar system r-process abundances, but the others can not reproduce their result because of shortage of entropy.

We use spherical symmetry steady state flow in Schwarzschild geometry as simple model of neutrino-driven wind. Exploring wide parameter region which determines the expansion dynamics of the wind (Figure 1), we find interesting physical conditions which lead to successful r-process nucleosynthesis. The conditions which we found realize in the neutrino-driven wind with very short dynamic time scale $\tau_{dyn} \sim 7$ ms and relatively low entropy $S \sim 140$. We carry out r-process nucleosynthesis calculation on these conditions and confirm quantitatively that the second and third r-process abundance peaks are produced in the neutrino-driven wind (Fig. 2).

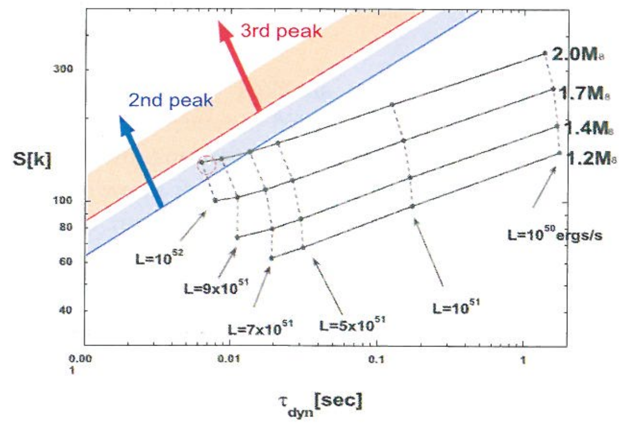

Fig. 1. Relation between entropy per baryon S and dynamic time scale τ_{dyn} for various combinations of the neutron star mass and the neutrino luminosity.

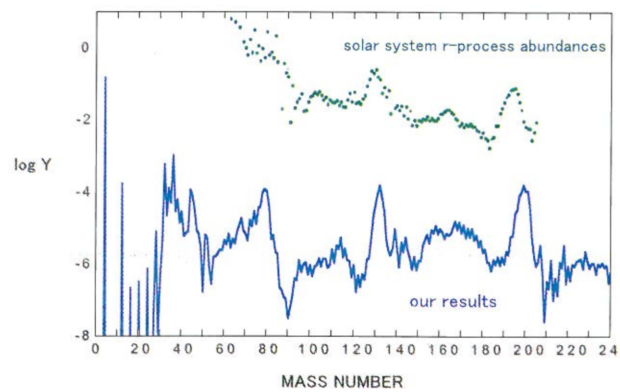

Fig. 2. Final r-process abundances of the shortest τ_{dyn} in Fig. 1 (blue) compared with the solar system r-process abundances (green). The solar system r-process abundances are shown in arbitrary unit.

Reference

1) Otsuki, K., Tagoshi, H., Kajino, T., Wanajo, S.; 2000, *Astrophys, J.*, **533**, 429

Interaction of the Supernova Remnant W28 with the Molecular Cloud

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The structure of the shocked layer between the supernova remnant (SNR) and a molecular cloud was resolved for the first time. Observations toward W28 were carried out with the James Clerk Maxwell Telescope (JCMT) in J=3–2 CO at 345 GHz and with the Nobeyama 45 m radio telescope in J=1–0 CO at 115 GHz. We have detected the broad molecular line emission clearly. It is very likely that this broad emission represents shock accelerated molecular gas due to the interaction of the SNR W28 with a molecular cloud. The OH maser spot (Claussen *et al.* 1997) is found to be located at the shock front. It becomes clearer that the 1720-MHz OH maser is a good probe of the SNR-cloud interaction (see also Frail & Mitchell 1998). Figure shows the spatial distribution of the unshocked gas (blue) and shocked gas (red) in the J=3–2 CO emission. It is shown that the unshocked gas is displaced by 0.4–1.0 pc outward with respect to the shocked gas. The distribution of the molecular gas is strongly correlated with the radio continuum "ridge", suggesting compression of magnetic fields due to the SNR-cloud interaction.

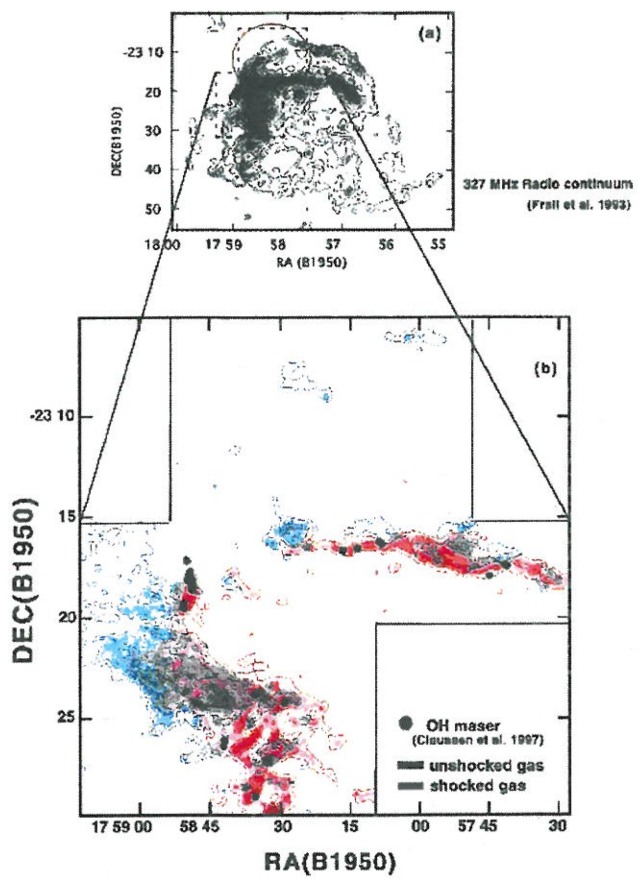

Fig. 1. (upper panel) Radio continuum map of the W28 SNR at 327 MHz reproduced from Frail *et al.* (1993). The red oval is the EGRET gamma-ray error circle (Esposito *et al.* 1996). The dashed line represents the boundary of the observed region. (lower panel) The integrated intensity map of J=3–2 CO near the W28 SNR. The blue contour and halftone map represents the distribution of the unshocked gas and the red contour and halftone map represents that of the shocked gas. The green filled circles are the OH maser (1720 MHz) spots by Claussen *et al.* (1997).

Reference

Arikawa, Y., Tatematsu, K., Sekimoto, Y., and Takahashi, T.: 1999, *Publ. Astron. Soc. Japan*, **51**, L7–L10 and Plate 23

2 Millimeter Observations of Bright-Rimmed Clouds with IRAS Point Sources

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We have made 2 mm continuum observations of 15 bright-rimmed clouds (BRCs) associated with IRAS point sources and S140 with the Nobeyama Bolometer Array (NOBA) mounted on the 45 m telescope of Nobeyama Radio Observatory on 1997 January 9–13 (Sugitani *et al.* 2000). The center of the bandpass l ter was 150 GHz and the bandwidth was 30 GHz. The beam size (FWHM) of the telescope was 12 arcsec. The details of NOBA have been reported in Kuno *et al.* (1993).

Continuum emission was detected in ve BRCs and in S140. These five BRCs are known to be associated with near-infrared YSO clusters, mostly on the side facing toward the exciting star(s) and, therefore, are likely the sites of small-scale sequential star formation (Sugitani, Tamura, & Ogura 1995 and 1999; Ogura & Sugitani 1999). The detected emission peaks of these five sources correspond to the IRAS positions within the positional errors, and the IRAS sources are considered to be protostars (Class 0/I-like sources) that were formed most recently in the BRCs. Four of them are clearly extended more than the telescope beam, suggesting the presence of circumstellar structures. The circumstellar masses derived from the 2 mm continuum are 5–90 Msun which are more massive than those of the nearby Class 0/I objects (<~1 Msun, e.g.,). This fact and the relatively large bolometric luminosities of these objects suggest that the mass of the cluster or star(s) most recently formed in these BRCs could be higher than those of the previously formed stars found in the near-infrared cluster. The comparisons with previous observations of Bok globules unassociated with bright rims and other objects are discussed. Most noteworthy is that the ratios of the bolometric luminosity to the circumstellar mass are signi cantly higher for these BRCs than for Bok globules.

We also compared our 2 mm continuum map of S140 with those obtained with JCMT in the submillimeter wavelengths (Minchin, Ward-Thompson, & White 1995) to performance of the NOBA system. Minchin *et al.* (1995) made submillimeter observations at 450, 800, and 1100 microns. The features in their maps at the three wavelengths are essentially the same but slightly different, probably because of the different beam sizes and samplings. Our 2 mm map is very similar to their maps, particularly to that at 800 micron, where the JCMT beam is nearly the same as ours (Fig. 1). These suggest good performance of the NOBA system.

References

Kuno, N., Matsuo, H., Mizumoto, Y., Lange, A. E., Beeman, J. W., and Haller, E. E.: 1993, *Int. J. Infrared Millimeter Waves,* **14**, 749

Minchin, N. R., Ward-Thompson, D., and White, G. J.: 1995, *Astron. and Astrophys.* **298**, 894

Ogura, K., and Sugitani, K.: 1999, *Proceedings of Star Formation 1999* Ed. T. Nakamoto (Nobeyama Radio Observatory), 381

Sugitani, K., Tamura, M., and Ogura, K.: 1995, *Astrophys. J.*, **455**, L39

Sugitani, K., Tamura, M., and Ogura, K.: 1999, *Proceedings of Star Formation 1999* Ed. T. Nakamoto (Nobeyama Radio Observatory), 358

Sugitani, K., Matsuo, H., Nakano, M., Tamura, M., and Ogura, K.: 2000, *Astron. J.*, **119**

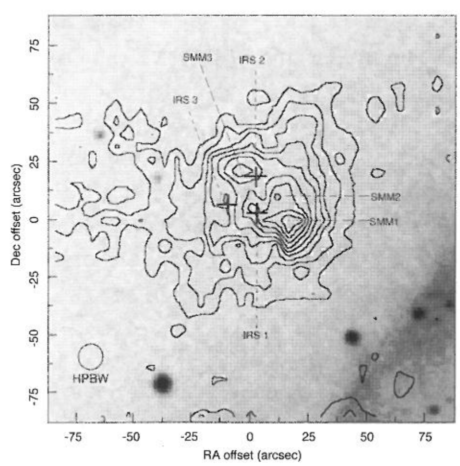

Fig. 1. DSS-II image and 2 mm continuum map of S140. The map center is the position. The contour [a (1950)=22 h 17 m 41 s. 3, Dec (1950)=63°40′.0]. Interval and the lowest contour are both 10% of the peak intensity. Interval and the lowest contour are both 10% of the peak intensity.

A Deep Near-Infrared Survey of the Chamaeleon I Dark Cloud Core

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We have carried out a deep near-infrared imaging survey to search for low-mass young stellar objects (YSOs) in the densest star-forming core of the Chamaeleon I dark cloud. Our observations cover an area of 30 arcmin^2, including an early B9 star (HD 97300) and an outflow source (HM 23). The 10 sigma limiting magnitudes are 18.1, 17.0, and 16.2 mag at J, H, and K, respectively, which is sensitive enough to provide a census of the embedded stellar population down to substellar objects in the cloud. Source classification is performed based on the near-infrared (NIR) color-color diagram. Many of the YSO candidates with NIR excesses are more than 7 mag fainter than typical T Tauri stars in the same cloud. Some of them are even fainter than the known brown dwarfs in the Pleiades. The luminosities of newly identified YSO candidates and the recent evolutionary models for very low mass objects suggest that they appear to be substellar, if their typical age is assumed to be similar to that of classic T Tauri stars or, namely, 1 Myr with an upper limit of 10 Myr. Therefore it is highly likely that young brown dwarfs form in this molecular cloud core. The J-band luminosity function of the YSO candidates does not appear to turn over down to the completeness limit. In the Chamaeleon I dark cloud core, stars form in a clustered mode characterized by both a high star formation efficiency and high stellar density such as in the rho Oph core.

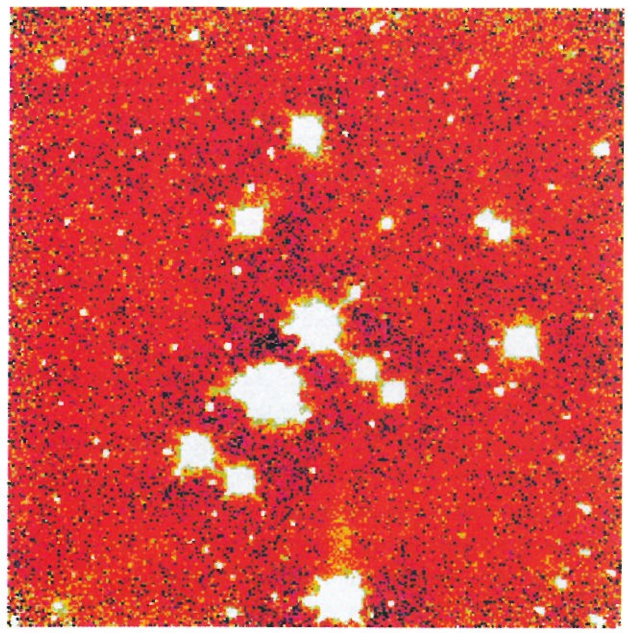

Fig. 1. K-bard image at the Chamaeleon cloud core.

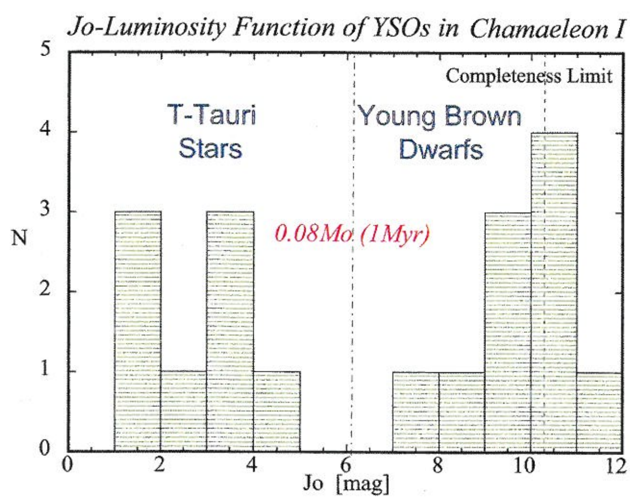

Fig. 2. J-band luminosity function of the Class II like YSO Candidates.

Reference

Oasa, Y., Tamura, M., and Sugitani, k.: 1999, *Astrophys. J.*, **526**, 376–343.

Theoretical Studies of Star Formation Processes

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Toru TSURIBE
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Dynamical collapse of rotating molecular clouds due to the gravitational instability is investigated by using three-dimensional numerical hydrodynamical calculations (Tsuribe & Inutsuka 1999a). The condition for disk fragmentation is derived by systematic numerical experiments for various initial density distributions, rotations, temperatures, and amplitudes of perturbation. We have also shown that we can predict the fragmentation condition by a semianalytic model that treat an axial ratio of an isodensity contour in the central region of clouds (Tsuribe & Inutsuka 1999b). The fragmentation process during gravitational collapse of molecular clouds is one of important basic processes that has not been well understood yet. This problem is also important to understand the property of IMF (Initial Mass Function) and formation of binary stars. As a first step we investigated the collapse of rotating isothermal clouds in detail. A semianalytic spheroid model and three-dimensional self-gravitating hydrodynamics are used to find out the criterion that predicts the outcome after the collapse of initially uniform-density rigid-rotating spheres. The geometrical flatness of the isodensity contour in the central region is shown to be a good indicator to predict whether the cloud fragments or not. The criteria derived by the three-dimensional calculations and the semianalytic model agree well in the α_0, β_0 diagram, where α_0 and β_0 are the ratio of the thermal and rotational energy to the gravitational energy, respectively. The warm clouds ($\alpha_0 > 0.5$) converge to the runaway collapsing self-similar solutions without fragmentation before the central core formation. Dependence on the initial rotation parameter β_0 is found to be small.

We have also investigated the protostellar evolution (a molecular cloud core, the first core, and the second core) by using the spherically-symmetric radiation hydrodynamical calculations (Masunaga & Inutsuka 2000a). The evolution of the resultant spectral energy distribution is directly compared with obsevations. The molecular line profiles from the protostellar objects are also obtained by accurate radiative transfer calculations (Masunaga & Inutsuka 2000b).

In addition to the above works, the fundamental processes in the formation of molecular clouds are investigated in detail (Koyama & Inutsuka 2000). Application to the primordial star formation is also developed (Uehara & Inutsuka 2000).

References

Tsuribe, T., and Inutsuka, S.: 1999a, *Astrophys. J.,* **523**, L158
Tsuribe, T., and Inutsuka, S.: 1999b, *Astrophys. J.,* **526**, 307
Masunaga, H., and Inutsuka, S.: 2000a, *Astrophys. J.,* **531**, 350
Masunaga, H., and Inutsuka, S.: 2000b, *Astrophys. J.,* **536**, 406
Koyama, H., and Inutsuka, S.: 2000, *Astrophys, J.,* **532**, 980
Uehara, H., and Inutsuka, S.: 2000, *Astrophys. J.,* **531**, L91

Three Dimensional Motions of Molecular Outflows Revealed by Relative Proper Motions of Water Masers in W3 IRS5

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We have made multi-epoch VLBA observations of water masers in the massive-star forming region W3 IRS5. We measured radial velocities and proper motions of 108 water maser features during three observing sessions. The masers are clustered in two groups which are associated with at least two different outflows. Positions of the outflow origins are close to the hyper-compact radio continuum sources, which are clustered within a scale of 6000 AU. The continuum sources are probably driving sources of the outflows. We performed a 3-dimensional kinematic model analysis of the maser motions in one of the two outflows, assuming a spherically symmetric expanding flow. We obtained a distance to the W3 IRS5 region as 1.83±0.14 kpc. The directions of the two outflows are roughly in the north-south direction, which is not significantly different from the direction of the global outflow seen in CO (J=2-1) emission. This suggests that the massive-star cluster in the W3 IRS5 region was created during formation of hierarchical structure in a parent molecular-cloud core. Such a structure is expected to preserve the angular momentum vector during star-formation process, which may be along the directions of the present outflows. (See the abstract in the following paper.)

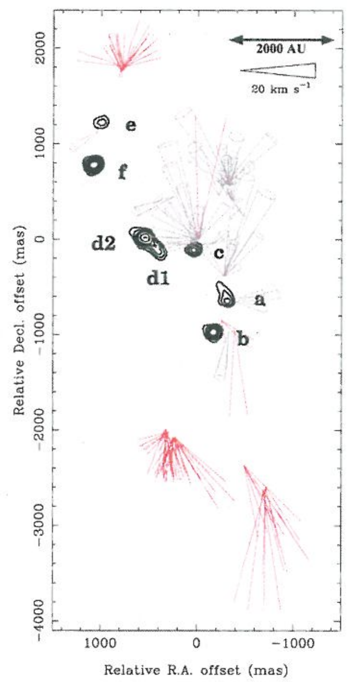

Fig. 1. Spatial distribution of water maser features and compact radio continuum sources, and 3-dimensional motions of the water maser features in W3 IRS5. An origin of a cone shows the maser feature position. Direction and length of the cone show the direction and magnitude of the proper motion per year (×325), respectively. The cone opening angles are fixed to all maser features independent of uncertainty of the motion vector. The red and blue cones indicate the red-shifted and blue-shifted maser features, respectively, with respect to the assumed systemic velocity. The cone with the larger inclination from the figure screen indicates the larger radial velocity relative to the systemic velocity, or the larger absolute value of the raidal velocity with respect to the transverse velocity. The radio continuum sources previously mapped are shown as contours.

Reference

Imai, H., Kameya, O., Sasao, T., Miyoshi, M., Deguchi, S., Horiuchi, S., and Asaki, Y.: 2000, *Astrophys. J.,* **538**, in press

Global Structure of the Interstellar Matter Revealed by High Resolution Hydrodynamical Simulations

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We have developed a high resolution two-dimensional hydro-dynamical code, and using this code we have succeeded in reproducing the globally stable, multi-phase structure of the interstellar matter (ISM), in which star formation and stellar energy feedback are explicitly included. We solve the basic equations using a high-accuracy Euler mesh code with $1024^2\sim 4096^2$ grid points. We have found that the porous density structure and turbulent-like velocity structure are formed as natural consequences of non-linear evolution of gravitational and thermal instabilities in the self-gravitating, rotationally supported gas disk[1]. The maximum density contrast is 10^7, and log-normal probability density distribution is achieved over five decade in density. In our simulations, evolution of the supernovae in the inhomogeneous, turbulent, rotating media and interaction between the SNe and the ISM are consistently followed[3,4]. A globally stable multi-phase ISM, in which filamentary and clumpy structure and low-density cavities are a characteristic feature, is formed with a hot component of $10^{6\text{-}8}$ K gas that is a direct consequence of the energy input from the feedback (Fig. 1). We also applied this method to the gas in the central region of nearby Seyfert galaxy, NGC 4303, and found that the observed two-armed but flocurrent spiral-like dust-lanes which are revealed by the recent high resolution observations by HST, can be naturally explained by our models (Fig. 2). We found that the gas accretion rate to the nuclear region ($R<8$ pc) is $\sim 0.01\,M_{\odot}\mathrm{yr}^{-1}$ on average, and that the nuclear stellar bar observed by the near infrared contributes to form the spirals. However the spirals are not simple, smoothed shocks, but are formed from many filaments and dense clumps as those in the observations.

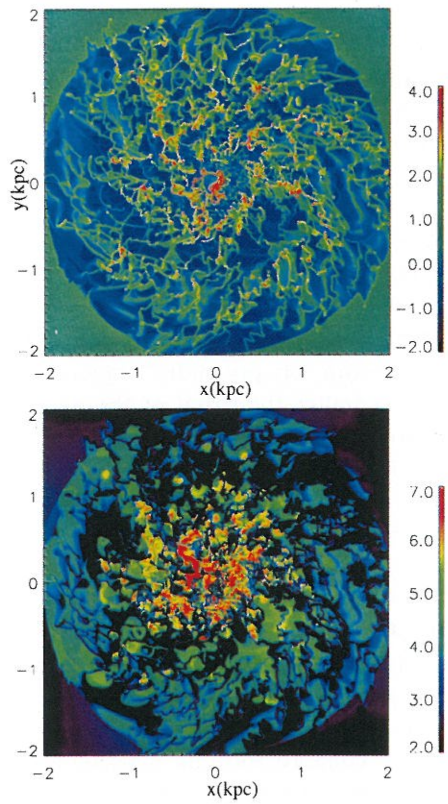

Fig. 1. Log-scaled density and temperature distribution of the ISM in a quasi-steady state in the central 2 kpc region of a galaxy. The units are $M_{\odot}\,\mathrm{yr}^{-2}$ for the density and K for the temperature.

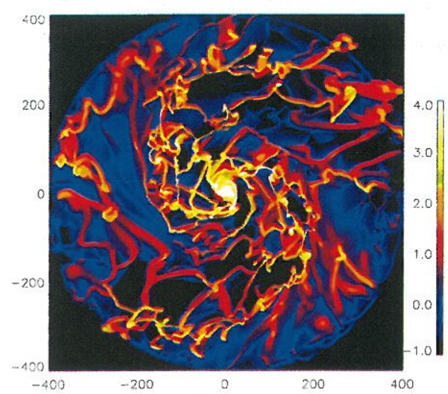

Fig. 2. Log-scaled density distribution of the ISM in the nuclear region of Seyfert galaxy NGC 4303. The two global spirals are caused by the outer Lindblad resonance due to a nuclear stellar bar whose scale is $\sim$ 200 pc.

References

1) Wada, K., and Norman C. A.: 1999, *Astrophys. J.*, **516**, L13
2) Colina, L., and Wada, K.: 2000, *Astrophys. J.*, **529**, 845
3) Wada, K.: 1999, *RIKEN Review*, **25**, 106
4) Wada, K., Spaans, M., Kim, S., and Norman, C.: 1999, "Star Formation 1999", ed. T. Nakamoto, (Nobeyama Radio Observatory, Nobeyama) 36–37

Numerical Study of Star Formation: Bipolar Outflow from Rotating Magnetized Clouds and Angular Momentum Problem of New-born Stars

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Star formation has been a long target of theoretical and observational astrophysics. Multiplicity of new-born stars (single, binary, or triplet stars) and the initial mass function as well as the mass, angular momentum and magnetic flux of respective stars should be explored by studying the contraction of the interstellar clouds.

There has been existed so called "angular momentum problem of new-born stars." That is, the specific angular momenta of pre-main sequence stars are $\sim 10^{-5}$ times smaller than that of the parent molecular cloud cores. If the angular momentum of the molecular cloud core were to be conserved during its contraction, the core would cease to collapse before its size reaches ~ 0.01 pc.

Recently, we have explored the bipolar molecular outflow plays an important role to this problem from numerical MHD simulations of the collapse of rotating isothermal clouds.

Before the central density reaches $10^{10}\,\mathrm{cm}^{-3}$, the gas is essentially isothermal and the core experiences the run-away collapse forming a pseudo-disk (a disk which is not in a force balance). See Figure 1 left panels. However, as collapse proceeds, the thermal radiation from the dusts, which cools the gas isothermally, becomes trapped in the central part of the core and an adiabatic hydrostatic core is formed. The outer isothermal gas continues accrete on to the adiabatic core. As the gas rotates around the adiabatic core, toroidal magnetic field component B_ϕ is amplified due to the rotation motion. The Lorentz force in the ϕ-direction transports the angular momentum from the accreting disk gas to the outflow gas. Finally the outflow gas which brings the excess angular momentum is collimated and ejected (Figure 1 right panels). As a result, the specific angular momentum of the adiabatic core and thus a new-born star is reduced to the value found in the pre-main sequence stars. Interaction between the rotation and magnetic fields seems to play an important role to determine the angular momentum of the new-born stars.

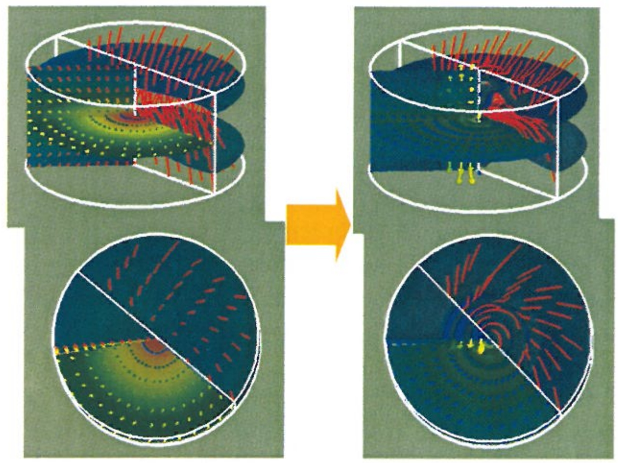

Fig. 1. Isothermal run-away collapse (left) and accretion flow associated with the outflow (right). The upper panels are side views and the bottom are pole-on views. The blue surfaces represent iso- density surfaces, and arrows indicate the velocity vectors. Red lines represent the magnetic fields, whose distribution change greatly from the isothermal run-away collapse phase to the acc- retion stage. The diameter is approximately equal to 300 AU and the time elapsed from the left to the right is approximately 1000 yrs.

Reference

Tomisaka, K. 2000, *Astrophys. J.*, **528**, L41

Mid-Infrared Observations of the Red-Rectangle with COMICS Attached on the SUBARU Telescope

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We have developed a new instrument COMICS (COoled Mid-Infrared Camera and Spectrometer) attached on the SUBARU telescope. This is optimized for mid-infrared wavelengths (8–26 micron), and has both imaging and spectroscopic capabilities. Its spatial resolution can be achieved to be 0.3 arcseconds at 10 micron which is comparable with the diffraction limited resolution of the SUBARU telescope. On December 1999, COMICS was taken to the summit of the Mauna Kea, and succes fully obtained its first image (the "First Light"). In this first run, we made sepctroscopic observations of the Red Rectangle in the N-band to demonstrate its performances.

The Red Rectangle is a Carbon-rich Proto-Planetary Nebula (PPN) associated with A0 type stars HD44179.

Fig. 1. COMICS attached on the SUBARU Telescope.

It shows the strong unidentified infrared (UIR) emissions, and is one of the most studied sources of them. Especially, it is suitable for investigating spatially distribution and variety of the UIR features, because it is near (330 pc) from the earth.

The high spatial resolution of the COMICS reveals that spectra vary as its distance from the central star. In the nebula region (distance from the central star >0.8 arcsec=260 AU), the UIR features at 7.7, 8.6, 11.27, and 12.7 micron dominate the spectra, while the continuum is relatively very weak. On the other hand, the continuum emission is observed very prominent in the central region (distance<0.8 arcsec). It can be represented by a blackbody emission with temperature of 300 K. There, the UIR features are relatively weak. The features at 8.6 and 11.27 micron disappear, and two weak features at 11.0 and 11.9 micron which are not seen in typical UIR emissions arise.

Similar features as this 11.0 micron feature have been detected in the central region of a reflection nebula NGC1333 (Sloan *et al.* 1999) and a Herbig Ae/Be star WL16 (DeVite *et al.* 1998). Sloan *et al.* (1999) suggested that this feature can be attributed to be PAH cation. PAH molecules would be usually ionized near central stars, and emit the 11.0 micron feature.

The 11.9 micron bump may be attributed to the duo CH out-of-plane bending mode. Although this mode is usually weak and possibly smeared into the plateau emission in astronomical objects, the observed feature is prominent and isolated. This could be caused by smaller size distribution of the UIR carriers.

References

Sloan *et al.*: 1999, *Astrophys. J.*, **513** L65
DeVite *et al.*: 1998, *Astrophys. J.*, **504** L43

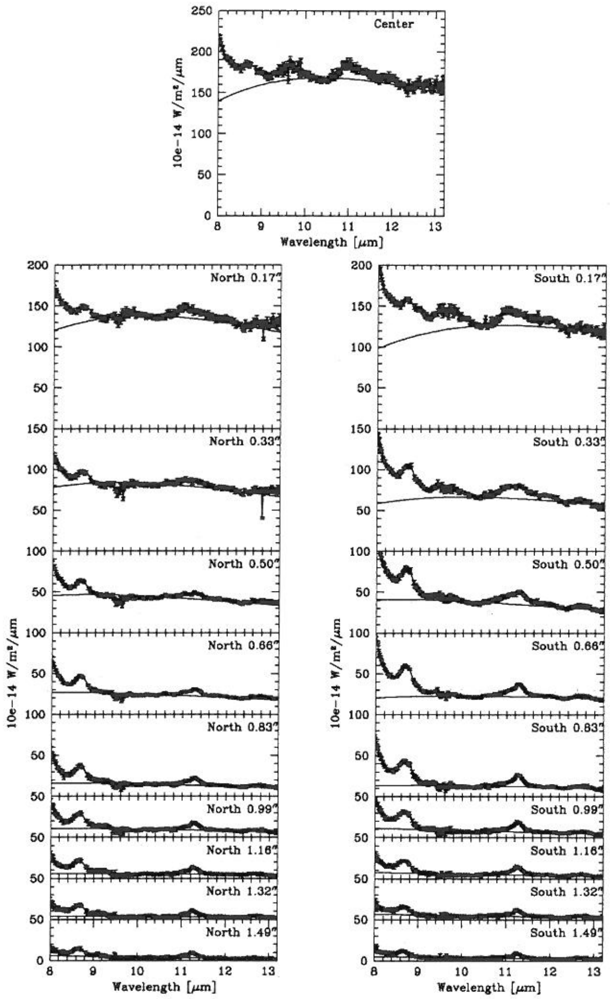

Fig. 2. Obtained spectra of the Red Rectangle and the fitted continua.

Origin of Helical Coronal Disturbances from the Sun

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By combining data from the Nobeyama Radioheliograph and the LASCO coronagraph aboard the *SoHO* spacecraft, we report two helical coronal disturbances accompanying white-light coronal mass ejections (CMEs). These are activated prominences at the base, rotating around each vertical axis while moving on the solar surface with projected speeds of ≥ 50 km s^{-1}. The activity continues in a CME core and in a neighboring streamer growing over 6 $R_{\odot}$. Neither flare activity nor radio bursts were observed during the two events. We suggest that the apparent presence/absence of a CME core depends on the density of the eruptive material associated with the CME. (Abstract of Hori 2000)

Reference

Hori, K.: 2000, *Astrophys. J.*, (November 10, 2000 issue)

[1] Present Position Mullard Space Science Laboratory, University College London.

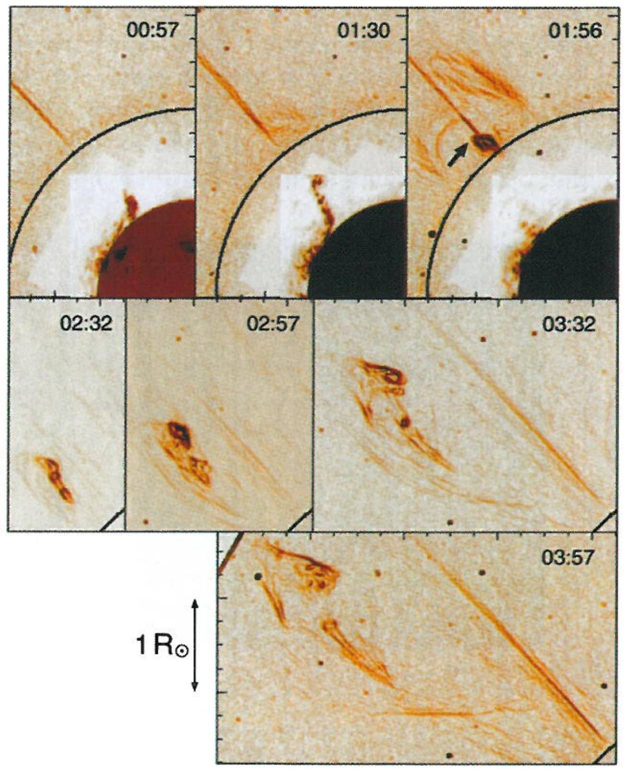

Fig. 1. Structural evolution of the 1999 February 9 CME. The quadrant image of the Sun in upper three frames are from NoRH 17 GHz, whereas the other images are from LASCO C2. The edge of the C2 occulting disc ($2R_{\odot}$) is represented by the black line in the bottom right corner. Time is indicated at upper right in UT. All images are shown with the same scale.

High-Energy Electrons in Double-Loop Flares

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We studied the fast temporal variations in the brightness of the radio and hard X-ray sources of three double-loop flares observed with the Nobeyama Radioheliograph, Yohkoh, and CGRO/BATSE. As shown in Figure 1a, in such flares, the main radio/hard X-ray source is located near to one of the footpoints of a large overlying loop, where a small, newly emerging loop appears and the two loops interact, and the remote source is located at another footpoint of the large loop. Figure 1b schematically shows the configuration of the emerging loop and the overlying loop. The following results were obtained from the analysis:

(1) The main source and the remote source basically show a correlated brightness fluctuation in radio and hard X-rays, but the rapid fluctuation of the brightness of the remote source lags behind that of the main source for about 500 ms. This result is evidence that the electron-acceleration region is close to the main source and, therefore, it is most presumable that the high-energy electrons in the double-loop flares are accelerated in the interaction region of the two loops.

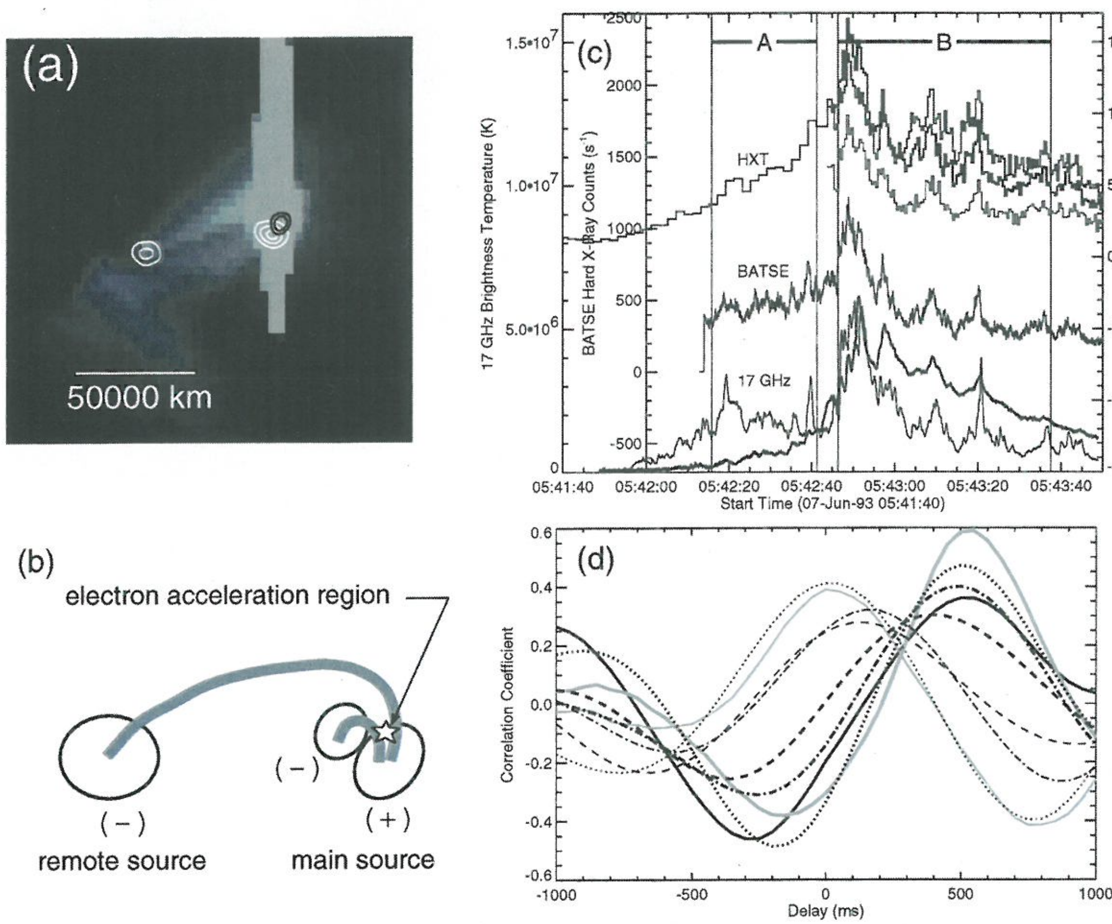

Fig. 1. (a) Soft X-ray image of a double-loop flare on 1993 June 7 overlaid by white contours showing the 17 GHz radio image and black contours showing the hard X-ray image. (b) Schematic drawing of the flare loops. (c) Changes in the hard X-ray and microwave intensities of the 1993 June 7 flare. (d) Relation between the assumed delay and the correlation coefficient between two of the rapidly fluctuating components shown in (c). The thick lines show the correlation coefficients between the time variation of the remote source and that of the main source, and the thin lines show the correlation coefficients between the time variation of the main source and another time variation of the main source.

(2) The brightness of the hard X-rays from the main source and that of the microwaves from the remote source fluctuate highly, but the microwaves from the main source fluctuate less. This result means that the microwave-emitting electrons are effectively trapped at the main source region.

[This is based on the abstract of a paper by Hanaoka, Y. (1999, PASJ, 51, 483)]

Reference

Hanaoka, Y.: 1999, *Publ. Astron. Soc. Japan,* **51**, 483

Microwave Measurements of Magnetic Fields in the Solar Atmosphere

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The solar atmosphere is filled with hot plasma. Charged particles in the plasma are gyrating around active region magnetic fields. Gyrating charged particles interact (emit and absorb) with electromagnetic waves. Generally, any EM waves can be expressed by the combination of right-handed-circular (R) and left-handed-circular (L) polarized waves. When the EM waves propagate through the atmosphere filled with the magnetized plasma, the absorption coefficients of R and L waves differ. This is caused by the interaction of the gyrating electron around the magnetic field and the circular EM wave. By measuring the difference of the circular polarization of the EM waves generated and propagated through the active region atmosphere, we can estimate the line-of-sight magnetic field strength in the atmosphere. As the magnetic field is the energy source of solar activities in the atmosphere, direct measurement of the field strength is very important for the studies of solar activities.

In optical or infrared observations, polarization around spectral lines is used to measure magnetic field strength. Available lines are formed in the

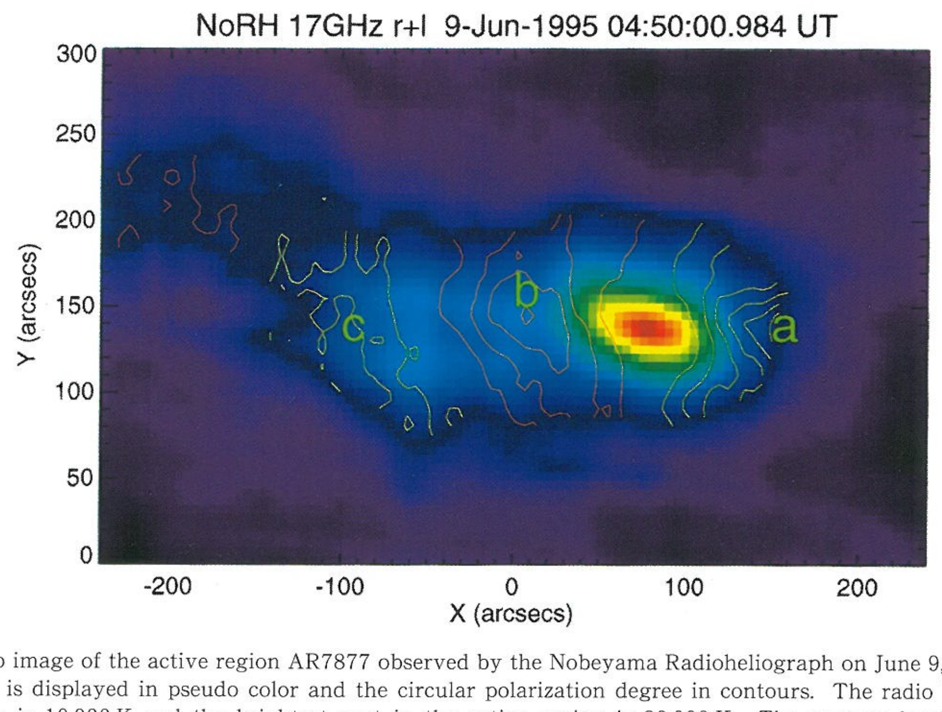

Fig. 1. The radio image of the active region AR7877 observed by the Nobeyama Radioheliograph on June 9, 1995. The radio intensity is displayed in pseudo color and the circular polarization degree in contours. The radio brightness of the quiet sun is 10,000 K and the brightest part in the active region is 30,000 K. The contour levels of the circular polarization degree are in every 2 percent. The red lines represent N polarity and the yellow lines represent S polarity. The field of view is 8 arc min. (EW) by 5 arc min. (NS).

lower atmosphere: the photosphere or the chromosphere. Magnetic fields in the upper atmosphere need to be extrapolated from the measured at the lower height with some assumptions. In the microwave region, measurements are done in continuum and we can measure directly the magnetic field in the upper atmosphere: the transition region and the corona.

The Nobeyama Radioheliograph (NoRH) observes the Sun with both R and L waves at 17 GHz. We can synthesize full disk images of the Sun in R and L, or intensity (I) and circular polarization (V). The ratio V/I (circular polarization degree) is directly related to the line-of-sight magnetic field strength of the atmosphere where the emission is generated. Intensity images at 34 GHz can be used to know the opacity of the atmosphere around 17 and 34 GHz, which is important for the conversion from the circular polarization degree to the magnetic field strength. When active regions are located on the disk, we can measure the magnetic field in the upper chromosphere and transition region, where most of the microwave emission comes from. By combining with the RATAN-600 observation of active regions with wider spectral range, we can determine the 3-D distribution of the magnetic field strength. Above the limb, we can measure the height distribution of the magnetic field.

The attached figure shows the distribution of the 17 GHz intensity (I) by pseudo color and the circular polarization degree (V/I) by the contour lines of the active region observed on June 9, 1995. The intensity peak is located at the polarity reversal line, not on the sunspot. This shows that the emission is due to the thermal plasma contained in the coronal loop which connects the opposite polarity regions, not by the gyroresonance due to the strong magnetic field. The measured magnetic field strength around (a), (b), and (c) are 150, 110, and 60 Gauss respectively. The magnetic field strength at the photosphere measured at Beijing observatory were 320, 320, and 160 Gauss respectively.

References

Grebinskij, A., Bogod, V., Gelfreikh, G., Urpo, S., Pohjolainen, S., and Shibasaki, K.: 2000, *Astron. and Astrophys. Suppl.*, **144**, 169–180

Grebinskij, A., Shibasaki, K., and Zhang, H.: 1999, *Proceedings of the Nobeyama Symposium*, "Solar Physics with Radio Observations", (held in Kiyosato, Japan, Oct. 27–30, 1998), Eds. T. S. Bastian, N. Goppalswamy and K. Shibasaki, *NRO Report*, **479**, 59–64

Solar Microwave Bursts with Sub-Second Time Structures

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Study of solar bursts with fast time variations is important from a viewpoint of particle acceleration. Microwave observations are expected to contribute essentially in this aspect, because they are sensitive to non-thermal electrons. We presents preliminary results of analyses of solar microwave bursts at 17 GHz with sub-second time structures observed by the Nobeyama Radioheliograph (NoRH) with temporal resolution of 50 ms or 100 ms.

About 7% of bursts detected by NoRH contained bursts with fast time variations of less than 1s duration (FWHM). Microwave and hard X-ray time profiles of the 1992 September 7 event are shown as one of typical examples in Figure 1. We can see excellent correlation between both time profiles, suggesting that these sub-second bursts can be interpreted in terms of gyrosynchrotron radiation.

Sub-second time structures with high amplitude variations were observed in most cases when their flux densities were less than 10 sfu (in all cases when their flux densities were less than 50 sfu). We carried out a detailed analysis of one event and found that sub-second bursts were observed only in the onset phase accompanied by weak microwave emission, and that later, time differences between successive peaks increased with increasing flux density.

The fastest rise and fall times of sub-second bursts are less than 100 ms. This result can impose some restrictions on mechanisms of electron acceleration in solar flares.

It was shown in Figure 2 that sub-second bursts with high amplitude variations were generated by directly precipitating electrons from one footpoint with stronger magnetic fields of a highly asymmetric loop. Trapping effect is very small in this magnetic configuration, and therefore, microwave emission from the footpoint does not lose information on electron acceleration.

Sub-second bursts did not show any clear source shift from peak to peak. This suggests that electrons are successively accelerated rather in the similar region.

References

Altyntsev, A. T., Nakajima, H., Takano, T., and Rudenko, G. V.: 2000, *Solar Physics,* **195**, in press.

Nakajima, H.: 2000, *Astronomical Society of the Pacific Conference Series,* **206**, 313–317.

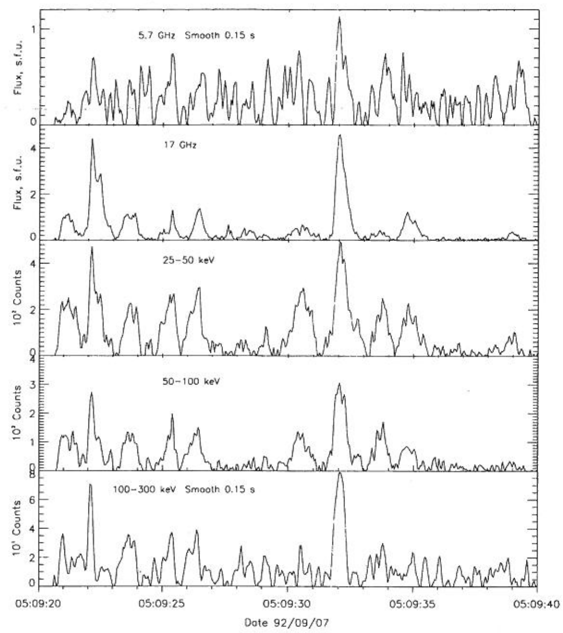

Fig. 1. Time profiles of microwave and hard X-ray bursts with sub-second time structures for the 1992 September 7 event. Microwave and hard X-ray time profiles are very similar.

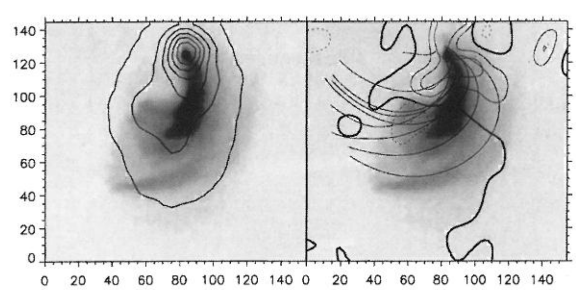

Fig. 2. Contours of microwave brightness temperature (left) and radial components of calculated coronal magnetic fields (right) both of which are overlaied on a Yokoh/SXT image.

Polarimetric Imaging and Color of the Inner Coma of Comet Hale-Bopp

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Comet Hale-Bopp (C/1995O1) is one of the brightest comets during latest 30 years. Optical-imaging polarimetry of the comet Hale-Bopp was performed on 1997 March 17, using the Okayama Optical Polarimetry and Spectroscopy system (OOPS), which was mounted on the 91-cm reflector at Okayama Astrophysical Observatory. Using two different narrowband filters for the continuum, color maps and polarization maps of dust particles of comet Hale-Bopp were obtained. The center wavelength of the filter for shorter wavelength is 526.1 nm, and that for longer wavelength is 714.5 nm.

A dust "jet" structure (also called 'arc structure') was seen in the intensity, polarization, and color maps (see Fig 1). Please note that the polarization degree of the arc structure was higher than in other parts of the coma, and the color of the arc structure was bluer compared to other coma regions. This fact may indicate the smaller dust grains are richer in the dust jet than other parts of the coma.

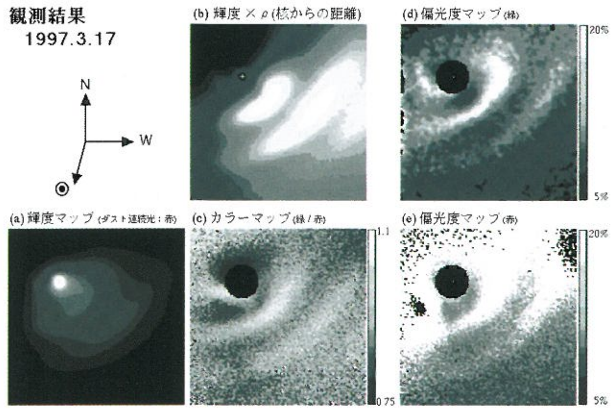

Fig. 1. Intensity map, color map, and polarization map of comet Hale-Bopp.

References

Furusho, R. *et al.*: 1999, *Publ. Astron. Soc. Japan,* **51**, 367
Schleicher, D. *et al.*: 1997, *Science,* **275**, 1913
Sekanina, Z.: 1998, *Astrophys. J.,* **494**, L121
Licandro, J. *et al.*: 1998, *Astrophys. J.,* **501**, L221
Rodriguez E. *et al.*: 1997, *Astron. and Astrophys.,* **324**, L61

TV Observation of the Leonid Meteor Shower in 1998: No Strong Activity over Japan

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Since the parent comet returned in 1998, the Leonid meteor shower was expected to show a higher than usual activity. Because the epoch of the nodal crossing corresponded to about 20 h UT on November 17 in 1998, many expeditions, including NASA's Leonids Multi-Instrument Aircraft Campaign, were performed in Asia. In order to monitor the activity of the Leonid, and to participate in the Campaign, we carried out a high-sensitivity TV observation at the Nobeyama Radio Observatory, from 15 h 20 m UT through 20 h 24 m UT on 1998 November 17.

This camera comprised an image intensifier (Hamamatsu Optical Co. type V1366P) along with a monochromatic CCD camera (KP-M1, Hitachi-Denshi, Ltd.). A 35-mm camera lens (Nikon Nikkor 50 mm F/1.2) was used as the objective lens. This system gives a field of view of 16.6×11.9 degrees, along with a limiting magnitude of 8 under the best sky condition.

The activity of the Leonid increased from November 16. Many bright meteors were witnessed in Europe. This was the activity peak by half a day earlier than expected. During our observation, the activity was still recognized. We detected 58 Leonid meteors, along with 99 sporadic meteors. The peak of the activity, as expected around 20 h UT, was not clearly observed. The average influx rate of meteoroids was $1.4\times10^{-5}\,km^{-2}s^{1}$ (mag$<+8$) during our observation, which indicated no strong activity over Japan.

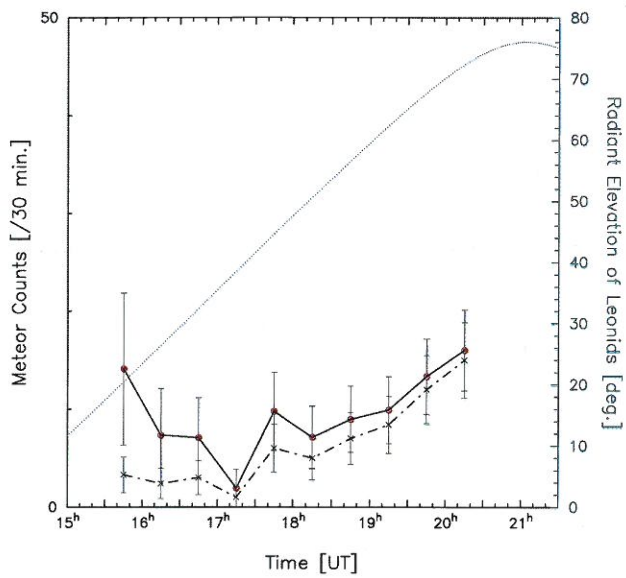

Fig. 1. Time variation of the number of Leonid meteors detected in our TV observation on 1998 November 17. The dash-dotted line is the raw number of meteors observed in a 30-min interval, and the solid line is the number after a correction for the radiant point elevation. The dotted line is the elevation of the radiant point.

Reference

Watanabe, J., Abe, S., Fukushima, H., and Kinoshita, D.: 1999, *Publ. Astron. Soc. Japan,* **51**, No 4, L11–L14

Millimeter Continuum Observations of Parent Comets of Meteor Storms

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The 2 millimeter continuum observations of parent comets of meter storms, P/Tempel-Tuttle and P/Giacobini-Zinner, were made with a bolometer array installed on the 45 m radio telescope at the Nobeyama Radio Observatory. P/Tempel-Tuttle was observed on January 16, 1998, near its closest approach to the earth, and P/Giacobini-Zinner was observed November 5 and 8, 1998. The maps obtained showed no signal from these comets greater than 12.0 mJy for P/Tempel-Tuttle and 17.4 mJy for P/Giacobini-Zinner (3\sigma). Using the same assumptions in Jewitt and Mathews (1997, AJ, 113, 1145), we estimated that the mass upper limits in the 12 arcsec beam were 7.5E9 kg and 6.2E10 kg for P/Tempel-Tuttle and P/Giacobini-Zinner respectively. Meteoroids in meteor storms are submillimeter to centimeter size dust grains which are ejected from the cometary nuclei by their out gassing process. Millimeter and submillimeter continuum observations are suitable to detect thermal emissions from such larger dust particles while optical and infrared observations are difficult to observe large size particles, because of contaminations by gas emission lines in visible wavelength region and by thermal emissions from much abundant small grains in the coma at mid-infrared region. In the radio wavelength, the thermal emissions from submicron to micron size dust particles are relatively weak due to their low thermal emissivity. We performed 2 mm continuum observations of two meteor storm parents, P/Giacobini-Zinner and P/Temple-Tuttle to estimate the total mass production rate from these comets and to investigate the development of the meteor storms. Comet P/Temple-Tuttle is known to the parent comet of the Leonid meteor storm and comet P/Giacobini-Zinner is known to the parent of the Giacobinid (or Draconid) meteor storm.

Our millimeter continuum observations were made with the Nobeyama Bolometer Array (NOBA) mounted on the focus of the 45 m radio telescope of the Nobeyama Radio Observatory. The frequency of the NOBA is 150 GHz (2 mm) and the band width is 30 GHz.

We observed comet P/Tempel-Tuttle on January 16, 1998. The heliocentric distance of the comet was 1.20 AU, and the geocentric distance was 0.36 AU at our observation. The 3 sigma r.m.s. noise level of the map was 12.0 mJy and we could not find any flux concentrations vicinity of the predicted position of the comet.

Comet P/Giacobini-Zinner was observed on November 5 and 8, 1998. The heliocentric distances were 1.06 and 1.05 AU, and the geocentric distances were 0.90 and 0.89 AU. The obtained radio continuum map showed no cometary signals brighter than the 3 sigma upper limit of 17.4 mJy.

We estimated the mass upper limit of the dusts in the beam from the observed flux density upper limit, using a model by Jewitt and Mathews (1997). The resulting dust mass upper limits using the above definition are 7.5E9 kg and 6.2E10 kg for P/Tempel-Tuttle and P/Giacobini-Zinner respectively. The derived upperlimits of the dust production rates are 2.4E4 kg/s and 7.9E4 kg/s for P/Tempel-Tuttle and P/Giacobini-Zinner, respectively. These production rate upper limits are 2 orders lower than that of C/Hale Bopp (Jewitt and Mathews, 1999).

References

Hasegawa, H., et al: 2000, *Astron. J.*, **119**, 417–418
Jewitt, D., 1996, *Astrophys. J.*, **111**, 1713
Jewitt, D., and Mathews, H. E.: 1997, *Astrophys. J.*, **113**, 1145
Jewitt, D., and Mathews, H. E.: 1999, *Astrophys. J.*, **117**, 1056

Movement of the Amurian Plate Determined by Space Geodesy

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According to the plate tectonic theory, Japan is a typical island arc. The Pacific Plate subducts at the Japan Trench from the east and the Philippine Sea Plate subducts at the Nankai Trough from the south. This process is responsible for the recurrence of interplate earthquakes at trenches. Inland thrust earthquakes that occur in Northeast Japan can be understood in the same framework: they release the east-west compressional crustal stresses caused by the subducting Pacific Plate. On the other hand, tectonic backgrounds of island earthquakes in Southwest Japan, e.g. the 1995 Hyogoken-Nanbu Earthquake, have been unknown. These earthquakes have mechanisms showing east-west compression and north-south extension. If this stress is due to the subducting Philippine Sea Plate, the compression should be in northwest-southeast rather than east-west. It is mechanically unlikely, either, that the subducting Pacific Plate far to the east is responsible for this stress field.

We analyzed data of permanent Global Positioning System (GPS) stations deployed in Eastern Asia over the last few years, and found that an extensive region covering the northeastern China, Korean Peninsula, southeastern Russia, behaves as a rigid body independent from the Eurasian Plate (Heki et al., 1999). This "Amurian Plate" moves by about 1 cm/year eastward with respect to the Eurasian Plate, and the lake Baikal, Russia, marks the divergent boundary between them. The Amurian plate collides with the North American Plate to the east by about 2 cm/yr along the boundary running from Sakhalin, the eastern margin of the Japan Sea, down to central Japan. From GPS point velocities we found that the east-west convergence at the central Japan is accomodated by southward extrusion of the landmass rather than crustal uplift (Miyazaki and Heki, in press), a process similar to the eastward extrusion of continental blocks (the Amurian Plate itself is one of those) due to the northward movement and collision of the Indian subcontinent with Eurasia. Although less active than on the Pacific coast, there recur large thrust earthquakes along the eastern margin of the Japan Sea, as seen by the 1983 Nihonkai-Chubu, and the 1993 Hokkaido-Nansei-Oki earthquakes. Our study provided a quantitative basis for the plate convergence along this margin, which will be of importance for future hazard assessment in this zone.

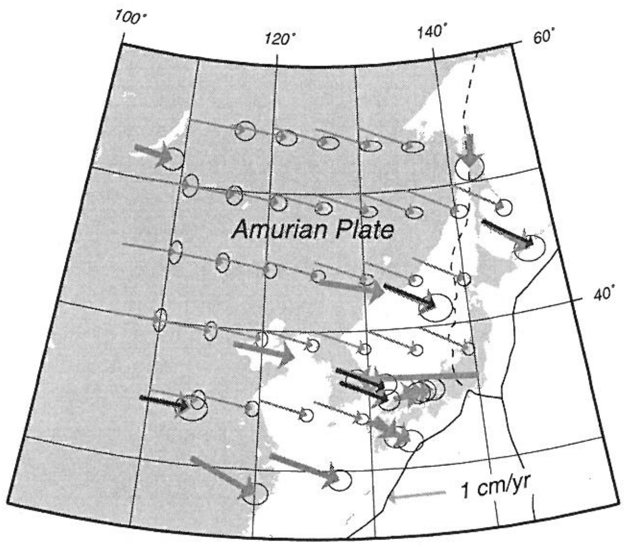

Fig. 1. Movement of the Amurian Plate ralative to the Eurasian Plate estimated from continuous GPS stations. Thick arrows indicate GPS points, and the black ones indicate points which are considered to be in the stable interior of the Amurian Plate and used in estimating the kinematic parameters of the plate (error ellipses show one sigma errors). Thin arrows show velocities at grid points calculated using the obtained kinematic parameters of the Amurian Plate (error ellipses are obtained by letting the parameter uncertainties propagate into velocity errors).

References

Heki, K., S. Miyazaki, H. Takahashi, M. Kasahara, F. Kimata, S. Miura, N. Vasilenco, A. Ivashchenco and An K.: 1999, *J. Geophys. Res.*, **104**, 29147–29155
Miyazaki, S. and Heki K.: 2000, *J. Geophys. Res.*, in press.

The Vernier Scale Adopted in Astronomical and Land-Survey Instruments Produced by Kume Michikata in the Beginning of the 19th Century in Japan

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Taira SAWADA
(Sakai Antique Gun Society)
Keiko HASEGAWA
(Kamada Corporation Museum)

KUME Eizaemon Michikata (1780–1841) was a low-ranking vassal who served the Sanuki (now Kagawa prefecture) domain ("Han") of the Shikoku island, and had well been known before World War II as an ingenious inventor of firearms and artillery products as well as a developer of a modern salt farm in the Sakaide district of the domain. At his age of nineteen (1789), Kume learned for four years astronomy and land-survey techniques under the supervision of HAZAMA Shigetomi, one of the shognal astronomers. Although, because of this, a considerable number of astronomical and land-survey instruments and relating historical documents produced by him in the 1810s are left in the Sakaide district, none of his concrete achievements in the field have ever been known.

Recently we had a chance to make an extensive investigation of the instruments and documents preserved at the Kamada Corporation Museum in Sakaide city. We found that Kume was the first and probably the only one throughout the Edo period in Japan to make a precision octant (navigational instrument) as early as in 1806, and one of the first to understand the principle of the Vernier scale and its importance in astronomy and land-survey engineering. He also made for the first time applications of the Vernier scale to the Chihei-gi (transit instrument) and the Shogen-gi (quadrant). With these instruments, Kume performed in 1806 an official land-survey tour of the whole Sanuki domain, about which we estimate the accuracy in his azimuth measurements to be 2–3'. These values were twice more accurate than the accuracy in the INO Tadataka's reputed whole Japan land-survey expedition done in 1801–1817; Ino and the contemporary shognal astronomers all then continued to use the diagonal sub-scale,

Fig. 1. Octant produced by M. Kume.

Fig. 2. Chihei-gi (transit instrument).

which had long time ago been replaced by the Vernier scale in Europe, because of its superiority in convenience and accuracy.

Although a few famous science historians such as MIKAMI Yoshio and YAMAMOTO Issei visited the Kamada Museum in the 1930–40s to examine Kume's astronomical works, it seems that they were totally unaware of the fact that Kume made extensive applications of the Vernier scale in his instruments. In this respect, we believe that Kume deserves to be highly estimated, though he has long been neglected in the Japanese history of astronomy and land-survey.

References

Nakamura, T.: 1999, *Toyo Kenkyu ("Oriental Study")*, *(Daitobunka University)* **133**, 1–21

Nakamura, T., Sawada, T., and Hasegawa, K.: 2000, *Report of the National Astronomical Observatory of Japan*, in press.

II. Publications, Presentations

1. Refereed Publications

Abe, M., Sato, I., and **Araki, H.**: 1999, Photometric Observation of near-Earth asteroid 1989ML, *Adv. Space Res.*, **25, No. 2**, 269–272.

Aikawa, Y., Umebayashi, T., **Nakano, T.**, and **Miyama, S. M.**: 1999, Evolution of Molecular Abundances in Pro-Planetary Disks with Accretion Flow, *Astrophys. J.*, **519**, 705–725.

Akiyama, M., Ohta, K., Yamada, T., **Kashikawa, N.**, **Yagi, M.**, Kawasaki, W., Sakano, M., Tsuru, T., Ueda, Y., Takahashi, T., Lehmann, I., Hasinger, G., and Voges, W.: 2000, Optical Identification of the ASCA Large Sky Survey, *Astrophs. J.*, **532**, 700–727.

Akiyama, M., Ohta, K., Yamada, T., Ueda, Y., Takahashi, T., Sakano, M., Tsuru, T., Lehmann, I., and Hasinger, G.: 1999, Nature of Hard X-ray Sources from Optical Identifications of the ASCA Large Sky Survey, *Astron. Nachr.*, **320**, 255–256.

Allen, B., Blackburn, J. K., Brady, P. R., Creighton, J. D. E., Creighton, T., Droz, S., Gillespie, A. D., Hughes, S. A., **Kawamura, S.**, Lyons, T. T., Mason, J. E., Owen, B. J., Raab, F. J., Regehr, M. W., Sathyaprakash, B. S., Savage, R. L., Whitcomb, Jr., S., and Wiseman, A. G.: 1999, Observational Limit on Gravitational Waves from Binary Neutron Stars in the Galaxy, *Phys. Rev. Lett.*, **83**, 1498–1501.

Ando, M., **Arai, K.**, Kawabe K., and Tsubono, K.: 2000, Signal-separation experiments for a power-recycled Fabry-Perot-Michelson interferometer by sideband elimination, *Phys. Lett. A*, **268**, 268–273.

Aoki, K., **Kosugi, G.**, Wilson, A. S., and **Yoshida, M.**: 1999, The Radio Emission of the Seyfert Galaxy NGC 7319, *Astrophys. J.*, **521**, 565–571.

Aoki, W., Tsuji, T., and Ohnaka, K.: 1999, Infrared Spectra of Carbon Stars Observed by the ISO SWS. II. HCN and C_2H_2 Bands at 14 um Astron. *Astrophys. J.*, **350**, 945.

Aoyama, Y., and **Naito, I.**: 2000, Wind Contributions to the Earth's Angular Momentum Budgets in Seasonal Variation, *J. Geophys. Res.*, **105**, 12417–12431.

Araki, H., **Ooe, M.**, **Tsubokawa, T.**, **Kawano, N.**, **Hanada, H.**, and **Heki, K.**: 1999, Lunar Laser Altimetry in the SELENE project, *Adv. Space Res.*, **23, No. 11**, 1813–1816.

Araya, A., **Telada, S.**, Tochikubo, K., Taniguchi, S., **Takahashi, R.**, Kawabe, K., Tatsumi, D., **Yamazaki, T.**, **Kawamura, S.**, Miyoki, S., Moriwaki, S., Musha, M., Nagano, S., **Fujimoto, M.-K.**, Horikoshi, K., Mio, N., Naito, Y., Takamori, A., and Yamamoto, K.: 1999, Absolute length determination of a long-baseline Fabry-Perot cavity by means of resonating modulation sidebands, *Appl. Opt.*, **38**, 2848–2856.

Arikawa, Y., **Tatematsu, K.**, **Sekimoto, Y.**, and Takahashi, T.: 1999, Shocked Molecular Gas Associated with the Supernova Remnant W28, *Publ. Astron. Soc. Japan*, **51**, L7–L10 and Plate 23, (*NROR*. **498**).

Aschwanden, M. J., Fletcher, L., **Sakao, T.**, Kosugi, T., and Hudson, H.: 1999, Deconvolution of Directly Precipitating and Trap-Precipitating Elections in Solar Hard X-Rays. III. YOHKOH Hard X-Ray Telescope Data Analysis, *Astrophys. J.*, **517**, 977–989.

Aschwanden, M. J., Kosugi, T., **Hanaoka, Y.**, Nishio, M., and Melrose, D. B.: 1999, Quadrupolar Magnetic Reconnection in Solar Flares. I. Three-Dimensional Geometry infrared from Yohkoh Observations, *Astrophys. J.*, **526**, 1026–1045.

Baba, N., Miura, N., **Sakurai, T.**, **Ichimoto, K.**, Soltau, D., and Brandt, P.: 1999, Shift-And-Add Reconctruction of Solar Granulation Images, *Solar Phys.*, **188**, 41–46.

Beisbart, C., Buchert, T., and Wagner, H.: 2000, Morphometry of spatial patterns, *Physica A*, in press.

Bernard, J. P., Dobashi, K., and **Momose, M.**: 1999, Outflow and Disk Around the Very Young Massive Star GH_2O 092.67+03.07, *Astron. Astrophys.*, **350**, 197–203.

Beskin, V. S., and **Okamoto, I.**: 2000, On the magnetohydrodynamic decollimation in compact objects, *Mon. Not. R. Astron. Soc., NRAS*, **313**, 445–453.

Beskin, V. S., and Rafikov, R. R.: 2000, On the particle acceleration near the light surface of radio pulsars, *Mon. Not. R. Astron. Soc., NRAS*, **313**, 433–444.

Brumberg, V. A., Bretagnon, P., Capitaine, N., Damour, T., Eubanks, T. M., **Fukushima, T.**, Guinot, B., Klioner, S. A., Kopeikin, S. M., Krivov, A. V., Seidelmann, P. K., and Soffel, M. H.: 1998, General Relativity and the IAU Resolutions, *Highlights of Astronomy*, **11A**, 194.

Buchert, T., Kerscher, M., and Sicka, C., 2000, Backreaction of inhomogeneities on the expansion: the evolution of cosmological parameters, *Phys. Rev. D*, **62**, 043525.

Chiba, M., and Futamase, T.: 1999, Statistics of QSO Lensing and Cosmological Parameters, *Progr. Theor. Phys.*, **133**(Suppl.), 115–135.

Chiba, M., and Yoshii, Y.: 1999, New Limits on a Cosmological Constant from Statistics of Gravitational

Lensing, *Astrophys. J.*, **510**, 42–53.

Cohen, M., Walker, R. G., Carter, B., Hammersley, P., Kidger, M., and **Noguchi, K.**: 1999 Spectral Irradiance Calibration in the Infrared. X. A Self-Consistent Radiometric All-Sky Network of Absolutely Calibrated Stellar Spectra, *Astron. J.*, **117**, 1864.

Colina, L., and **Wada, K.**: 2000, Nuclear Bar, Star Formation and Gas Fueling in the Active Galaxy NGC 4303, *Astrophys. J.*, **529**, 845.

Crossley, D., Hinderer, J., Casula, G., Francice, O., Hsu, H.-T., Imanishi, Y., Jenzch, G., Kaariainen, J., Merriam, J., Meurers, B., Neumeyer, J., Richter, B., Shibuya, K., **Sato, T.**, and Van Dam, T. : 1999, Network of Superconducting Gravimeters Benefits a Number of Displines, EOS, *Transaction American Geophysical Union*, **80**(11), 125–126.

Deguchi, S., Fujii, T., **Izumiura, H.**, **Kameya, O.**, Nakada, Y., Nakashima, J., Ootsubo, T., and **Ukita, N.**: 2000, SiO Maser Survey of the Galactic Disk IRAS Sources. II. $|l|<3°$ and $|b|<3°$, the Galactic Center Area, *Astrophys. J.*, **128** (Supple. No. 2), June in press.

Deguchi, S., Fujii, T., **Izumiura, H.**, Matsumoto, S., Nakada, Y., Wood, P. R., and Yamamura, I.: 1999, Apparent Double SiO Maser Sources, *Publ. Astron. Soc. Japan*, **51**, 355–361. (*NROR.* **489**).

Dehant, V., Arias, F., Bizouard, Ch., Bretagnon, P., Brezinski, A., Buffett, B., Capitaine, N., Defraigne, P., Viron, O. De, Feissel, M., Fligel, H., Forte, A., Gambis, D., Getino, G., Gross, R., Herring, T., **Kinoshita, H.**, Klioner, S., Mathews, P. M., McCarthy, D., Moisson, X., Petrov, S., Ponte, R. M., Roosebeek, F., Salstein, D., Schuh, H., Seidelmann, K., Soffel, M., Souchay, J., Vondrak, J., Wahr, J. M., Wallace, P., Weber, R., Williams, J., Yatskiv, Zharov, V., and Zhu, S. Y.: 1999, Considerations Concerning the Non-Rigid Earth Nutation Theory, *Celest. Mech. Dyn. Astron.*, **72**, 245–310.

Dehant, V., and **Fukushima, T.**: 1998, Precession, Nutation, and Astronomical Constants in the Dawn of the 21st Century, *Highlights of Astronomy*, **11A**, 149.

Deo, M. N., and **Kawaguchi, K.**: 1999, Millimeter- and Submillimeter-Wave Spectrum of Methylene Fluoride-d_2, *J. Mol. Spectrosc.*, **196**, 212–219.

Ferruit, P., Wilson, A. S., Falcke, H., **Simpson, C.**, Pecontal, E., and Durret, F.: 1999, The Extended Emission-line Region of the Seyfert Galaxy Mrk 573, *Mon. Not. R. Astron. Soc.*, **309**, 1.

Ferruit, P., Wilson, A. S., Whittle, M., **Simpson, C.**, Mulchaey, J. S., and Ferland, G. J.: 1999, HST/FOS Spectroscopy of Spatially Resolved Narrow Line Regions in the Seyfert 2 Galaxies NGC 2110 and NGC 5929, *Astrophys. J.*, **523**, 147.

Fragile, P. C., and **Mathews, G. J.**: 2000, Reconstruction of Stellar Orbits Close to Sagittarius Â: Possibilities for Testing General Relativity, *Astrophys. J.*, in press.

Fujimoto, M.-K., and TAMA collaboration: 2000, TAMA Ground-based Interferometer for the Detection of Gravitational Waves, *Adv. Space Res.*, **25**, 1161–1164.

Fujimoto, M. Y., Aikawa, M., and Kato, K.: 1999, A Model of Deep Mixing in Globular Cluster Red Giants, *Astrophys. J.*, **519**, 519–744.

Fujimoto, M. Y., Ikeda, Y., and Iben, Jr. I.: 2000, The Origin of Extremely Metal-Poor Carbon Stars and the Search for Population III, *Astrophys. J.*, **529**, L25–L28.

Fujisawa, K., Kobayashi, H., Hirabayashi, H., **Kameno, S.**, and **Inoue, M.**: 1999, Discovery of Large Doppler Factors in Radio-Loud Active Galactic Nuclei, *Publ. Astron. Soc. Japan*, **51**, 537–545.

Fujita, Y., Nagashima, M., and **Gouda, N.**: 2000, The Detection Rate of Molecular Gas in Elliptical Galaxies: Constraints on Galaxy Formation Theories, *Publ. Astron. Soc. Japan*, in press.

Fukuda, H., Habe, A., and **Wada, K.**: 2000, The Effect of Self-Gravity of Gas Fueling in Barred Galaxies with a Supermassive Black Hole, *Astrophys. J.*, **529**, 109.

Fukushima, T.: 1999a, Parallel/Vector Integration Methods for Dynamical Astronomy, *Cele. Mech. Dyn. Astr.*, **73**, 231–241.

Fukushima, T.: 1999b, Fast Transform from Geocentric to Geodetic Coordinates, *J. Geodesy.*, **73**, 603–610.

Fukushima, T.: 1999c, Fast Procedure Solving Universal Kepler's Equation, *Cele. Mech. Dyn. Astr.*, **75**, 201–226.

Fukushima, T.: 1999d, Symmetric Multistep Methods Revisited: II. Numerical Experiments, *Proc. IAU Colloq. 173* (Svoren *et al.* (eds.)), 309–314.

Furusho, R., Suzuki, B., Yamamoto, N., Kawakita, H., **Sasaki, T. Shimizu, Y.**, and **Kurakami, T.**: 1999, Imaging Polarimetry and Color of the Inner Coma of Comet Hale-Bopp (C/1995 O1) *Publ. Astron. Soc. Japan*, **51**, 367–373 and Plate 13–179.

Furuya, R. S., Kitamura, Y., Saito, M., **Kawabe, R.**, and Wootten, H. A.: 1999, VLA Observations of H_2O Masers in the Class 0 Protostar S106 FIR: Evidence for a 10 AU-Scale Accelerating Jet-like Flow, *Astrophys. J.*, **525**, 821–831. (*NROR.* **494**).

Gangadhara, R. T., **Deguchi, S.**, and Lesch, H.: 1999, Stimulated Raman Scattering of Water Maser Lines in Astrophysical Plasmas, *Phys. Plasmas*, **6**, 4088–4092.

Ghosh, P. N., Deo, M. N., and **Kawaguchi, K.**: 1999, Vibrational Transition Moment of the CH Radical Determined from the Herman-Wallis Effect, *Astrophys. J.*, **525**, 539–542. (*NROR*. **492**).

Glass, I. S., Matsumoto, S., Carter, B. S., and **Sekiguchi, K.**: 1999, Luminous Variables in the Quintuplet Cluster. *Mon. Not. R. Astron. Soc.*, **304**, L10–L14.

Gopalswamy, N., **Shibasaki, K.**, Thompson, B. J., Gurman, J., and Deforest, C.: 1999, Microwave Enhancement and Variability in the Elephant's Trunk Coronal Hole: Comparison with SOHO Observations, *J. Geophys. Res.*, **104**, 9767.

Gray, M. B., McClelland, D. E., Barton, M., and **Kawamura, S.**: 1999, A Simple High-sensitivity Interferometric Position Sensor for Test Mass Control on an Advanced LIGO Interferometer, *Optical and Quantum Electronics*, **31**, 571–582.

Hanaoka, Y.: 1999, High-Energy Electrons in Double-Loop Flares, *Publ. Astron. Soc. Japan*, **51**, 483–496.

Hara, H., and **Ichimoto, K.**: 1999, Microscopic Nonthermal Plasma Motions of Coronal Loops in a Solar Active Regions, *Astrophys. J.*, **513**, 969–982.

Hara, H., Nagata, S., **Kano, R.**, **Kumagai, K.**, **Sakao, T.**, **Shimizu, T.**, Tsuneta, S., Yoshida, T., Ishiyama, W., Oshino, T., and Murakami, K.: 1999, Narrow-Bandpass Multilayer Mirrors for an Extreme-ultraviolet Doppler Telescope, *Appl. Optics*, **38**, 6617–6627.

Harra-Murnion, L. K., Matthews, S. A., **Hara, H.**, and **Ichimito, K.**: 1999, Dynamics of Solar Active Region Loops, *Astron. Astrophys.*, **345**, 1011–1018.

Hasegawa, H., Ichikawa, T., Abe, S., Hamamura, S., Ohnishi, K., **Watanabe, J.**: 1997, Near-Infrared Photometric and Polarimetric Observations of Comet Hale-Bopp, *Earth, Moon, and Planets*, **78**, 353–358.

Hasegawa, H., **Ukita, N.**, **Matsuo, H.**, **Kuno, N.**, Saitoh, T., Sekiguchi, T., Fuse, T., Kawamura, R., and Yokogawa, S.: 2000, Millimeter Continuum Observations of Parent Comets of Meteor Storms, *Astron. J.*, **119**, 417–418.

Heki, K., **Matsumoto, K.**, and Floberghagen, R.: 1999, Three-dimensional Tracking of a Lunar Satellite with Differential Very-long-baseline-interferometry, *Adv. Space Res.*, **23**, 1821–1824.

Heki, K., Miyazaki, S., Takahashi, H., Kasahara, M., Kimata, F., Miura, S., Vasilenco, N., Ivashchenco A., and An, K.: 1999, The Amurian Plate Motion and Current Plate Kinematics in Eastern Asia, *J. Geophys. Res.*, **104**, 29147–29155.

Herrnstein, J. R., Moran, J. M., Greenhill, L. J., Diamond, P. J., **Inoue, M.**, **Nakai, N.**, **Miyoshi, M.**, Henkel, C., and Riess, A.: 1999, A Geometric Distance to the Galaxy NGC4258 from Orbital Motions in a Nuclear Gas Disk, *Nature*, **400**, 539–541.

Hirota, T., Yamamoto, S., **Kawaguchi, K.**, **Sakamoto, A.**, and **Ukita, N.**: 1999, Observations of HCN, HNC, and NH_3 in Comet Hale-Bopp, *Astrophys. J.*, 520, 895–900.

Hirotani, K., Iguchi, S., Kimura, M., and Wajima, K.: 1999, Pair Plasma Dominance in the 3C 279 Jet on Parsec Scales, *Publ. Astron. Soc. Japan*, **51**, 263–267.

Hirotani, K., and Shibata, S.: 1999, One-Dimensional Electric Field Structure of an Outer Gap Accelerator-I. Gamma-Ray Production Resulting from Curvature Radiation, *Mon. Not. R. Astron. Soc.*, **308**, 54–66.

Hirotani, K., and Shibata, S.: 1999, One-Dimensional Electric Field Structure of an Outer Gap Accelerator-II. Gamma-Ray Production Resulting from Inverse Compton Scattering, *Mon. Not. R. Astron. Soc.*, **308**, 67–76.

Hirotani, K., and Shibata, S.: 1999, Gamma-Ray Emission from Pulsar Outer Magnetosphere: Spectra of Curvature Radiation, *Publ. Astron. Soc. Japan*, **51**, 683–691.

Honma, M.: 1999, The Caustic Crossing Microlensing Event by Binary MACHOS and the Timescale Bias, *Astrophys. J.*, **511**, L29–L32.

Honma, M.: 1999, The Mass-to-Light Ratio of Binary Galaxies, *Astrophys. J.*, **516**, 693–703.

Honma, M.: 1999, MACHO Mass Determination Based on Space Telescope Observation, *Astrophys. J. Lett.*, **517**, L35–L38.

Honma, M., Oyama, T., Hachisuka, K., **Sawada-Satoh, S.**, Sebata, K., **Miyoshi, M.**, **Kameya, O.**, **Manabe, S.**, **Kawaguchi, N.**, **Sasao, T.**, **Kameno, S.**, **Fujisawa, K.**, **Shibata, K. M.**, **Bushimata, T.**, **Miyaji, T.**, **Kobayashi, H.**, **Inoue, M.**, **Imai, H.**, **Araki, H.**, **Hanada, H.**, **Iwadate, K.**, **Kaneko, Y.**, **Kuji, S.**, **Sato, K.**, **Tsuruta, S.**, **Sakai, S.**, **Tamura, Y.**, **Horiai, K.**, **Hara, T.**, **Yokoyama, K.**, Nakajima, J., Kawai, E., Okubo, H., Osaki, H., Koyama, Y., Sekido, M., Suzuyama, T., Ichikawa, R., Kondo, T., Sakai, K., Wada, K., Harada, N., Tougou, N., Fujishita, M., Shimizu, R., Kawaguchi, S., Yoshimura, A., Nakamura, M., Hasegawa, W., Morisaki, S., Kamohara, R., Funaki, T., Yamashita, N., Watanabe, T., Shimoikura, T., Nishio, M., Omodaka, T., and Okudaira, A.: 2000, J-Net Galactic Plane Survey of VLBI Radio Sources for VLBI Exploration of Radio Astrometry (VERA), *Publ. Astron. Soc. Japan*,

52, in press.

Horaguchi, T., Nishihara, E., **Yoshida, M.**, **Aoki, K.**, **Ito, T.**, Watanabe, M., **Ichikawa, S.**, **Takata, T.**, Yoshida, S., and Hamabe, M.: 1999, An Astronomical Data Archive System with a Java-based User Interface, *Publ. Astron. Soc. Japan,* **51**, 693–701.

Hori, K., Kosugi, T., Fujiki, K., Koshiishi, H., and **Shibasaki, K.**: 2000, Microwave Observation of Eruptive Solar Events with and without Flare Activity, *Astrophys. J.*, **533**, 557–567.

Horiuchi, S., and **Kameya, O.**: 2000, Highly Polarized Emission from the Bursting Water Maser in Orion-KL, *Publ. Astron. Soc. Japan,* **52**, in press.

Hosokawa, M., Ohnishi, K., and **Fukushima, T.**: 1999, Uncertainty of Pulsar Time Scale due to the Gravitational Time Delay of Intervening Stars and MACHOs, *Astron. Astrophys.*, **351**, 393–397.

Ichimoto, K., **Noguchi, M.**, **Tanaka, N.**, **Kumagai, K.**, **Shinoda, K.**, **Nishino, T.**, **Fukuda, T.**, **Sakurai, T.**, and Takeyama, N.: 1999, A New Observing System of the Corona at Norikura, *Publ. Astron. Soc. Japan,* **51**, 383–391.

Ikeda, M., Maezawa, H., Ito, T., Saito, G., **Sekimoto, Y.**, Yamamoto, S., **Tatematsu, K.**, Arikawa, Y., Aso, Y., **Noguchi, T.**, Shi, S.-C., Miyazawa, K., Saito, S., Ozeki, H., Fujisawa, H., **Ohishi, M.**, and Inatani, J.: 1999, Large-Scale Mapping Observations of the CI ($^3P_1$–$^3P_0$) and CO (J=3–2) Lines toward the Orion A Molecular Cloud, *Astrophys. J.*, **527**, L59–L62. (*NROR,* **508**)

Ikeda, Y., **Kawabata, K. S.**, and Akitaya, H.: 2000, The Spectropolarimetric Observations of Three Outburst Objects, CI Camelopardalis, Nova Sagittarii 1998, and U Scorpii, *Astron. Astrophys.*, **355**, 256–260.

Ikeda Y., and Tamura, S.: 2000, Spectroscopic Diagnostics of Symbiotic Stars. III.—Radial Velocity Analyses of HBV475, *Publ. Astron. Soc. Japan,* in press.

Imai, H., **Deguchi, S.**, and **Miyoshi, M.**: 1999, VLBA Observations of SiO Masers in the M Giant IRC-10414, *Publ. Astron. Soc. Japan,* **51**, 587–593. (*NROR.* **502**).

Imanishi, M., and Ueno, S.: 1999, The Optical/near-infrared Broad-line Emission and Hard X-ray Continuum of Active Galactic Nuclei and Ultraluminous Infrared Galaxies, *Mon. Not. R. Astron. Soc.*, **305**, 829–833.

Imanishi, M., and Ueno, S.: 1999, Hard X-ray Luminosities of Multinuclei Infrared Luminous Galaxies Showing a Radio/far-infrared Excess, *Astrophys. J.*, **527**, 709–718.

Irwin, A., and **Fukushima, T.**: 1999, A Numerical Time Ephemeris of the Earth, *Astron. Astrophys.*, **348**, 642–652.

Ishimaru, Y., and **Wanajo, S.**: 1999, Enrichment of the *r*-Process Element Europium in the Galactic Halo, *Astrophys. J.*, **511**, L33–L36.

Ito, T., and **Fukushima, T.**: 1997, Parallelized Extrapolation Method and its Application to the Orbital Dynamics, *Astron. J.*, **114**, 1260–1267.

Ito, T., and **Tanikawa, K.**: 1999, Stability and Instability of the Terrestrial Protoplanet System and their Roles in the Final Stage of Planet Formation, *ICARUS*, **139**, 336–349.

Itoh, Y., Chrysostomou, A., Burton, M., Hough, J. H., and **Tamura, M.**: 1999, The Magnetic Field Structure of the DR21 Region, *Mon. Not. R. Astron. Soc.*, **304**, 406–414.

Itoh, Y., **Kaifu, N.**, **Hayashi, M.**, **Hayashi, S. S.**, **Yamashita, T.**, **Usuda, T.**, **Noumaru, J.**, Maihara, T., Iwamuro, F., Motohara, K., Taguchi, T., and Hata, R.: 2000, A Pair of Twisted Jets of Ionized Iron from L 1551-IRS 5, *Publ. Astron. Soc. Japan,* **52**, 81.

Itoh, Y., **Tamura, M.**, and **Nakajima, T.**: 1999, A Near-Infrared Search for Companions around Very Low Luminosity Young Stellar Objects in Taurus, *Astron. J.*, **117**, 1471–1478.

Iwabuchi, T., and **Naito, I.**: 1999, Ten-yearly Polar Motion Connected with Precipitation Changes over the North American and Eurasian Continents, *J. Meteor. Soc. Japan,* **77**, 1185–1197.

Iwabuchi, T., **Naito, I.**, and Mannoji, N.: 2000, A Comparison of Global Positioning System Retrieved Precipitable Water Vapor with the Numerical Weather Prediction Analysis Data over the Japanese Islands, *J. Geophys. Res.*, **105**, 4573–4585.

Iwamuro, F., Motohara, K., Maihara, T., Iwai, J., Tanabe, H., Taguchi, T., Hata, R., Terada, H., Goto, M., Oya, S., Akiyama, M., **Ando, H.**, Aoki, T., Chikada, Y., Doi, M., Fukuda, T., Hamabe, M., **Hayashi, M.**, **Hayashi, S. S.**, Horaguchi, T. **Ichikawa, S.**, Ichikawa, T. **Imanishi, M.**, **Imi, K.**, **Inata, M.**, **Isobe, S.**, **Itoh, Y.**, **Iye, M.**, **Kaifu, N.**, **Kamata, Y.**, **Kanzawa, T.**, **Karoji, H.**, **Kashikawa, N.**, Kato, T., **Kobayashi, N.**, **Kobayashi, Y.**, **Kodaira, K.**, **Kosugi, G.**, **Kurakami, T.**, **Mikami, Y.**, **Miyashita, A.**, **Miyata, T.**, **Miyazaki, S.**, **Mizumoto, Y.**, **Nakagiri, M.**, Nakajima, K., **Nakamura, K.**, **Nariai, K.**, **Nishihara, E.**, **Nishikawa, J.**, **Nishimura, S.**, **Nishimura, T.**, **Nishino, T.**, **Noguchi, K. Noguchi, T.**, **Noumaru, J.**, **Ogasawara, R.**, **Okada, N.**, **Okita, K.**, **Omata, K.**, **Oshima, N.**, **Otsubo, M.**, **Sasaki, G.**, **Sasaki, T.**, Sekiguchi, M., **Sekiguchi, K.**, **Shelton, I. Simpson, C.**, **Suto, H.**, **Takami, H.**, **Takata, T.**, **Takato, N. Tamura, M.**, **Tanaka, K.**, **Tanaka, W. Tomono, D.**, **Torii, Y.**,

Usuda, T., Waseda, K., Watanabe, J., Watanabe, M., Yagi, M., Yamashita, T., Yamashita, Y., Yasuda, N. Yoshida, M., Yoshida, S., and **Yutani, M.**: 2000, Infrared Imaging of the Gravitational Lens PG 1115+080 with the Subaru Telescope, *Publ. Astron. Soc. Japan,* **52**, 25.

Iwamuro, F., Motohara, K., Maihara, T., Iwai, J., Tanabe, H., Taguchi, T., Hata, R., Terada, H., Goto, M., Oya, S., **Iye, M., Yoshida, M., Karoji, H., Ogasawara, R.,** and **Sekiguchi, K.**: 2000, Near-infrared Emission-line Galaxies in the Hubble Deep Field North, *Publ. Astron. Soc. Japan,* **52**, 73–79.

Iwata, I., **Okumura, S.,** and Saito, M.: 1999, Possible Young Stellar Objects without Detectable CO Emission, *Publ. Astron. Soc. Japan,* **51**, 653–662.

Iye, M., Iwamuro, F., Maihara, T. **Miyazaki, S.,** Okamura, S., Shimasaku, K., **Simpson, C., Akiyama, M., Ando, H.,** Aoki, T., Aoki, T., **Chikada, Y.,** Doi, M., Ebizuka, N., **Fukuda, T.,** Furusawa, H., Goto, M., Hamabe, M., Hata, R., **Hayashi, M., Hayashi, S. S.,** Horaguchi, T., **Ichikawa, S.,** Ichikawa, T., **Imanishi, M., Imi, K., Inata, M., Isobe, S., Itoh, Y.,** Iwai, J., **Kaifu, N., Kamata, Y., Kanzawa, T., Karoji, H., Kashikawa, N.,** Kato, T., Kawasaki, W., Kimura, M., **Kobayashi, N., Kobayashi, Y., Kodaira, K.,** Komiyama, Y., **Kosugi, G., Kurakami, T., Mikami, Y., Miyashita, A., Miyata, T., Mizumoto, Y.,** Motohara, K., **Nakagiri, M.,** Nakajima, K., **Nakamura, K.,** Nakata, F., **Nariai, K., Nishihara, E., Nishikawa, J., Nishimura, S., Nishimura, T., Nishino, T., Noguchi, K., Noguchi, T., Noumaru, J., Ogasawara, R., Okada, N., Okita, K., Omata, K., Oshima, N., Otsubo, M.,** Oya, S., **Sasaki, G., Sasaki, T.,** Sawada, Y., **Sekiguchi, K.,** Sekiguchi, M., **Shelton, I., Suto, H.,** Suzuki, K., Taguchi, T., **Takami, H., Takata, T., Takato, N., Tamura, M.,** Tanabe, H., **Tanaka, K., Tanaka, W.,** Terada, H., **Tomono, D., Torii, Y.,** Tsukamoto, H., **Usuda, T., Watanabe, J., Watanabe, M., Yagi, M., Yamashita, T., Yamashita, Y., Yasuda, N., Yoshida, M.,** Yoshida, S., and **Yutani, M.**: 2000, Subaru First-Light Deep Photometry of Galaxies in A 851 Field, *Publ. Astron. Soc. Japan,* **52**, 9.

Izumiura, H., Deguchi, S., Fujii, T., **Kameya, O.,** Matsumoto, S., Nakada, Y., Ootsubo, T., and **Ukita, N.**: 1999, SiO Maser Survey of the Galactic Disk IRAS Sources. I. $15° < l < 25°$, Near End of the Galactic Bar, *Astrophys. J., Suppl.,* **125**, 257–276.

Jiang, B. W., Szczerba, R., and **Deguchi, S.**: 1999, IRAS 03313+6058: an AGB Star with 30 Micron Emission, *Astron. Astrophys.,* **344**, 918–922.

Kagi, E., and **Kawaguchi, K.**: 2000, Rotational Spectrum of the $MgN^{13}C$ Radical, *J. Molec. Spectrosc.,* **199**, 309–310.

Kaifu, N., Usuda, T., Hayashi, S. S., Itoh, Y., Akiyama, M., Yamashita, T., Nakajima, Y., **Tamura, M., Inutsuka, S., Hayashi, M.,** Maihara, T., Iwamuro, F., Motohara, K., Iwai, J., Tanabe, H., Taguchi, T., Hata, R., Terada, H., Goto, M., **Ando, H.,** Aoki, T., **Chikada, Y.,** Doi, M., Ebizuka, N., **Fukuda, T.,** Hamabe, M., Hasegawa, T., Horaguchi, T., **Ichikawa, S.,** Ichikawa, T., Imanishi, M., **Imi, K., Inata, M., Isobe, S., Iye, M., Kamata, Y., Kanzawa, T., Karoji, H., Kashikawa, N.,** Kataza, H., Kato, T., **Kobayashi, N., Kobayashi, Y., Kodaira, K., Kosugi, G., Kurakami, T., Mikami, Y., Miyama, S. M., Miyashita, A., Miyata, T., Miyazaki, S., Mizumoto, Y., Nakagiri, M.,** Nakajima, K., **Nakamura, K., Nariai, K., Nishihara, E., Nishikawa, J., Nishimura, S., Nishimura, T., Nishino, T., Noguchi, T., Noguchi, K., Noumaru, J., Ogasawara, R., Okada, N., Okita, K., Omata, K., Oshima, N., Otsubo, M., Sasaki, G., Sasaki, T.,** Sekiguchi, M., **Sekiguchi, K., Shelton, I., Simpson, C., Suto, H., Takami, H., Takata, T., Takato, N., Tanaka, K.,** Tanaka, W., **Tomono, D., Torii, Y., Waseda, K., Watanabe, J., Watanabe, M., Yagi, M., Yamashita, Y., Yasuda, N., Yoshida, M.,** Yoshida, S., and **Yutani, M.**: 2000, The First Light of the Subaru Telescope: A New Infrared Image of the Orion Nebula, *Publ. Astron. Soc. Japan,* **52**, 1–8.

Kajino, T., Otsuki, K., Wanajo, S., Orito, M., and **Mathews, G. M.**: 2000, Impact of a Few Body Reactions on Explosive Nucleosynthesis: Supernovae and Big-Bang, *Few-Body Systems, Suppl.,* **12**, in press.

Kajino, T., Terasawa, M., Sumiyoshi, K., **Otsuki, K.,** Tagoshi, H., and Wanajo, S.: 2000, *r*-Process Nucleo-Synthesis in Relativistic Neutrino-driven Winds and the Role of Light Nuclear Reactions, *Nucl. Phys. A,* in press.

Kajino, T., and Wanajo, S.: 2000, *r*-Process Nucleosynthesis in Core-collapse Supernova Explosion, *Nucl. Phys. A,* in press.

Kajisawa, M., Yamada, T., Tanaka, I., Maihara, T., Iwamuro, F., Terada, H., Goto, M., Motohara, K., Tanabe, H., Taguchi, T., Hata, R., **Iye, M., Imanishi, M.,** Chikada, Y., **Simpson, C., Sasaki, T., Kosugi, G., Usuda, T., Kanzawa, T.,** and **Kurakami, T.**: 2000, Subaru Observations for the K-band Luminosity Distribution of the Galaxies in the Clusters at $z=1.2$, *Publ. Astron. Soc. Japan,* **52**, 53–60.

Kajisawa, M., Yamada, T., Tanaka, I., Maihara, T., Iwamuro, F., Terada, H., Goto, M., Motohara, K., Tanabe, H., Taguchi, T., Hata, R., **Iye, M., Imanishi, M., Chikada, Y., Yoshida, M., Simpson, C., Sasaki, T., Kosugi, G., Usuda, T., Sekiguchi, K.**: 2000, Color-

Magnitude Sequence in the Clusters at $z=1.2$ near the Radio Galaxy 3C 324, *Publ. Astron. Soc. Japan*, **52**, 61–72.

Kakuta, C., **Tsubokawa, T.**, and **Iwadate, K.**: 2000, Coupling of Long Oceanic Waves in the Pacific Ocean and the Rotating Elastic Earth During the 1986–1987 El Niño, *J. Geophys. Res*, **105, B2**, 3089–3094.

Kameno, S., Horiuchi, S., Shen, Z.-Q., **Inoue, M., Kobayashi, H.**, Hirabayashi, H., and Murata, Y.: 2000, Asymmetric Free-Free Absorption towards a Double Lobe of OQ 208, *Publ. Astron. Soc. Japan*, **52**, 209–216.

Kano, R., Hara, H., Kobayashi, K., Nagata, S., **Sakao, T., Shimizu, T., Tsuneta, S.**, and Yoshida, T.: 2000, Initial Results from the XUV Doppler Telescope, *Adv. Space Res.*, **25**, 1739–1742.

Kawabata, K. S., Hirata, R., Ikeda, Y., Akitaya, H., Seki, M., Matsumura, M., and Okazaki, A.: 2000, Nova V4444 Sagittarii 1999: A Spectropolarimetric Evidence for a Pre-existing Circumstellar Dust Cloud, *Astrophys. J.*, in press.

Kawabata, K. S., Okazaki, A., Akitaya, H., Hirakata, N., **Hirata, R.**, Ikeda, Y., Kondoh, M., Masuda, S., and Seki, M.: 1999, A New Spectropolarimeter at the Dodaira Observatory, *Publ. Astron. Soc. Pacific*, **111**, 898–908.

Kawano, N., Hosokawa, M., **Hanada, H.**, and Imae, M.: 1999, Feasibility Study of Planetodesy by Use of Inverse VLBI Method, *J. Geod. Soc. Japan*, **45**, 181–204.

Kikuchi, K., Furusho, T., **Ezawa, H.**, Yamasaki, N. Y., Ohashi, T., Fukazawa, Y., and Ikebe, Y.: 1999, ASCA Measurements of Metallicity and Temperature Distributions in Three Clusters: A4059, MKW 3s, and 2 A 0335+096, *Publ. Astron. Soc. Japan*, **51**, 301–315.

Kinoshita, D., **Watanabe, J.**, Fukushima, H., Sekiguchi, T., Yamamoto, N., and Abe, S.: 1997, Wide Field Imaging of Ion Tail of Comet C/Hale-Bopp, *Earth, Moon, and Planets*, **78**, 265–269.

Kinoshita, H., and **Nakai, H.**: 1999, Analytical Solution of Kozai Mechanism and its Application to Dynamical Astronomy, *Celest. Mech. Dyn. Astron.*, **75**, 125–147.

Kobayashi, C., **Tsujimoto, T.**, and Nomoto, K.: 2000, The History of the Cosmic Supernova Rate Derived from the Evolution of the Host Galaxies, *Astrophys. J.*, **539**, in press.

Kobayashi, N., Nagata, T., **Tamura, M.**, Takeuchi, T., **Takami, H., Kobayashi, Y.**, and Sato, S.: 1999, Near-Infrared Spectropolarimetry of Three Prototype Low-Mass Young Stellar Objects in the Taurus Dark Cloud, *Astrophym. J.*, **517**, 256–263.

Kodaira, K., Kashikawa, N., and **Misawa, T.**: 2000, Luminosity Versus Phase-Space-Density Relation of Galaxies Revisited, *Astrophys. J.*, **531**, 665.

Kodaira, K., Vansevicius, V., **Tamura, M.**, and **Miyazaki, S.**: 1999, The Stellar Population of the M31 Spiral Arm around OB Association A2, *Astrophys. J.*, **515**, 153–164.

Kodaira, K., Vansevicius, V., **Tamura, M.**, and **Miyazaki, S.**: 1999, The Stellar Population of the M31 Spiral Arm around OB Association A24 *Astrophys. J.*, **519**, 153.

Kohno, K., Kawabe, R., Ishizuki, S., and **Vila-Vilaro, B.**: 1999, NMA Survey of CO and HCN Emission from Nearby Active Galaxies, *Adv. Space Res.*, **23**, 1011–1014.

Koike, O., Hashimoto, M., Arai, K., and **Wanajo, S.**: 1999, Rapid Proton Capture on Accreting Neutron Stars—Effects of Uncertainty in the Nuclear Process, *Astron. Astrophys.*, **342**, 464.

Komatsu, E., Kitayama, T., Suto, Y., Hattori, M., **Kawabe, R., Matsuo, H.**, Schindler, S., and Yoshikawa, K.: 1999, Submillimeter Detection of the Sunyaev-Zeldovich Effect toward the Most Luminous X-Ray Cluster at $z=0.45$, *Astrophys. J.*, **516**, L1–L4.

Komiyama, Y., Yagi, M., Miyazaki, S., Okamura, S., Tamura, S., **Fukushima, H.**, Doi, M., Furusawa, H., Fuse, T., Hamabe, M., **Hayashi, M.**, Hayashino, T., **Imi, K., Iye, M., Kaifu, N., Karoji, H.**, Kawasaki, W., Kimura, M., **Kosugi, G.**, Nakata, F., **Noumaru, J., Okada, N., Sasaki, T.**, Sawada, Y., Sekiguchi, M., **Shelton, I.**, Shimasaku, K., Suzuki, K., **Takata, T.**, Taniguchi, Y., **Usuda, T., Yamashita, T.**, and **Yasuda, N.**: 2000, High-Resolution Images of the Ring Nebula Taken with the Subaru Telescope, *Publ. Astron. Soc. Japan*, **52**, L93–L98.

Kondoh, M., and Nakamura, Y.: 2000, A Probable Variation in the Polarizaiton of the Early-Type Eclipsing Binary System XZ Cep, *Inf. Bull. Var. Stars.* submitted

Korchagin, V., Kikuchi, N., and **Miyama, S. M.**: 2000, Global Instabilities in Disks of Spiral Galaxies Comparison of Theory and Observations for Galaxies NGC 488, NGC 1566, and NGC 6503, *Astron. Astrophys. Transactions*, **20**, 1.

Korchagin, V., Kikuchi, N., **Miyama, S. M.** Orlova, N., and Peterson, B. A.: 2000, Global Spiral Modes in NGC 1566: Observations and Theory, *Astrophys, J.*, **541**, 565.

Korchagin, V., Mayya, Y. D., and Vorobyov, E.: 2000, Optical Color Gradients in Star-Forming Ring Galaxies, *Astrophys. J.*, submitted.

Korchagin, V., and Theis, C.: 1999, Global Spiral Modes in the Star-Forming Gravitating Disks, *Astron. Astrophys.*, **347**, 442

Korchagin, V., Tsuchiya, T., and **Miyama, S. M.**: 2000, On the Origin of Faint Intracluster Starlight in Coma, *Astrophy, J.*, accepted.

Korchagin, V., Vorobyov, E. I., and Mayya, Y. D.: 1999, Chemical Abundance Gradients in the Star Forming Ring Galaxies, *Astrophys. J.*, **522**, 767.

Koyama, H., and **Inutsuka, S.**: 2000, Molecular Cloud Formation in Shock-Compressed Layers, *Astrophys. J.*, **532**, 980–993.

Kundu, M. R., Nindos, A., Raulin, J.-P., **Shibasaki, K.**, White, S. M., Nitta, N., Shibata, K., and Shimojo, M.: 1999, A Microwave Study of Coronal Ejecta, *Astrophys. J.*, **520**, 391–398.

Kuroda, K., Ohashi, M., Miyoki, S., Tatsumi, D., Sato, S., Ishizuka, H., **Fujimoto, M.-K., Kawamura, S., Takahashi, R., Yamazaki, T., Arai, K., Fukushima, M., Waseda, K., Telada, S., Ueda, A.**, Shintomi, A., Yamamoto, A., Suzuki, T., Saito, Y., Haruyama, T., Sato, N., Tsubono, K., Kawabe, K., Ando, M., Ueda, K., Yoneda, H., Musha, M., Mio, N., Moriwaki, S., Araya, A., and Kanda, N.: 1999, Large-scale Cryogenic Gravitational Wave Telescope, *Int. J. of Mod. Phys. D*, **8**, 557–579.

Laughlin, G., Korchagin, V., and Adams, F. C.: 1999, The Fate of an Unstable Mode, *Astron. Soc. Pac. Conf. Ser.*, **Vol. 160**, 132.

Lee, J., Gary, D. E., and **Shibasaki, K.**: 2000, Magnetic Trapping and Electron Injection in Two Contrasting Solar Microwave Bursts, *Astrophys. J.*, **531**, 1109–1120.

Maezawa, H., Ikeda, M., Ito, T., Saito, G., **Sekimoto, Y.**, Yamamoto, S., **Tatematsu, K., Arikawa, Y., Aso, Y., Noguchi, T.**, Shi, S. C., Miyazawa, K., Saito, S., Ozeki, H., Fujisawa, H., **Ohishi, M.**, and Inatani, J.: 1999, Large-Scale Mapping Observations of the CI $^3P_1$–$^3P_0$ Line toward Heiles Cloud 2 in the Taurus Dark Cloud, *Astrophys. J.*, **524**, L129–L132.

Masunaga, H., and **Inutsuka, S.**: 1999, Does $\tau \approx 1$ Terminate the Isothermal Evolution of Collapsing Clouds? *Astrophys. J.*, **510**, 822–827.

Masunaga, H., and **Inutsuka, S.**: 2000, A Radiation Hydrodynamic Model for Protostellar Collapse II. The Second Collapse and the Birth of a Protostar, *Astrophys. J.*, **531**, 350–365.

Masunaga, H., and **Inutsuka, S.**: 2000, Infall Signatures in Line Spectral Profiles of Protostellar Envelopes, *Astrophys. J.*, **536**, 406–415.

Mathews, G. J., and Wilson, J. R.: 2000, Revised Relativistic Hydrodynamical Model for Neutron-Star Binaries, *Phys. Rev, D*, **61**, 127–304.

Matsumoto, K., Heki, K., and Rowlands, D. D.: 1999, Impact of Far-side Satellite Tracking on Gravity Estimation in the SELENE Project, *Adv. Space Res.*, **23**, 1809–1812.

Matsuo, H., Kuno, N., Kashihara, H., and Tsarevsky, G. S.: 1999, Millimeter-Wave Continuum Observations of High-Z Radio Quasars, *Adv. Space Res.*, **23**, 1147–1150.

Matsushita, S., **Kohno, K., Vila-Vilaro, B.**, Tosaki, T., and **Kawabe, R.**: 1999, High-Density and High-Temperature Molecular Gas around the AGN in M 51, *Adv. Space Res.*, **23**, 1015–1018.

Matsushita, S., **Matsuo, H.**, Pardo, J. R., and Radford, S. J. E.: 1999, FTS Measurements of Submillimeter-Wave Atmospheric Opacity at Pampa la Bola II: Supra-Terahertz Windows and Model Fitting, *Publ. Astron. Soc. Japan*, **51**, 603–610 and Plate 24. (*NROR*. 491).

Migenes, V., Horiuchi, S., Slysh, V. I., Val'tts, I. E., Golubev, V. V., Edwards, P. G., Fomalont, E. B., Okayasu, R., Diamond, P. J., **Umemoto, T., Shibata, K. M.**, and **Inoue, M.**: 1999, The VSOP Prelaunch H_2O Maser Survey. I. VLBA Observations, *Astrophys. J., Suppl.*, **123**, 487–513. (*NROR*. **495**).

Mikkola, S.: 1999, Efficient Symplectic Integration of Satellite Orbits, *Cele. Mech. Dyn. Astron.*, **74**, 275–285.

Mikkola, S., and **Tanikawa, K.**: 1999, Explicit Symplectic Algorithm for Time-Transformed Hamiltonians, *Cele. Mech. Dyn. Astron.*, **74**, 287–295.

Mikkola, S., and **Tanikawa, K.**: 1999, Algorithmic Regularization of the Few-Body Problem, *Mon. Not. R. Astron. Soc.*, **310**, 745–749.

Miura, N., Baba, N., **Sakurai, T., Ichimoto, K.**, Soltau, D., and Brandt, P.: 1999, Resolution Improvement of Solar Images, *Solar Phys.*, **187**, 347–356.

Miyazaki, S., and **Heki, K.**: 2000, Crustal Velocity Field of Southwest Japan: Subduction and Arc-arc Collision, *J. Geophys. Res.*, in press.

Motohara, K., Iwamuro, F., Terada, H., Goto, M., Iwai, J., Tanabe, H., Taguchi, T., Hata, R., Maihara, T., Oya, S., **Iye, M., Kosugi, G., Noumaru, J., Ogasawara, R., Sasaki, T., Takata, T.**: 2000, Infrared Imaging of $z=2.43$ Radio Galaxy B3 0731+438 with the Subaru Telescope—Detection of H alpha Ionization Cones of a Powerful Radio Galaxy, *Publ. Astron. Soc. Japan*, **52**, 33–42.

Muraishi, H., Tanimori, T., Yanagita, S., Yoshida, T., Kifune, T., Dazeley, S. A., Edwards, P. G., Gunji, S., Hara, S., Hara, T., Jinbo, J., Kawachi, A., Kubo, H., Kushida, J., Matsubara, Y., **Mizumoto, Y.**, Mori, M., Moriya, M., Muraki, Y., Naito, T., Nishijima, K., Patterson, J. R., Roberts, M. D., Rowell, G. P., Sako, T., Sakurazawa, K., Sato, Y., Susukita, R., Tamura, T., Yoshikoshi, T., and Yuki, A.: 1999, Observation of RX J1713.7–3946 by CANGAROO Telescope, *Astron. Nachr.*, **320**, 324.

Nagao, T., Murayama, T., Taniguchi, Y., and **Yoshida, M.**: 1999, Extended High-Ionization Nuclear Emission-Line Region in the Seyfert Galaxy NGC 4051, *Astron. J.*, **119**, 620–630.

Nagao, T., Murayama, T., Taniguchi, Y., and **Yoshida, M.**: 1999, Extended High-Ionization Nuclear Emission-Line Region in the Seyfert Galaxy NGC 4051, *Astron. J.*, **119**, 620–630.

Nagashima, M., **Gouda, N.**, and Sugiura, N.: 1999, Effects of the UV Background Radiation on Galaxy Formation, *Mon. Not. R. Astro. Soc.*, **305**, 449–456.

Naito, I., Zhou, Y.-H., Sugi, M., Kawamura, R., and Nobuo, N.: 2000, Three-Dimensional Atmospheric Angular Momentum simulated by the Japan Meteorological Agency Model for the Period of 1955–1994, *J. Meteorol. Soc. Japan*, **78**, 111–122.

Nakagawa, T., Kii, T., Fujimoto, R., Miyazaki, T., Inoue, H., Ogasaka, Y., Ikebe, Y., and **Kawabe, R.**: 1999, SCA Observations of Ultra Luminous Infrared Galaxies—Evolution from Starburst to AGN? *Astron. Nachr.*, **320, no. 4**, 246.

Nakajima, T.: 2000, Future Studies of Brown Dwarfs from Space, *Adv. Space Res.*, **25**, 2225.

Nakajima, T., Tsuji, T., Maihara, T., Iwamuro, F., Motohara, K., Taguchi, T., Hata, R., **Tamura, M.**, and **Yamashita, T.**: 2000, Near-Infrared Spectroscopy of the Cool Brown Dwarf, SDSS 1624+00, *Publ. Astron. Soc. Japan*, **52**, 87.

Nakajima, Y., **Tamura, M.**, Oasa, Y., and **Nakajima, T.**: 2000, A Near-Infrared Imaging Survey of the Lupus 3 Dark Cloud: A Modest Cluster of Low-Mass, Pre-Main-Sequence Stars, *Astron. J.*, **119**, 873.

Nakamura, T. T., and **Deguchi, S.**: 1999, Wave Optics in Gravitational Lensing, *Prog. Theor. Phys. Suppl.*, **133**, 137–153.

Nakata, F., Shimasaku, K., Doi, M., **Kashikawa, N.**, Kawasaki, W., Komiyama, Y., Okamura, S., Sekiguchi, M., **Yagi, M.**, and **Yasuda, N.**: 1999, Probing the Evolution of Early-type Galaxies Using Multicolour Number Counts and Redshift Distributions, *Mon. Not. R. Astron. Soc.*, **309**, L25–L29.

Nakayama, H., Fujii, Y., **Ishiguro, M.**, Nakamura, R., Yokogawa, S., Yoshida, F., and Mukai, T.: 2000, Observations of Polarization and Brightness Variations with the Rotation for Asteroids 9 Metis, 52 Europa and 1036 Ganymed, *ICARUS*, in press.

Namiki, N., **Hanada, H.**, **Tsubokawa, T.**, **Kawano, N.**, **Ooe, M.**, **Heki, K.**, Iwata, T., Ogawa, M., Takano, T., and RSAT/VRAD/LALT mission groups: 1999, Selenological Experiments of SELENE: Relay Satellite, Differential VLBI and Laser Altimeter, *Adv. Space Res.*, **23**, 1817–1820.

Nan, R. D., Zhang, H. Y., Gabuzda, D. C., and **Inoue, M.**: 1999, VLBA Polarimetry Observation of the BL Lacertae Object 0300+470, *Publ. Astron. Soc. Japan*, **51**, 955–959.

Nan, R. D., Gabuzda, D. C., **Kameno, S.**, Schilizzi, R. T., and **Inoue, M.**: 1999, VLBI Polarimetry of the High Rotation Measure Source 3C 119 at 8.4 GHz, *Astron. Astrophys.*, **344**, 402–408.

Nindos, A., Kundu, M. R., White, S. M., Gary, D. E., **Shibasaki, K.**, and Dere, K. P.: 1999, Microwave and Extreme Ultraviolet Observations of Solar Polar Regions, *Astrophys. J.*, **527**, 415–425.

Nishida, S., Tanabe, T., Nakada, Y., Matsumoto, S., **Sekiguchi, K.**, and Glass, I. S.: 2000, The Variability of Magellanic Cluster Infrared Mtars, *Mon. Not. R. Astron. Soc.*, **313**, 136–140.

Nitta, S.: 1999, An Application of the Kerr Black Hole Fly-wheel Model to Statistical Properties of QSOs/AGNs, *Mon. Not. R. Astron. Soc.*, **308**, 995–1005.

Nitta, S., **Tanuma, S.**, Shibata, K., and Maezawa, K.: 2000, Fast Magnetic Reconnection in Free Space: Self-similar Evolution Process, *Astrophys. J.*, (Mar. 2000) submitted.

Oasa, Y., **Tamura, M.**, and Sugitani, K.: 1999, A Deep Near-Infrared Survey of the Chamaeleon I Dark Cloud Core, *Astrophys. J.*, **526**, 336–343.

Ohnaka, K., Tsuji, T., and **Aoki, W.**: 2000, Elemental Abundances of Carbon, Nitrogen and Oxygen in Carbon Stars, *Astron. Astrophys.*, **353**, 528.

Ohnishi, K., Hosokawa, M., and **Fukushima, T.**: 1999, MACHO Detections from Measurements of Gravitational Deflection, *Proc. IAU Symp.* 183 (ed. K. Sato), 261.

Ohta, K., Matsumoto, T., Maihara, T., Iwamuro, F., Terada, H., Goto, M., Motohara, K., Taguchi, T., Hata, R., **Yoshida, M.**, **Iye, M.**, **Simpson, C.**, **Takata, T.**: 2000, [OII] 3727 Emission from the Companion to the Quasar BR 1202–0725 at $z=4.7$, *Publ. Astron. Soc. Japan*, in press.

Ohtsuka, K., Shimoda, C., Yoshikawa, M., **Watanabe, J.**: 1997, Activity Profile of the Sextantid Meteor Shower, *Earth, Moon, and Planets*, **77**, 83–91.

Ohyama, Y., **Yoshida, M.**, **Takata, T.**, **Imanishi, M.**, **Usuda, T.**, Saito, Y., Taguchi, H., Ebizuka, N., Iwamuro, F., Motohara, K., Taguchi, T., Hata, T., Maihara, T., **Iye, M.**, **Sasaki, T.**, **Kosugi, G.**, **Ogasawara, R.**, **Noumaru, J.**, **Mizumoto, Y.**, **Yagi, M.**, and **Chi-**

kada, Y.: 2000, Superwind-Driven Intense H_2 Emission in NGC 6240, *Publ. Astron. Soc. Japan*, in press.

Okamoto, I.: 1999, Do Magnetized Winds Self-collimate? *Mon. Not. R. Astron. Soc.*, **307**, 253–278.

Okoshi, K., and Ikeuchi, S.: 1999, Evolution of Lyman alpha Clouds at Low Redshifts, *Publ. Astron. Soc. Japan*, **51**, 63–70.

Omodaka, T., Maeda, T., **Miyoshi, M.**, Okudaira, A., Nishio, M., **Miyaji, T.**, Motiduki, N., Morimoto, M., Kobayashi, H., and **Sasao, T.**: 1999, The Enormous Outburst of the 7.9 km s^{-1} Water-Maser Feature in Orion KL, *Publ. Astron. Soc. Japan*, **51**, 333–336. (*NROR*. **504**).

Orito, M., Kajino, T., Mathews, G. J., and Boyd, R. N.: 2000, Neutrino Degeneracy and Decoupling: New Limits from Primordial Nucleosynthesis and the Cosmic Microwave Background, *Astrophys. J.*, submitted.

Otsuki, K., Tagoshi, H., **Kajino, T.**, and **Wanajo, S.**: 2000, The General Relativistic Effects on Neutrino-driven Winds from Young, Hot Neutron stars and the *r*-Process Nucleosynthesis, *Astrophys. J.*, **533**, 424–439.

Raulin, J.-P., White, S. M., Kundu, M. R., Silva, A. V., and **Shibasaki, K.**: 1999, Multiple Components in the Millimeter Emission of a Solar Flare, *Astrophys. J.*, **522**, 547–558.

Reeves, J. N., O'Brien, P. T., Vaughan, S., Law-Green, D., Ward, M., **Simpson, C.**, Pounds, K., Edelson, R.: 2000, PDS 456: An Extreme Accretion Rate Quasar?, *Mon. Not. R. Astron. Soc.*, **312**, L17.

Reich, W., Sofue, Y., and **Matsuo, H.**: 2000, 150 GHz NOBA Observations of the Galactic Center Arc, *Publ. Astron. Soc. Japan*, **52**, 355–361.

Roberts, M., McGee, P., Dazeley, S. A., Edwards, P. G., Hara, T., Holder, J., Kawachi, A., Kifune, T., Matsubara, Y., **Mizumoto, Y.**, Mori, M., Muraishi, H., Muraki, Y., Naito, T., Nishijima, K., Ogio, S., Osaki, T., Patterson, J. R., Rowell, G. P., Sako, T., Sakurazawa, K., Susukita, R., Tamura, T., Tanimori, T., Thornton, G. J., Yanagita, S., Yoshida,T., and Yoshikoshi, T.: 1999, TeV Gamma-ray Observations of Three X-ray Selected BL Lacs, *Astron. Astrophys.*, **343**, 691–696.

Rowell, G. P., Dazeley, S. A., Edwards, P. G., Gunji, S., Hara, T., Holder, J., Kawachi, A., Kifune, T., Matsubara, Y., **Mizumoto, Y.**, Mori, M., Muraishi, H., Muraki, Y., Naito, T., Nishijima, K., Ogio, S., Patterson, J. R., Roberts, M. D., Sako, T., Sakurazawa, K., Susukita, R., Tamura, T., Tanimori, T., Thornton, G. J., Yanagita, S., Yoshida, T., and Yoshikoshi, T.: 1999, TeV Observations of Centaurus A, *Astroparticle Phys.*, **11**, 217–219.

Ryan, S. G., Beers, T. C., **Kajino, T.**, and Rosolankova, K.: 2000, Ultra-Lithium-Deficient Halo Stars and Blue Stragglers: A Unifying View, *Astrophys. J.*, submitted.

Ryan, S. G., **Kajino, T.**, Beers, T. C., **Suzuki, T.-K.**, Romano, D., Matteucci, F., and Rosolankova, K.: 2000, Abundances and Evolution of Lithium in the Galactic Halo and Disk, *Astrophys. J.*, submitted.

Saito, M., Iwata, I., **Okumura, S.**, Mori, A., and Yamashita, T.: 1999, Near-Infrared Photometry of Evolved Planetary Nebulae, *Publ. Astron. Soc. Japan*, **51**, 673–676.

Saito, M., **Sunada, K., Kawabe, R.**, Kitamura, Y., and Hirano, N.: 1999, The Initial Conditions for Formation of Low-Mass Stars: Kinematics and Density Structure of the Protostellar Envelope in B335, *Astrophys. J.*, **518**, 334–345.

Saito, Y., Ogawa, Y., Horikoshi, G., Matuda, N., **Takahashi, R.**, and **Fukushima, M.**: 1999, Vacuum System of the 300 m Gravitational Wave Laser Interferometer in Japan (TAMA300), *Vacuum*, **53**, 353–356.

Sakamoto, K., Okumura, S. K., Ishizuki, S., and Scoville, N. Z.: 1999, Bar-Driven Transport of Molecular Gas to Galactic Centers and its Consequences, *Astrophys. J.*, **525**, 691–701. (*NROR*. **500**).

Sakamoto, K., Okumura, S. K., Ishizuki, S., and Scoville, N. Z.: 1999, CO Images of the Central Regions of 20 Nearby Spiral Galaxies, *Astrophys. J., Suppl.*, **124**, 403–437. (*NROR*. **499**).

Sakamoto, S.: 1999, Mass and Physical Conditions of Molecular Gas at Cosmological Distances Probed with CO Lines, *Astrophys. J.*, **523**, 701–708. (*NROR*. **488**).

Sakao, T., Tsuneta, S., Hara, H., Shimizu, T., Kano, R., Kumagai, S., Yoshida, T., Nagata, S., and Kobayashi, K.: 1999, The XUV Doppler Telescope (XDT), *Solar Phys.*, **187**, 303–333.

Salmonson, J. D., Wilson, J. R., and **Mathews, G. J.**: 2000, Gamma-Ray Bursts via the Neutrino Emission from Heated Neutron Stars, *Astrophys. J.*, submitted.

Sano, T., and **Miyama, S. M.**: 1999, Magnetorotational Instability in Protoplanetary Disks. I. On the Global Stability of Weakly Ionized Disk with Ohmic Dissipation, *Astrophys. J.*, **515**, 776–786.

佐々成正, **吉田春夫**: 2000, 非線形 Schrodinger 方程式に対する symplectic 数値解法, 日本応用数理学会論文誌, **10**, 119–131.

Sato, I., Sarounova, L., **Fukushima, H.**: 1999, Size and Shape of Trojan Asteroi Diomedes from its Occultation and Photometry, *ICARUS*, **145**, 25–32.

Sato, J., Kosugi, T., and Makishima, K.: 1999, Improvement of YOHKOH Hard X-ray Imaging, *Publ. Astron. Soc. Japan,* **51**, 127–150.

Sato, K.-H., Hara, T., Kuji, S., Asari, K., Nishio, M., and **Kawano, N.**: 1999, Development of an Ultra Stable Fiber Optic Frequency Distribution System Using an Optical Delay Control Module, *IEEE Trans. Instrumentation and Measurement,* **49**, 19–24.

Sato, S., Miyoki, S., Ohashi, M., **Fujimoto, M.-K., Yamazaki, T., Fukushima, M., Ueda, A.,** Ueda, K., Watanabe, K., Nakamura, K., Etoh, K., Kitajima, N., Ito, K., and Kataoka I.: 1999, Loss Factors of Mirrors for a Gravitational-wave Antenna, *Appl. Opt.,* **38**, 2880–2885.

Seely, J. F., **Watanabe, T.,** Harada, T., Rife, J. C., and Hunter, W. R.: 1999, Normal-Incidence Efficiencies of 4,800 g/mm Ruled Replica Gratings with Multilayer and Gold Coatings in the 125 to 325 Angstrom Wavelength Region, *Appl. Opt.,* **38**, 1920.

Sekiguchi, T., **Watanabe, J., Fukushima, H.,** Yamamoto, T., Yamamoto, N.: 1997, Observations of C_2 Molecules in the Coma of Comets at Mitaka, *Earth, Moon, and Planets,* **78**, 143–148.

Shen, Z.-Q., Edwards, P. G., Lovell, J. E. J., **Fujisawa, K., Kameno, S.,** and **Inoue, M.**: 1999, High-Resolution VSOP Imaging of the Southern Blazar PKS 1921–293 at 1.6 GHz, *Publ. Astron. Soc. Japan,* **51**, 513–518. (*NROR*. **503**).

Shibata, K., and **Yokoyama, T.**: 1999, Origin of the Universal Correlation Between the Temperature and the Emission Measure for Solar and Stellar Flares, *Astrophys. J. Lett.,* **526**, L49–L52.

Shirai, T., and **Fukushima, T.**: 2000, Numerical Convolution in the Time Domain and its Application to the Non-Rigid Earth Nutation Theory, *Astron. J.,* **119**, 2475–2480.

Simpson, C., and Eisenhardt, P.: 1999, The Detection and Photometric Redshift Determination of Distant Galaxies Using SIRTF's Infrared Array Camera, *Publ. Astron. Soc. Paci.,* **111**, 691.

Simpson, C., Eisenhardt, P., Armus, L., Chokshi, A., Dickinson, M., Djorgovski, S. G., Elston, R., Jannuzi, B. T., McCarthy, P. J., Pahre, M. A., and Soifer B. T.: 1999, Young Stars and Non-stellar Emission in the Aligned Radio Galaxy 3C 256, *Astrophys. J.,* **525**, 659.

Simpson, C., Rawlings, S., and Lacy, M.: 1999, Thermal-infrared Imaging of 3C Radio Galaxies at $z=1$, *Mon. Not. R. Astron. Soc.,* **306**, 828.

Singh, J., **Ichimoto, K., Imai, H., Sakurai, T.,** and Takeda, A.: 1999, Spectroscopic Studies of the Solar Corona I. Spatial Variations in Line Parameters of Green and Red Coronal Lines, *Publ. Astron. Soc. Japan,* **51**, 269–276.

Slysh, V. I., Val'tts, I. E., Migenes, V., Fomalont E., Hirabayashi, H., **Inoue, M.,** and **Umemoto, T.**: 1999, Protoplanetary Disk and/or Bipolar Outflow Traced by H_2O Masers in IC 1396N, *Astrophys. J.,* **526**, 236–241.

Sofue, Y., Tomita, A., **Honma, M.,** and Tutui, Y.: 1999, Central Kinematics and Rotation Curve of the Sb Spiral Galaxy NGC 4527 in CO, Halpha, and [NII] Lines, *Publ. Astron. Soc. Japan,* **51**, 737–743.

Sofue, Y., Tutui, Y., **Honma, M.,** Tomita, A., Takamiya, T., Koda, J., and Takeda, Y.: 1999, Central Rotation Curves of Spiral Galaxies, *Astrophys. J.,* **523**, 136–146.

Sterling, A. C., Pike, C. D., Mason, H. E., **Watanabe, T.,** and Antiochos, S. K.: 1999, Variation of Thermal Structure with Height of a Solar Active Region Derived from SOHO CDS and YOHKOH BCS Observations, *Astrophys. J.,* **524**, 1096–1104.

Sugai, H., Davies, R. I., Malkan, M. A., McLean, I. S., **Usuda, T.,** and Ward, M. J.: 1999, Near-Infrared Line Observations of Arp 299 as a Tracer of Activity in the Nuclei, *Astrophys. J.,* **527**, 778.

Sugitani, K., **Matsuo, H.,** Nakano, M., Tamura, M., and Ogura, K.: 2000, 2 Millimeter Observations of Bright-Rimmed Clouds with IRAS Point Sources, *Astron. J.,* **119**, 323–334.

Suh, I., and **Mathews, G. J.**: 2000, Mass-Radius Relation for Magnetic White Dwarfs, *Astrophys. J.,* **530**, 949.

Suh, I., and **Mathews, G. J.**: 2000, Ground Quation of State for Strongly Magnetized npe Gas: Effects of Muon Production and Pion Condensation, *Astrophys. J.,* submitted.

Sumi, T., and **Honma, M.**: 2000, Constraining the Location of Microlensing Objects by Finite Source Effect in EAGLE Events, *Astrophys. J.,* in press.

Sumiyoshi, K., Suzuki, H., **Otsuki, K., Terasawa, M.,** and Yamada, S.: 2000, Hydrodynamic Study of Neutrino-driven Wind as an *r*-Process Site, *Publ. Astron. Soc. Japan,* in press.

Suto, Y., Kitayama, T., Komatsu, E., Hattori, M., **Kawabe, R., Matsuo, H.,** Schindler, S., and Yoshikawa, K.: 2000, Cosmological Implications of Galaxy Clusters in X-Ray, Millimeter, and Submillimeter Bands, *Adv. Space Res.,* **25**(3–4), 771–780.

Suzuki, T. K., Yoshii, Y., and **Kajino, T.**: 1999, Evolution of Beryllium and Boron in the Inhomogeneouse Early Galaxy, *Astrophys. J.,***522**, L125–L128.

Takahashi, H., Kasahara, M., Kimata, F., Miura, S., **Heki, K.,** Seno, T., Kato, T., Vasilenko, N., Ivashchenko, A., Bahtiarov, V., Levin, V., Gordeev, E., Korchagin, F., and Gerasimenko, M.: 1999, Velocity Field of around the Sea of Okhotsk and Sea of Japan Regions Determined from a New Continuous GPS Network Data, *Geophys. Res. Lett.*, **26**, 2533–2536.

Takahashi, J.: 1999, MD Simulation for H_2 Formation on Amorphous Ice, *Earth Planets Space*, **51**, 1215–1222.

Takahashi, J., Masuda, K., and Nagaoka, M.: 1999, The Formation Mechanism of Molecular Hydrogen on Icy Mantles of Interstellar Dust, *Mon. Not. R. Astron. Soc.*, **306**, 22–30.

Takahashi, J., Masuda, K., and Nagaoka, M.: 1999, Product Energy Distribution of Molecular Hydrogen Formed on Icy Mantles of Interstellar Dust, *Astrophys. J.*, **520**, 724–731.

Takami, M., **Usuda, T.**, Sugai, H., Kawabata, H., **Suto, H.**, and Tanaka, M.: 2000, H_2 Line Ratios to Discriminate Dense Photodissociation Regions from Shocks: Application to NGC 2023 and NGC 7023, *Astrophys. J.*, **529**, 268.

Tamura, M., Hough, J. H., Greaves, J. S., Morino, J., Chrysostomou, A., Holland, W. S., and **Momose, M.**: 1999, First Detection of Submillimeter Polarization from T Tauri Stars, *Astrophys. J.*, **525**, 832–836.

Tanikawa, K., and Mikkolla, S.: 2000, Triple Collisions in the One-Dimensional Three-Body Problem, *Cele. Mech. Dyn. Astron.*, **76**, 23–34.

Tatematsu, K., Jaffe, D. T., Plume, R., and Evans, II, N. J.: 1999, Atomic Carbon Is a Temperature Probe in Dark Clouds, *Astrophys. J.*, **526**, 295–306. (*NROR.* **497**).

Tokuhisa, A., and **Kajino, T.**: 1999, Meson Synchrotron Emission from Central Engines of Gamma-Ray Bursts with Strong Magnetic Fields, *Astrophys. J.*, **525**, L117–L120.

Tomisaka, K.: 2000, Evolution of Angular Momentum Distribution during Star Formation, *Astrophys. J.*, **528**, L41–L44.

Tomita, A., **Maehara, H.**, Takeuchi, T., **Nakanishi, K.**, **Honma, M.**, Tutui, Y., and Sofue, Y.: 1999, Optical and CO Radio Observation of Poor Cluster Zwicky 1615.8+3505, *Publ. Astron. Soc. Japan*, **51**, 285–300.

Totani, T.: 1999, Galaxy Formation by Galactic Magnetic Fields, *Astrophys. J.*, **517**, L69–L72.

Totani, T.: 1999, Pair-Creation by Very High Energy Photons in Gamma-Ray Bursts: A Unified Picture for Energetics of GRBs, *Mon. Not. R. Astron. Soc.*, **307**, L41–L45.

Totani, T.: 2000, An Interpretation of the Evidence for TeV Emission from Gamma-Ray Burst 970417a, *Astrophys. J. Lett.*, in press.

Totani, T., and Kobayashi, C.: 1999, Evolution of Dust Extinction and Supernova Cosmology, *Astrophys. J.*, **526**, L65–L68.

Totani, T., and Yoshii, Y.: 2000, Unavoidable Selection Effects in the Analysis of Faint Galaxies in the Hubble Deep Field: Probing the Cosmology and Merger History of Galaxies, *Astrophys. J.*, in press.

Truong-Bach, Sylvester, R. J., Barlow, M. J., Nguyen-Q-Rieu, Lim, T., Liu, X. W., Baluteau, J. P., **Deguchi, S.**, Justtanont, K., and Tielens, A. G. G. M.: 1999, H_2O from R Cas: ISO LWS-SWS Observations and Detailed Modelling, *Astron. Astrophys.*, **345**, 925–935.

Tsuboi, M., Miyazaki, A., Imaizumi, S., and **Nakai, N.**: 1999, A Search for the CO (J–1–0) Emission Line toward the Quasar H1413+117, *Publ. Astron. Soc. Japan*, **51**, 479–482. (*NROR.* **496**).

Tsuchiya, T., and **Gouda, N.**: 2000, Relaxation and Lyapunov Time Scale in a One-Dimensional Gravitating Sheet System, *Phys. Review E*, **61**, 948–951.

Tsuji, T., Ohnaka, K., and **Aoki, W.**: 1999, Warm Dust in the Cool Brown Dwarf Gliese 229B and Spectroscopic Diagnosis of Dusty Photospheres, *Astrophys. J. Lett.*, **520**, L119.

Tsujimoto, T., and Shigeyama, T.: 1999, New Insights into the Early Stage of the Galactic Chemical Evolution, *Astrophys. Space Sci.*, **265**, 49–50.

Tsujimoto, T., Shigeyama, T., and Yoshii, Y.: 1999, Chemical Evolution of the Galactic Halo through Supernova-Induced Star Formation and Its Implication for Population III Stars, *Astrophys. J. Lett.*, **519**, L63–L67.

Tsujimoto, T., Shigeyama, T., and Yoshii, Y.: 2000, Probing the Site for *r*-Process Nucleosynthesis with Abundances of Barium and Magnesium in Extremely Metal-Poor Stars, *Astrophys. J. Lett.*, **531**, L33–L36.

Tsuribe, T., and **Inutsuka, S.**: 1999, Criteria for Fragmentation of Rotating Isothermal Clouds Revisited, *Astrophys. J.*, **523**, L155–L158.

Tsuribe, T., and **Inutsuka, S.**: 1999, Criteria for Fragmentation of Rotating Isothermal Clouds I: Semianalytic Approach, *Astrophys. J.*, **526**, 307–313.

Ueda, Y., Takahashi, T., Inoue, H., Tsuru, T., Sakano, M., Ishisaki, Y., Ogasaka, Y., Makishima, K., Yamada, T., **Akiyama, M.**, and Ohta, K.: 1999, Log *N*–log *S* Relations and Spectral Properties of Sources from the ASCA Large Sky Survey: Their Implications for the Origin of the Cosmic X-ray Background (CXB), *Astrophys. J.*, **518**, 656–671.

Uehara, H., and **Inutsuka, S.**: 2000, Does Deuterium

Enable the Formation of Primordial Brown Dwarfs? *The Astrophys. J. Lett.*, **531**, L91–L94.

Umeda, H., Nomoto, K., Yamaoka, H., and **Wanajo, S.**: 1999, Evolution of 3–9 M⊙ Stars for $Z=0.001$–0.03 and Metallicity Effects on Type Ia Supernovae, *Astrophys. J.*, **513**, 861.

Umehara, H., and **Tanikawa, K.**: 1999, Orbital Distribution Arbitrarily Close to the Homothetic Equilateral Triple Collision in the Free-Fall Three-Body Problem with Equal Masses, *Cele. Mech. Dyn. Astron.*, **74**, 69–94.

Umemoto, T., Mikami, H., Yamamoto, S., and Hirano, N.: 1999, The Ortho-to-Para Ratio of Ammonia in the L1157 Outflow, *Astrophys. J. Lett.*, **525**, L105–L108. (*NROR*. **505**).

Wada, K., and Norman, C.: 1999, The Global Structure and Evolution of a Self-Gravitating Multi-Phase Interstellar Medium in a Galactic Disk, *Astrophys. J. Lett.*, **516**, L13–L16.

Wanajo, S., Hashimoto, M., and Nomoto, K.: 1999, Nucleosynthesis in ONeMg Novae: Models versus Observations to Constrain the Masses of ONeMg White Dwarfs and Their Envelopes, *Astrophys. J.*, **523**, 409.

Watanabe, J., Abe, S., **Fukushima, H.**, and Kinoshita, D.: 1999, TV Observation of the Leonid Meteor Shower in 1998: No Strong Activity over Japan, *Publ. Astron. Soc. Japan*, **51**, L11–L14.

Weber, M. A., Acton, L. W., Alexander, D., Kubo, S., and **Hara, H.**: 1999, A Method for Characterizing Rotation Rates in the Soft X-Ray Corona, *Solar Phys.*, **189**, 271–288.

Yamada, T., Kajisawa, M., Tanaka, I., Maihara, T., Iwamuro, F., Terada, H., Goto, M., Motohara, K.; Tanabe, H., Taguchi, T., Hata, R., **Iye, M.**, **Imanishi, M.**, **Chikada, Y.**, **Yoshida, M.**, **Simpson, C.**, **Sasaki, T.**, **Kosugi, G.**, **Usuda, T.**, **Omata, K.**, and **Imi, K.**: 2000, High-Resolution Near-Infrared Imaging of the Powerful Radio Galaxy 3C 324 at $z=1.21$ with the Subaru Telescope, *Publ. Astron. Soc. Japan*, **52**, 43–51.

Yamamoto, N., **Watanabe, J.**: 1997, Observations of the Dust Cloud in Comet Hale-Bopp on 9–11 May 1997, *Earth, Moon, and Planets*, **78**, 229–233.

Yano, T., and **Gouda, N.**: 2000, Universal Profile of the Dark Matter Halo and the Two Point Correlation Function, *Astrophys. J.*, in press.

Yoshida, H.: 1999, A New Necessary Condition for the Integrability of Hamiltonian Systems with a Two Dimensional Homogeneous Potential, *Physica D*, **128**, 53–69.

Yoshida, M., Taniguchi, Y., and Murayama, T.: 1999, Three Dimensional Optical Spectroscopy of the Superwind Galaxy NGC 2782, *Astron. J.*, **117**, 1158–1167.

Yoshikoshi, T., Dazeley, S. A., Gunji, S., Hara, S., Hara, T., Holder, J., Jimbo, J., Kawachi, A., Kifune, T., Kubo, H., Kushida, J., Le Bohec, S., Matsubara, Y., **Mizumoto, Y.**, Mori, M., Moriya, M., Muraishi, H., Muraki, Y., Naito, T., Nishijima, K., Patterson, J. R., Roberts, M. D., Rowell, G. P., Sakurazawa, K., Susukita, R., Tamura, T., Tanimori, T., Yanagita, S., Yoshida, T., and Yuki, A.: 1999, Present Status of the 7–10 M Telescope of CANGAROO II, *Astroparticle Phys.*, **11**, 267–269.

Yun, M. S., Carilli, C. L., **Kawabe, R.**, Tutui, Y., **Kohno, K.**, and Ohta, K.: 2000, Sensitive Radio Observations of High-Redshift Dusty QSOs, *Astrophys. J.*, **528**, 171–178.

2. Other Publications

Aikawa, Y., Umebayashi, T., Nakano, T., and **Miyama, S. M.**: 1999, Molecular Evolution in Planet-Forming Circumstellar Disks, *Proc. Numerical Astrophysics 1998* (*NAP98*), eds. by S. M. Miyama, K. Tomisaka and T. Hanawa, (Kluwer Academic), p. 179.

Altyntsev, A., Grechnev, V., **Nakajima, H., Hanaoka, Y.**, Konovalov, S., and Takano, T.: 1999, The Study of Solar Flares with Microwave Sub-second Pulses at 5.7 and 17 GHz. "Solar Physics with Radio Observations", Proc. the Nobeyama Symposium, (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report.*, **479**, 283–286.

Altyntsev, A., **Nakajima, H.**, Takano, T., Grechnev, V., and Konovalov, S.: 1999, Microwave Observations of Sub-second Pulses with Spatial Resolution. "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 279–282.

Aoki, K., and **Yoshida, M.**: 1999, "Correlation between Si [III] 1892/C [III] 1909 and Fe II 4500/H-beta in low Redshift QSOs", Quasars as Standard Candles for Cosmology, *ASP Conference Series,* **162**, 385–390.

Aoki, W., Tsuji, T., and Ohnaka, K.: 2000, Molecular Absorption Detected by the ISO SWS, *Adv. Space Res.*, **25**, 2189.

Arai, K., and the TAMA Collaboration: 1999, Current Status of The TAMA Project, *Proc. the 9th International School "Particles and Cosmology"*, 160–171.

Araki, H., Mukai, T., and Mizuno, T.: 1999, Mass Estimation of MUSES-C Target Asteroid from MUSES-C-LIDAR Data, *Proc. 9th Workshop* on Astrodynamics and Flight Mechanics, 101–106.

Arikawa, Y., Tatematsu, K., Sekimoto, Y., Aso, Y., Noguchi, T., Shi, S.-C., Miyazawa, K., Yamamoto, S., Ikeda, M., Maezawa, T., Ito, T., Saito, G., Saito, S., Ozeki, H., Fujiwara, H., Inatani, J., and **Ohishi, M.**: 1999, Large-Scale CI ($^3P_1$–$^3P_0$) and CO (J=3–2) Observations of the W51 Complex Region with the Mt. Fuji Submillimeter-Wave Telescope, Star Formation 1999, Proc. "Star Formation 1999", (Nagoya, Japan, June 21–25, 1999), ed. T. Nakamoto, (Nobeyama Radio Observatory), 88–89.

Aso, Y., **Tatematsu, K., Sekimoto, Y.**, Nakano, T., Umemoto, T., Koyama, K., and Yamamoto, S.: 1999, Dense Cores and Molecular Outflows in the OMC-2/3 Region, Proc. "Star Formation 1999", (Nagoya, Japan, June 21–25, 1999), ed. T. Nakamoto, (Nobeyama Radio Observatory), 189–190.

Bastian, T. S., Gopalswamy, N., and **Shibasaki, K.**: 1999, Solar Physics with Radio Observations, *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), *NRO Report,* **479**.

Beers, T. C., Yoshii, Y., and **Suzuki, T. K.**: 1999, The Light Elements Be and B as Stellar Chronometers in the Early Galaxy, *Proc. IAU Synposium* 198 (Light Elements and their Evolution).

Callebaut, D. K., Gelfreikh, G. B., Makarov, V. I., **Shibasaki, K.**, and Tlatov, A. G.: 1999, Differential Rotation, Torsional Oscillations and Polarward Migration of the Solar Magnetic Fields. Period: 1975–1999 yrs, Ninth European Meeting on Solar Physics: Magnetic Fields and Solar Processes. Ninth Meeting of the Solar Physics Section of the Joint Astrophysics Division of the European Physical Society (EPS) and of the European Astronomical Society (EAS). Florence, Italy, 12–18 September 1999. *Proc. in ESA SP Series* (*SP-448*), ed. A. Wilson, 13.

Chertok I. M., and **Shibasaki, K.**: 1999, Large-Scale Shining Chains on the Solar Disk: Nobeyama Radioheliograph Data, "Solar Physics with Radio Observations", Proc. the Nobeyama Symposium, (Kiyosato, Japan, Oct. 27–30, 1998), Eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 175–179.

Chertok, I. M., Fomichev, V. V., Gorgutsa, R. V., Hildebrandt, J., Krueger, A., and **Shibasaki, K.**: 1999, Nobeyama Radioheliograph Data on Dynamics of Microwave Counterparts of Giant Post-Eruptive Soft X-ray Arches, "Solar Physics with Radio Observations". *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), Eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 203–206.

Chiba, M.: 1998, Kinematics of Metal-Poor stars and the Formation of the Galaxy, In Subaru Workshop on "Stars and Galaxies: Decipherment of Cosmic History with Spectroscopy", (Hilo, Hawaii), in press.

Chiba, M., and Yoshii, Y.: 1998, Early Evolution of the Galaxy Revealed from Hipparcos Observations, "Origin of Matter and Evolution of Galaxies 97", eds. S. Kubono, T. Kajino, K. I. Nomoto and I. Tanihata, (World Scientific) 101–110.

Chiba, M., Yoshii, Y., and Beers, T. C.: 1999, Three-Dimensional Kinematics of Metal-Poor Stars Revealed from HIPPARCOS Observations, The Third Stromlo Symposium: "The Galactic Halo", eds. B. K. Gibson, T. S. Axelrod and M. E. Putman, *ASP Conference Series,* **165**, 269–273.

Deguchi S., and the SiO Maser Survey Team: 1999, Stellar Velocity Field in the Galactic Bar, *Conference Proc.* (Johannesburg Sep. 13–18, 1999) in "To-

wards a New Millennium in Galaxy Morphology" eds. by D. L. Block, I. Puerari, A. Stockton and D. Ferreira (Kluwer, Dordrecht). *NROR*. **506**.

Deguchi, S., Fujii, T., **Izumiura, H.**, **Kameya, O.**, Nakada, Y., Nakashima, J., Ootsubo, T., and Ukita, N.: 2000, SiO Maser Survey of the Galactic Disk IRAS Sources. II. $|l|<3°$ and $|b|<3°$, the Galactic Center Area. *NROR*. **513**.

Ebizuka, N., Kobayashi, H., Hirahara, Y., Wakaki, M., Kawaguchi, K., **Sasaki, T.**, and **Iye, M.**: 1999 Development of Grisms and Immersion Gratings for the Spectrographs of the Subaru Telescope. *3D Spectroscopy Conf.*.

Eisenhardt, P., and **Simpson, C.**: 1999, Photometric Redshifts for Distant Galaxies using SIRTF's Infrared Array Camera, Workshop on "Photometric Redshifts and High Redshift Galaxies", eds R. Weymann, L. Storrie-Lombardi, M. Sawicki and R. Brunner (ASP: San Francisco).

Fang, C., Tang, Y. H., Ding, M. D., Zhao, J., **Sakurai, T.**, and Hiei, E.: 1999, Coronal Loops above a Sunspot Region, "The Sun and Human Environment", eds. H. Q. Zhang, K. Y. Tang, *et al.*, (Science Press, Beijing), 37–43.

Fu, Q., Huang, G., **Shibasaki, K.**, **Nakajima, H.**, and Liu, Y.: 1999, Temporal and Spatial Evolution of Microwave Spikes Observed by Beijing and Nobeyama Observatories, "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium*, (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report*, **479**, 273–277.

Fujiki, K., and **Nakajima, H.**: 2000, Microwave Preflare Enhancement and Depletion in Long Duration Events, *Adv. Space Res.*, **26–3**, 477–480.

Fujimoto, M.-K., and TAMA collaboration: 1999, Japanese Gravitational Wave Detector—TAMA300, CRL International Sympo. on "Optical Communications and Sensing toward the Next Century, Technical Digest", 46–50.

Fujimoto, M. Y.: 2000, Internal and External Process of Chemical-Pollution in Extremely Metal-Poor Stars, *Proc. Int. Symp.* on "Origin of Matter and Evolution of Galaxies" (Tokyo), eds. T. Kajino, S. Kubono, K.-I. Nomoto and I. Tanihata (World Scientific), in press.

Fujimoto, M. Y., Ikeda, Y., Kanya, Y., and Jugaku, J.: 1999, Current Status of Population III. Stars, *Proc. Subaru HDS Workshop* on "Stars and Galaxies" (Tokyo), in press.

Fujita, Y., Tosaki, T., Nakamichi, A., and Kuno, N.: 1999, CO ($J=1$–0) Observations of the cD Galaxy of AWM7: Constraints on the Evaporation of Molecular Gas. *NROR*. **510**

Fukuda, H., **Wada, K.**, and Habe, A.: 1999, Effects of a Supermassive Black Hole on Nuclear Gas Dynamics, "Star Formation 1999", ed. T. Nakamoto, (Nobeyama Radio Observatory, Nobeyama), 42–43.

Fukushima, T.: 1999e, Super Implicit Multistep Methods, *Proc. 31st Symp on Cele. Mech.* ed. Umehara, 343–366.

Furuya, R. S., Kitamura, Y., Claussen, M. J., Wootten, H. A., Saito, M., Marvel, K. B., and **Kawabe, R.**: 1999, A Micro Jet in the Extremely Young Protostar S106 FIR, Star Formation 1999, *Proc. Star Formation 1999*, (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 297.

Furuya, R., Kitamura, Y., Claussen, M., Wootten, A., Saito, M., Marvel, K. B., and **Kawabe, R.**: 1999, A Micro Jet in the Extremely Young Protostar S106 FIR, American Astronomical Society Meeting 194, 50.13.

Gelfreikh, G. B., Makarov, V. I., Makarova, V. V., **Shibasaki, K.**, and Tlatov, A. G.: 1999, Polar Activity of the Sun from Optical and Radio Observations, Ninth European Meeting on Solar Physics: Magnetic Fields and Solar Processes. Ninth Meeting of the Solar Physics Section of the Joint Astrophysics Division of the European Physical Society (EPS) and of the European Astronomical Society (EAS). (Florence, Italy, 12–18 September, 1999). *Proc. published in ESA SP Series* (*SP-448*), ed. A. Wilson, 21.

Gelfreikh, G. B., and **Shibasaki, K.**: 1999, Radio Magnetography of Solar Active Regions Using Radio Observations, Ninth European Meeting on Solar Physics: Magnetic Fields and Solar Processes. Ninth Meeting of the Solar Physics Section of the Joint Astrophysics Division of the European Physical Society (EPS) and of the European Astronomical Society (EAS). (Florence, Italy, 12–18 September 1999). *Proc. published in ESA SP Series* (*SP-448*), ed. A. Wilson, 263.

Gelfreikh, G. B., and **Shibasaki, K.**: 1999, Observations of Oscillations in Solar Active Regions using Radio Observations, Ninth European Meeting on Solar Physics: Magnetic Fields and Solar Processes. Ninth Meeting of the Solar Physics Section of the Joint Astrophysics Division of the European Physical Society (EPS) and of the European Astronomical Society (EAS). (Florence, Italy, 12–18 September 1999). *Proc. published in ESA SP Series* (*SP-448*), ed. A. Wilson, 36.

Gopalswamy, N., **Hanaoka, Y.**, and Hudson, H. S.: 2000, Structure and Dynamics of the Corona Surrounding an Eruptive Prominence, *Adv. Space Res.*,

25–9, 1851–1854.

Gopalswamy, N., **Shibasaki, K.**, Thompson, B. J., Gurman, J. B., and Deforest, C. E.: 1999, Is the Chromosphere Hotter in Coronal Holes?, *Proc. the Ninth International Solar Wind Conference,* (Nantucket, MA., October 1998). eds. S. R. Habbal, R. Esser, J. V. Hollweg and P. A. Isenberg, *AIP Conference Proceedings,* **471**, 277.

Grebinskij, A., **Shibasaki, K.**, and Zhang, H.: 1999, Microwave Measurements of the Solar Magnetic Fields at Chromosphere-Corona, "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 59–64.

Habe, A., Tokumaru, T., Fukuda, H., and **Wada, K.**: 1999, Evolution of a Cloud System in a Gas Rich Dwarf Galaxy "Star Formation 1999", ed. T. Nakamoto, (Nobeyama Radio Observatory, Nobeyama), 38–39.

Hanaoka, Y.: 1999, Radio and X-ray Observations of the Flares Caused by Interacting Loops, "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 229–234.

Hanaoka, Y.: 1999, Long Duration Events Observed with the Nobeyama Radioheliograph, "Solar Physics with Radio Observations", *Proc. of the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report.* **479**, 153–158.

Hanaoka, Y.: 2000, Radio and X-Ray Observations of Double Loop Flares, *Adv. Space Res.,* **26–3**, 453–456.

Hanaoka, Y., Sakurai, T., Sato, J., and Gopalswamy, N.: 1999, CMEs Caused by Emerging Flux Activity, *Proc. of the Yohkoh 8th Anniversary Symposium* "Explosive Phenomena in Solar and Space Plasmas", eds. T. Kosugi, T. Watanabe, and M. Shimojo, 99–100.

Handa, T., Hasegawa, T., Morino, J. I., Usuda, K. S., Sawada, T., Bronfman, L., Castellanos, A. L., **Sakamoto, S.**, Booth, R., **Hayashi, M.**, Nyman, L. Å., and Shaver, P.: 1999, A CO(2–1) Survey of the Galactic Plane with the 60 cm Telescope to Explore the Density and Temperature of Molecular Gas, *ASP Conf. Ser. 168,* "New Perspectives on the Interstellar Medium", eds. A. R. Taylor, T. L. Landecker and G. Joncas, 399–403.

Hasegawa, T., **Ukita, N., Matsuo, H., Kuno, N.**, Saitoh, T., Sekiguchi, T., Fuse, T., Nakamura, R., and Yokogawa, S.: 1999, Millimeter Continuum Observations of Parent Comets of Meteor Storms. *NROR.* **507**

Hashimoto, M., Koike, O., Arai, K., and **Wanajo, S.**: 1999, Rapid Proton Capture Process in X-ray Bursts, *Proc. Int. Symp. on Nucleiin the Cosmos V* (Greece), ed. N. Prantzos, (Editions Frontieres), 451–454.

Hashimoto, O., and **Izumiura, H.**: 2000, "Compact Circumstellar Dust Envelopes of Evolved AGB Stars with Heavy Mass Loss", *Adv. Space Res.,* **25**, Issue 11, (Elsevier.) 2197–2200.

Hattori, T. G., **Yoshida, M.**, Ohtani, H., Ishigaki, T., Sugai, H., Hayashi, T., Ozaki, S., and Ishii, M.: 1999, Tridimensional Spectroscopy of the Interacting System NGC 7592, Imaging the Universe in Three Dimensions: Astrophysics with Advanced Multi-Wavelength Imaging Devices, *ASP Conference Series.*

Hayano, Y., **Takami, H., Takato, N., Kanzawa, T., Kamata, Y., Nakashima, K.**, and **Iye, M.**: 1999, Prototype of a Sodium Laser Guide Star System for the SUBARU Telescope in "Astronomy with Adaptive Optics Present Results and Future Programs", ed. D. Bonaccini, 211–215.

Hirano, N., Kamazaki, T., Mikami, H., Ohashi, N., and **Umemoto, T.**: 1999, Discovery of Two Extreme Young Protostars in Barnard 1, Star Formation 1999, *Proc. Star Formation 1999,* (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 181–182.

Hirata, R., Shimada, M. R., Masuda, S., and Katahira, J.: 1999, Be Phenomenon in Pleione, in The Be Phenomenon in Early-Type Stars, *IAU colloq. 175, ASP Conf. ser.* eds. M. Smith, F. H. Henrichs, J. Fabregat.

Honma, M.: 2000, Studying the Milky Way Galaxy with VERA (VLBI Exploration of Radio Astrometry), *International Conference of the Astronmische Gesellschaft* "Dynamics of Star Clusters and the Milky Way", in press.

Honma, M., Kawaguchi N., and **Sasao, T.**: 2000, Science with VERA, *SPIE Proc.,* 4015, in press.

Hori, K.: 1999, Study of Solar Decimetric Bursts with a Pair of Cutoff Frequencies, "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 267–272.

Hori, K.: 2000, Study of Microwave Blobs Above the Tops of Arcade Loops in the Solar Corona, *Adv. Space Res.,* **26**, 481–484.

Hosokawa, M., Ohnishi, K., and **Fukushima, T.**: 1998, Variation of Gravitational Delay in Pulsar Timing Observation and Distribution of Stars and

MACHOs, *Proc. Int'l Conf.* "Nuetron Stars and Pulsars" eds. Shibazaki *et al.*, 243.

Ikeda, M., **Ohishi, M.**, Nummelin, A., Dickens, J. E., Bergman, P., Hjalmarson, A., and Irvine, W. M.: 1999, Chemical Composition of Massive Star-Forming Regions, *Proc.* "Star Formation 1999", (Nagoya University, June 1999), ed. T. Nakamoto, 98–99.

Imaeda, Y., and **Inutsuka, S.**: 1999, The Improvement of SPH Method for the Long Term Evolution of Circumstellar Disk. "Star Formation 1999", ed. T. Nakamoto, (Nobeyama Radio Observatory, Nobeyama), 239–240.

Imaeda, Y., and **Miyama, S. M.**: 1999, Gas Accretion to the Jovian Planet in the Protoplanetary Disk, *Proc.* "Numerical Astrophysics 1998 (NAP98)", eds. S. M. Miyama, K. Tomisaka and T. Hanawa, (Kluwer Academic), 185.

Imai, H., **Kameya, O.**, **Sasao, T.**, **Miyoshi, M.**, **Deguchi, S.**, Horiuchi, S., and Asaki, Y.: 1999, Kinematics and Distance of Water Masers in W3 IRS5, *Proc.* "Star Formation 1999", (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 298–299.

Inoue, M.: 1999, Water Maser in Active Galactic Nuclei, *Proc.* "the Eighth Marcel Grossmann Meeting on General Relativity", eds. T. Piran and R. Ruffinl, 197–203.

Inoue, M.: 1999, Some Results with VSOP, *Proc.* "the 2nd Millimeter-VLBI Science Workshop", (IRAM Granada, Spain, May 27–29, 1999), eds. A. Greve and T. P. Krichbaum, 81–84.

Inutsuka, S.: 1999, Advanced Methods in Particle Hydrodynamics Numerical Astrophysics, eds. S. Miyama, K. Tomisaka, and T. Hanawa (Tokyo: Kluwer), 367–374.

Inutsuka, S., and Koyama, H.: 1999, The Formation of Molecular Clouds I: A Scenario "Star Formation 1999", ed. T. Nakamoto (Nobeyama Radio Observatory), 112–113.

Irimajiri, Y., Manabe, T., Ochiai, S., Masuko, H., **Noguchi, T.**, and Shi, S.-C.: 1999, A 650 GHz Band SIS Receiver for Balloon-Borne Limb-Emission Sounder, *Proc. IEEE Seventh International Conference* on "Terahertz Electronics", eds. M. Hangyo and K. Sakai, 222.

Ishimaru, Y., and **Wanajo, S.**: 1999, Inhomogeneous Enrichment of Our Galaxy at the Early Epoch, *Proc. Int. Symp.* on "Nuclei in the Cosmos V" (Greece), ed. N. Prantzos (Editions Frontieres), 527–539.

Ishizuki, S.: 1999, Cold Gas Contents of Galaxies and Its Relation to Fueling: Gas Dynamics and Related Phenomena in Bar-Driven Evolution of Disk Galaxies, *Adv. Space. Res.*, **23**, 991–1000.

Ishizuki, S.: 1999, Cold Gas Contents of Galaxies and Its Relation to Fueling: Individual Galaxies, *Adv. Space. Res.*, **23**, 1001–1005.

Isobe, S.: 1999, Proposed Lunar-Based Telescopes for NEO Observations, "The Moon and Mars", *Adv. Space Res.* **23**, 1865–1863.

Isobe, S., and Hamamura, S.: 1999, Monitering Light Energy Loss Estimated by the DMSP Satellites, *J. Italian Astron. Soc.*, **70** (No. 3), 131–138.

Ito, T., and **Tanikawa, K.**: 1999, Effect of Jovian Planets on the Stability of Terrestrial Protoplanet Systems, in "Star formation 1999", (Nagoya University, June 1999), ed. T. Nakamoto, 409–410.

Ito, T., and **Tanikawa, K.**: 2000, Long-term Stability of Our Solar System, *Proc. 32nd Symposium* on 'Celestial Mechanics', 47–96.

Ito, T., and **Tanikawa, K.**: 1999, Synchronization of orbital elements and stability of protoplanet systems, *Proc. the Symposium* on "Celestial Mechanics", **31**, 158–180.

Itoh, M., Fukunaga, H., **Sekimoto, Y.**, **Tatematsu, K.**, and Koyama, K.: 1999, Contribution of X-Rays to the Ionization of the Molecular Cloud in NGC1333, *Proc.* "Star Formation 1999", (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 100–101.

Itoh, M., Fukunaga, H., **Sekimoto, Y.**, **Tatematsu, K.**, Koyama, K., Tsuboi, Y., Yamauchi, S., Kobayashi, N., **Hayashi, M.**, and Ueno, S.: 1999, X-Ray and Radio Observations of NGC1333 Star Forming Region, *Proc. the symposium*, "Japanese-German Workshop on High Energy Astrophysics", (Kyoto, Japan, Oct. 19–21, 1998), eds. W. Becker and M. Itoh, *MPE Report* **270**, 49–51.

Itoh, Y., **Kaifu, N.**, **Hayashi, M.**, **Usuda, T.**, Subaru Team, Maihara, T., Iwamuro, F., Motohara, K., and CISCO Team: 1999, Subaru Observations of the L 1551 IRS 5 Jets, *Proc.* "Star Formation 99" 304.

Itoh, Y., **Tamura, M.**, and **Nakajima, T.**: 2000, Companions around Faint YSOs in Taurus, *IAUS 200*, 36.

Iwamatsu, H., **Hirata, R.**, and Masuda, S.: 1999, Origin of the Circumstellar Matter in a Spectroscopic Binary CX Dra, in The Be Phenomenon in Early-Type Stars *IAU colloq. 175, ASP Conf. ser.* eds. M. Smith, F. H. Henrichs, J. Fabregat.

Iye, M.: 2000, Scientific Results and Prospects with 8.2 m Subaru Telescope: Extragalactic Astronomy, *SPIE Proc.*, 4005–08.

Iye, M., and Ozawa, T.: 1999, Distinguishing the Near Side of Disks of Nearby Spirals, in "Galaxy Dynamics", eds. D. Merritt and J. A. Sellwood, *ASP Conf.*

Ser., **182**, 255–256.

Iye, M., and **Yamashita, T.**: 2000, Overview of Subaru Instrumentation, *SPIE Proc.* 4008–03 .

Izumiura, H.: 1999, "HIDES: a High Dispersion Echelle Spectrograph, Observational Astrophysics in Asia and its Future", *Proc. Fourth East-Asian Meeting on Astronomy,* (Yunnan Observatory, China), ed. P. S. Chen, 77–81.

Izumiura, H., and Hashimoto, O.: 2000, Circumstellar Dust Shells of Carbon Stars Resolved with ISO, *Adv. Space Res.*, **25**(11), (Elsevier.), 2205–2208.

Kajino, T.: 1999, Big-Bang Nucleosynthesis, *Proc. 11 Int. Summer School* in Physics from Quarks to Supernovae (Australia), ed. S. Kurchak (World Scientific), 351–401.

Kajino, T.: 1999, Theoretical Astrophysics, *Proc. Int. Summer School '99* on Subatomic Physics: Nuclear and Astro-physics with RI Beams (China), ed. J. Meng, 59–94.

Kajino, T.: 2000, Prospects for Nuclear Cosmology; from Big-Bang to Supernovae, *Proc. Int. Symp.* on "Origin of Matter and Evolution of Galaxies" (Tokyo), eds. T. Kajino, S. Kubono, K.-I. Nomoto and I. Tanihata (World Scientific), in press.

Kajino, T., and **Orito, M.**: 1999, Degenerate Neutrino and Big-Bang Nucleosynthesis, *Proc. Int. Symp.* on "Nuclei in the Cosmos V" (Greece), ed. N. Prantzos (Editions Frontieres), 17–20.

Kajino, T., and **Orito, M.**: 1999, Nucleosynthesis in Big-Bang and Galactic Chemical Evolution, *Proc. 3rd China-Japan Joint Symposium* on "Recent Topics in Physics" (Sendai, Niigata), eds. H. Orihara and K. Ikeda, 297–306.

Kajino, T., **Suzuki, T. K.**, **Kawanomoto, S.**, and **Ando, H.**: 1999, New Detremination Method of Primordial Li Abundance, *Proc. IAU Symposium 198* on "Light Elements and their Evolution" (Brasil), in press.

Kameno, S., Horiuchi, S., Shen, Z.-Q., **Inoue, M.**, **Kobayashi, H.**, Hirabayashi, H., and Murata, Y.: 1999, Asymmetric Free-Free Absorption towards a Double Lobe of QO 208. *NROR.* **511**

Kashikawa, N., **Aoki, K.**, Asai, R., Ebizuka, N., **Inata, M.**, **Iye, M.**, **Kawabata, K.**, **Kosugi, G.**, **Ohyama, Y.**, **Okita,K.**, Ozawa, T., Saito,Y., **Sasaki, T.**, **Sekiguchi, K.**, **Shimizu, Y.**, Taguchi, H., **Takata, T.**, Yadoumaru, Y., and **Yoshida, M.**: 2000, FOCAS: Faint Object Camera and Spectrograph for the Subaru Telescope, in *SPIE symp.*, "Astronomical Telescopes and Instrumentation 2000", 4008–11, in press.

Kashikawa, N., Asai, R., Aoki, K., **Inata, M.**, **Kosugi, G.**, **Okita, K.**, **Ohyama, Y.**, Saito, Y., **Sasaki, T.**, **Sekiguchi, K.**, **Shimizu, Y.**, Taguchi, H., **Takata, T.**, **Yoshida, M.**, Ebizuka, N., Ozawa, T., and Yadoumaru, Y.: 2000, Test Results of the Subaru Faint Object Camera and Spectrograph FOCAS, *SPIE Proc.*, 4008–11.

Kawabe, R., and LMSA working groups: 1999, The Future Large Millimeter and Submillimeter Array (LMSA/ALMA) Project and Technical Challenges, *Proc. IEEE Seventh International Conference* on "Terahertz Electronics", eds. M. Hangyo and K. Sakai, 102.

Kawamura S., and the TAMA collaboration: 1999, Can TAMA300 detect Gravitational Waves?, *Proc. 8 th Workshop* on "General Relativity and Gravitation", 123–132.

Kobayashi, C., **Tsujimoto, T.**, and Nomoto, K.: 1999, Galactic and Cosmic Supernova Rates and Metallicity Effects on Type Ia Supernovae, in "Nuclei in the Cosmos V", ed. N. Prantzos (Paris: Editions Frontieres), 543–547.

Kobayashi, C., **Tsujimoto, T.**, and Nomoto, K.: 1999, Cosmic Supernova Rates in Cluster *vs.* Field Galaxies, ASCA Symposium on "Heating and Acceleration in the Universe", eds. H. Inoue, T. Ohashi, and T. Takahashi, *Astron. Nachr.*, **320**, 334.

Kobayashi, C., **Tsujimoto, T.**, and Nomoto, K.: 2000, Metallicity Effects on Type Ia Supernovae and Galactic and Cosmic Chemical Evolution, in The Chemical Evolution of the Milky Way: "Stars *vs.* Cluster", ed. S. Fabrizio and F. Matteucci (Kluwer), in press.

Kobayashi, C., **Tsujimoto, T.**, Nomoto, K., Hachisu, I., and Kato, M.: 2000, Metallicity Effects on Type Ia Supernovae and Cosmic Supernova Rates in Cluster *vs.* Field Galaxies, *Memorie della Societa Astronmica Italiana*, in press.

Kohno, K., **Kawabe, R.**, and **Vila-Vilaro, B.**: 1999, NMA Survey of CO and HCN Emission from Nearby Active Galaxies, The Physics and Chemistry of the Interstellar Medium, *Proc. the 3rd Cologne-Zermatt Symposium,* (Zermatt, September 22–25, 1998), eds.: V. Ossenkopf, J. Stutzki and G. Winnewisser, (GCA-Verlag Herdecke), 34.

Kosugi, G., **Sasaki, T.**, **Mizumoto, Y.**, **Ogasawara, R.**, **Takata, T.**, **Yagi, M.**, Kawai, J., Kusumoto, T., Koura, N., and Iwai, S.: 2000, Data Quality Control of Subaru Telescope, *SPIE proc.*, 4010–19.

Koyama, H., and **Inutsuka, S.**: 1999, The Formation of Molecular Clouds II: Thermal Instability in the Interstellar Medium Swept Up by a Strong Shock Wave, *Proc. the International Conference* "Star Formation 1999", ed. T. Nakamoto (Nobeyama Radio Observatory), 114–115.

Kuan, Y.-J., Charnley, S. B., Wilson, T. L., **Ohishi, M.**, Huang, H.-C., and Snyder, L.E.: 1999, Alcohol Chemistry : Tentative Detection of Two New Interstellar Big Molecules $CH_3OC_2H_5$ and $(C_2H_5)_2O$, *AAS meeting*, **194**, 71.02.

Kundu, M. R., Nindos, A., Raulin, J.-P., **Shibasaki, K.**, White, S. M., Nitta, N., Shibata, K., and Shimojo, M.: 1999, A Microwave Study of Coronal Ejecta, *American Astronomical Society Meeting* **194**, 17. 04.

Lara, A., Gopalswamy, N., Perez-Enriquez, R., and **Shibasaki, K.**: 1999, 17 GHz Mode Coupling in the Solar Corona, "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium*, (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 83–87.

Masuda, S., **Sato, J.**, Kosugi, T., and **Sakao, T.**: 2000, Spectral Characteristics of Above-the-Looptop Hard X-ray Source, *Adv. Space Res.*, **26–3**, 493–496.

Masunaga, H., Inutsuka, S., and **Miyama, S. M.**: 1999, A Radiation Hydrodynamical Model for Protostellar Collapse, "Numerical Astrophysics", eds. S. Miyama, K. Tomisaka, and T. Hanawa (Tokyo: Kluwer), 169.

Mathews, G. J., Suh, In-Saeng, **Kajino, T.**, and **Orito, M.**: 1999, Coments on Primordial Nucleosynthesis, *Proc. Int. RESCEU Symp.* on "Particle Cosmology" (Tokyo), eds. K. Sato, T. Yanagida, and T. Shiromizu (Universal Academy Press), 113–116.

Matsumura, M., **Kawabata, K. S.**, Akitaya, H., Hirakata, N., and Seki, M.: 2000, Spectropolarimetry of the Young Stellar Object R Mon, *Proc.* on "Star Formation 1999", ed. T. Nakamoto, 320–321.

Matsuo, H., Noguchi, T., Shi, S.-C., Kashihara, H., and Takeda, M.: 1999, Development of Superconducting Camera in Submillimeter-Wave, *Proc. IEEE Seventh International Conference* on "Terahertz Electronics", eds. M. Hangyo and K. Sakai, 225.

Matsuzaki, K., **Sekimoto, Y.**, and Kamae, T.: 1999, Hard X-Ray Emission from Giant Molecular Cloud NGC6334 and M17, Proc. Symposium, "Japanese-German Workshop on High Energy Astrophysics", in (Kyoto, Japan, Oct. 19–21, 1998), eds. W. Becker and M. Itoh, *MPE Report* **270**, 56–59.

Migenes, V., Slysh, S., Val'Tts, I. E., Horiuchi, S., Altunin, V. I., Edwards, P. G., Fomalont, E., and **Inoue, M.**: 1999, Preliminary Results from the VLBA OH Maser Survey for Space-VLBI Observations, *American Astronomical Society Meeting*, **194**, 50. 08.

Mikkola, S.: 1999, A Method for Symplectic Integration of Satellite Orbits, *Proc. 31st Symposium* on "Celestial Mechanics", 337–342.

Minezaki, T., **Kobayashi, Y.**, Yoshii, Y., and Peterson, B. A.: 1999, K Band Galaxy Counts in the South Galactic Pole Region Near-infrared, *Proc.* on "Cosmological Parameters and the Evolution of the Universe." ed. K. Sato, 257.

Misawa, T., Suzuki, N., Tytler, D.,**Iye, M.**: 1999, QSO Metal Absorption Systems at High Redshifts, Subaru HDS, *Workshop* on "Stars and Galaxies", (Tokyo, Japan, Dec. 8–10).

Miyaji, T., and **Inoue, M.**: 1999, Japan mm-VLBI Network, *Proc. 2nd Millimeter-VLBI Science Workshop*, (IRAM Granada, Spain, May, 27–29, 1999), eds. A. Greve and T. P. Krichbaum, 65–68.

Miyama, S. M., Tomisaka, K., and Hanawa, T.: 1999, Numerical Astrophysics, *Proc. the International conference* on "Numerical Astrophysics 1998 (NAP98)", (Boston, Mass.: Kluwer Academic, 1999). *Astrophysics and space science library*; **v. 240**.

Miyauchi-Isobe, N., and **Maehara, H.**: 1998, The Second Kiso Survey for Ultraviolet-Excess Galaxies. II., *Publ. Natl. Astron. Obs. Japan*, **6**, 1–39.

Miyazaki, S.: 1999, CCD Plan of Subaru Telescope *Proc. of 4th ESO Workshop* on "Optical Detectors for Astronomy".

Miyoshi, Y., Wada-Takeda, M., Kawai, N., Sakoda, K., Inoue, K., Yuan, Z., Haus, J. W., and **Matsuo, H.**: 1999, The Photonic Line Defect Modes in the Square Air-Rod Pseudo-Triangular Lattice Revealed by Far-Infrared Measurements, *Proc. IEEE 7th International Conference* on Terahertz Electronics, eds. M. Hangyo and K. Sakai, 253.

Momose, M.: 1999, High Resolution Imaging of the Protostellar Envelope around L1551 IRS 5: Growth of the Circumstellar Disk, Star Formation 1999, *Proc.* on "Star Formation 1999", (Nagoya, Japan, June 21–25, 1999), ed. T. Nakamoto, (Nobeyama Radio Observatory), 221–224.

Nagai, T., Inutsuka S., and **Miyama, S. M.**: 1999, Formation and Evolution of Filamentary Structure in Molecular Clouds, 'Star Formation 1999' ed. T. Nakamoto, 116–117.

Nagai, T., Takahashi, N., Okyudo, M., Suginaka, M., Matsumoto, N., and Team of Live Eclipse: 2000, Internet Relaying of Total Solar Eclipse on 11 August 1999, "The Last Solar Eclipse of the Millennium in Turkey", eds. W. C. Livingston and A. Özgüc, *ASP Conference Series* **205**, 196–201.

Nagashima, M., and **Gouda, N.**: 1999, The Effects of Spatial Correlations on Merger Trees of Dark Matter Halos, "Galaxy Interactions at Low and High Redshift", eds. J. E. Barnes and D. B. Sanders, (Kluwer Academic) 484.

Nagashima, M., **Gouda, N.**, and Sugiura, N.: 1999, Effects of the UV Background Radiation on Galaxy Formation, Numerical Astrophysics: *Proc. the Inter-*

national Conference on "Numerical Astrophysics", eds. S. M. Miyama, K. Tomisaka, and T. Hanawa, (Kluwer Academic) 45.

Nakagawa, T., Kii, T., Fujimoto, R., Miyazaki, T., Inoue, H., Ogasaka, Y., Arnaud, K., and **Kawabe, R.**: 1999, ASCA Observations of Luminous Infrared Galaxies, *Proc. of the IAU Symp. 186,* "Galaxy Interactions at Low and High Redshift", eds. J. E. Barnes and D. B. Sanders, 341–344.

Nakagawa, T., Kii, T., Fujimoto, R., Miyazaki, T., Inoue, H., Ogasaka, Y., and **Kawabe, R.**: 1999, ASCA Observations of X-Ray Emission from Ultraluminous Infrared Galaxies, *Proc. of a Workshop,* "Ultraluminous Galaxies: Monsters or Babies?", eds. J. Duson, and S. A. Lamb, *Astrophys. Space Sci.,* **266**, 43–48.

Nakai, N.: 1999, Water Vapor Megamasers in Active Galactic Nuclei, *4th East Asian Meeting* on "Astronomy (4th EAMA)—Observational Astrophysics in Asia and its Future", (Feb. 3–10, 1999 Kunming, China. Feb. 3–10, 1999) ed. P. S. Chen.: (Yunnan Observatory, Chinese Academy of Sciences), 81.

Nakajima, H., and Grechnev, V.: 1999, Spatial and Temporal Characteristics of Microwave Flares with Sub-Second Structures, *Proc. The Yohkoh 8th Anniversary Symposium,* "Explosive Phenomena in Solar and Space Plasmas", eds. T. Kosugi, T. Watanabe and M. Shimojo, 119–122.

Nakajima, H., Sato, J., and Fujiki, K.: 1999, Thermal and Nonthermal Components in an X-Class Long Duration Flare, "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 243–248.

Nakajima, T., and Matsuhara, H.: 2000, Sensitivity of a Space Infrared Interferometer, "Darwin and Astronomy", ed. B. Schurmann, (ESTEC, Netherlands), 199.

Nakajima Y., **Tamura, M.**, Oasa, Y., and **Nakajima, T.**: 1999, A Deep Near-Infrared Imaging Survey of the Lupus 3 Dark Cloud, "Star Formation 1999", ed. T. Nakamoto, *NRO Report,* **343.**

Nakanishi, K., Akiyama, M., Ohta, K., and Yamada, T.: 1999, Near-Infrared Observations of a Type-2 QSO at $z=0.9$, *Proc. of the IAU Symp. 186,* "Galaxy Interactions at Low and High Redshift", eds. J. E. Barnes and D. B. Sanders, 361.

Nakano, T., Hasegawa, T., **Morino, J.-I.**, and Yamashita, T.: 2000, Evolution of Protostars Accreting Mass at Very High Rates: Is Orion IRc2 a Huge Protostar?. *NROR.* **512**

Nakashima, J., Jiang, B. W., **Deguchi, S.**, Sadakane, K., and Nakada, Y.: 1999, Period Measurement of AGB Stars in the Outer Galactic Disk. *NROR.* **509**

Nindos, A., Kundu, M. R., Raulin, J.-P., **Shibasaki, K.**, White, S. M., Nitta, N., Shibata, K., and Shimojo, M.: 1999, A Microwave Study of Coronal and Chromospheric Ejecta, "Solar Physics with Radio Observations", *Proc. of the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 135–140.

Nindos, A., Kundu, M. R., White, S. M., Gary, D. E., **Shibasaki, K.**, and Dere, K. P.: 1999, Microwave and Extreme Ultraviolet Observations of Solar Polar Regions, *American Astronomical Society Meeting* **194**, 32.07.

Nishida, S., Tanabe, T., Matsumoto, S., Onaka, T., Nakada, Y., **Sekiguchi, K.**, and Glass, I. S.: 1999, Discovery of infrared stars in globular clusters in the Magellanic Clouds and their light variations. *New Astronomy Reviews,* **43**, 473–474.

Nishio, M., Kosugi, T., Yaji K., and **Nakajima, H.**: 1999, Nobeyama/HXT Observations of Impulsive Flares, "Solar Physics with Radio Observations", *Proc. the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 235–242.

Nishio, M., Lui, Q., Miyazaki, T., Omodaka, T., Morimoto, M., **Kawaguchi, N., Sasao, T.**, and **Kuji S.**: 2000, Real-time VLBI System Using Telephone Network for On-line System Diagnosis, *SPIE's International Symposium,* (Munchen, Germany), in press.

Nitta, S.: 1999, Statistical Properties of Kerr BH FlyWheel Model of QSOs/AGNs, in *ASP, IAU Symposium Volumes,* "Highly Energetic Physical Processes and Mechanisms for Emissions from Astrophysical Plasmas".

Noguchi, T., Kanzawa, T., Kurakami, T., Hayashi, S. S., Yutani, M., Ohshima, N., Nakagiri, M., Okita, K., Imi, K., Potter, R., Sasaki, G., Kamata, Y., and Ishikawa, T.: 2000, Coating and Cleaning of Subaru Telescope Mirrors, *Proc. SPIE,* 4003–40, submitted.

Noguchi, T., Kanzawa, T., Kurakami, T., Hayashi, S., Yutani, M., Ohshima, N., Nakagiri, M., Okita, K., Imi, K., Potter, R., Sasaki, G., Kamata, Y., and Ishikawa, T.: 2000, Coating and Cleaning of Subaru Telescope Mirrors, *SPIE proc.,* 4003–40.

Nomoto, K., Umeda, H., Hachisu, I., Kato, M., Kobayashi, C., and **Tsujimoto, T.**: 2000, Type Ia Supernova Progenitors, Environmental Effects, and Cosmic Supernova Rates, "Type Ia Supernovae: Theory and Cosmology", ed. J. Truran, and J. Niemeyer (Cambridge University Press), in press.

Nomoto, K., Umeda, H., Kobayashi, C., Hachisu, I., Kato, M., and **Tsujimoto, T.**: 2000, Type Ia Supernovae: Progenitors and Evolution with Redshift, *Proc. of Maryland Conference*, in press.

Oasa, Y., Kamazaki, T., **Sunada, K.**, **Tamura, M.**, **Umemoto, T.**, Kitamura, Y., and Saito, M.: 1999, ISO-PHOT Observations of Nobeyama Dense Cores in the rho Ophiuchi Cloud. "The Universe seen by ISO", *ESA-SP-427*, 505.

Oasa, Y., **Tamura, M.**, **Itoh, Y.**, and **Nakajima, T.**: 1999, Deep Near Infrared Survey of Nearby Star-Forming Regions—Luminosity Function of Very Low-Mass YSOs, *Star Formation 1999 Proc.*, 343.

Ohishi, M: 1999, Observational Astrochemistry, *Proc. of the 1st Chemistry Symposium* (Cairo University), in press.

Ohishi, M.: 1999, Protection of Millimeter-wave Astronomy, *Proc. of the IAU symposium No. 196* "Preserving the Astronomical Sky", in press.

Ohta, K., **Nakanishi, K.**, Akiyama, M., Takeuchi, T. T., Yamada, T., Shioya, Y., **Kohno, K.**, **Kawabe, R.**, **Kuno, N.**, and **Nakai, N.**: 1999, CO Observations of High-z Objects, *Proc. the IAU Symp. 186*, "Galaxy Interactions at Low and High Redshift", eds. J. E. Barnes and D. B. Sanders, 362.

Okamura, S., Komiyama, Y., Doi, M., Shimasaku, K., Sekiguchi, M., **Yagi, M.**, **Kashikawa, N.**, Yasuda, N., **Iye, M.**, Mobasher, B., Carter, D., Poggianti, B., and Bridges, T.: 1999, Color od Dwarf Galaxies in the Coma Cluster, *IAUS. 183*, 104.

Okumura, S., Mori, A., Nishihara, E., Watanabe, E., and **Yamashita, T.**: 1999, Burst Star Formation and the Initial Mass Function in W51 Region, *Proc.* "Star Formation 1999", ed. T. Nakamoto, 347–348.

Omata, K., **Nishimura, T.**, **Noguchi, T.**, Sawada, S., **Usuda, T.**, and **Yutani, Y.**: 2000, Control of Subaru Telescope Instrument Exchanger Sysytem, *SPIE proc.*, 4009–40.

Orito, M.: 1999, Big-Bang Nucleosynthesis and Evolution of Li, Be, B, *Proc. Subaru HDS Workshop* on "Stars and Galaxies" (Tokyo), in press.

Orito, M., **Kajino, T.**, and Oberhummer, H.: 1999, Impact of Primordial LiBeB abundance in Cosmology and Nuclear Physics, *Proc. Int. Symp.* on "Nuclei in the Cosmos V" (Greece), ed. N. Prantzos (Editions Frontieres), 37–40.

Raju, K. P., **Sakurai, T.**, **Ichimoto, K.**, and Singh, J.: 1999, The Distribution of Emission Line Widths in a Polar Coronal Hole from Norikura Coronagraphic Observations, *Proc. Yohkoh 8th Anniversary Symposium* "Explosive Phenomena in Solar and Space Plasmas", eds. T. Kosugi, T. Watanabe, and M. Shimojo, 18–22.

Saito, M., Beltran, M. T., Ho, P. T. P., and **Kawabe, R.**: 1999, Survey of CM Continuum Emission Toward Protostars in Taurus, Science with the Atacama Large Millimeter Array (ALMA), Associated Universities, Inc., (Carnegie Institution of Washington October 6–8, 1999), 52.

Saito, M., Kitamura, Y., **Kawabe, R.**, **Sunada, K.**, **Ukita, N.**, Furuya, Y., and Ho, P. T. P.: 1999, Dispersal of Dense Cores around Young Stellar Objects in Taurus, Star Formation 1999, *Proc.* on "Star Formation 1999", (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 207–210.

Sakamoto, K.: 2000, Bar-Driven Transport of Molecular Gas in Spiral Galaxies: Observational Evidence, Dynamics of Galaxies: from the Early Universe to the Present, 15th IAP meeting (Paris, France, July 9–13, 1999), eds. Francoise Combes, Gary A. Mamon and Vassilis Charmandaris, *ASP Conference Series* **197**, 73.

Sakamoto, K., **Okumura, S. K.**, **Ishizuki, S.**, and Scoville, N. Z.: 1999, Radial Transport of Molecular Gas to the Nuclei of Spiral Galaxies, *Proc. of the workshop* held at STScI (Oct. 5–7, 1998), "The Formation of Galactic Bulges", eds. C. M. Carollo, H. C. Ferguson and R. F. G. Wyse, (Cambridge U. P.), 132–135.

Sakamoto, K., Scoville, N. Z., Yun, M. S., Crosas, M., Genzel, R., and Tacconi, L. J.: 1999, Subarcsecond Imaging of Gas and Dust in the Nucleus of Arp 220, *Proc.* on "Astrophysics with Infrared surveys: A Prelude to SIRTF", eds. M. D. Bicay, C. A. Beichman, R. M. Cutri and B. F. Madore, *ASP Conf. Ser.* **177**, 179–183.

Sakamoto, S.: 1999, Detailed Structure of High-Latitude Molecular Clouds, "New Perspectives on the Interstellar Medium", eds. A. R. Taylor, T. L. Landecker and G. Joncas, *ASP Conf. Ser.* **168**, 407–410.

Sakamoto, S.: 1999, Small-Scale Structure of Low-Density Molecular Gas in Nearby Clouds, Star Formation 1999, *Proc. of Star Formation 1999*, (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 108–109.

Sakamoto, S., Hasegawa, T., Handa, T., Morino, J.-I., Oka, T., Seta, M., **Sorai, K.**, Usuda, K. S., and **Hayashi, M.**: 1999, The Tokyo-Nobeyama CO $J=2$–1 Galactic Plane Survey, "New Perspectives on the Interstellar Medium", eds. A. R. Taylor, T. L. Landecker and G. Joncas, *ASP Conf. Ser.* **168**, 90–93.

Sakamoto, S., Hasegawa, T., Morino, J.-I., **Hayashi, M.**, and Usuda, K. S.: 1999, Detailed Structure of Giant Molecular Cloud Peripheries, "New Perspectives on the Interstellar Medium", eds. A. R. Taylor, T. L. Landecker and G. Joncas, *ASP Conf. Ser.* **168**, 403–

406.
Sakamoto, S., Ishiguro, M., Kawabe, R., and LMSA working groups: 1999, The Large Millimeter and Submillimeter Array, *Proc. of IEEE 7th International Conference* on "Terahertz Electronics", eds. M. Hangyo and K. Sakai, 284.

Sakamoto, S., and Tomita, A.: 1999, Vertical Motion of Molecular and Ionized Gas in Nearby Face-on Galaxies. "New Perspectives on the Interstellar Medium", eds. A. R. Taylor, T. L. Landecker and G. Joncas, *ASP Conf. Ser.* **168**, 283–286.

Sakao, T.: 1999, HXT Observations of Solar Flares—A Review and Perspective—, "Solar Physics with Radio Observations", *Proc. of the Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 321–333.

Sakao, T, Kosugi, T., Masuda, S., and **Sato, J.**: 2000, Evolution of Magnetic Field Structure and Particle Acceleration in Solar Flares, *Ad. Space Res.,* **26**(3), 497–500.

Sakurai, T., Irie, M., Imai, H., Miyazaki, H., and Sykora, J.: 1999, Emission Line Intensities of the Solar Corona and Sky Brightness Observed at Norikura: 1950–1997, *Publ. Natl. Astron. Obs. Japan,* **5**, 121–137.

Sakurai, T.: 1999, National Report 1998—*Japan, JOSO Annual Report 1998,* Joint Organization for Solar Observations, 32–33.

Sakurai, T., and Li, H.: 1999, Importance of Magnetic Shear in Flare Activity Inferred from Vector Magnetograph Observations, *Proc. the Yohkoh 8th Anniversary Symposium* "Explosive Phenomena in Solar and Space Plasmas", eds. T. Kosugi, T. Watanabe, and M. Shimojo, 51–53.

Sano, T., Inutsuka, S., and **Miyama, S. M.**: 1999, A Higher-Order Godunov Scheme for Non-Ideal Magnetohydrodynamics "Numerical Astrophysics", eds. S. Miyama, K. Tomisaka, and T. Hanawa (Tokyo: Kluwer), 383–386.

Sasaki, T., Kosugi, G., Kawai, J., Kusumoto, T., Koura, N., Hawkins, R., Kramer, L., Krueger, A., and Miller, G.: 2000, Observation scheduling scheme for Subaru telescope, *SPIE proc.,* 4009–36.

Sato, J., and **Hanaoka, Y.**: 1999, Observation of the Loop-Top Source of the 1998 April 23 Flare, "Solar Physics with Radio Observations", *Proc. Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 349–352.

Sato, J., Masuda, S., Kosugi, T., and **Sakao, T.**: 2000, Improvement of Yohkoh HXT Imaging and Analysis of the 1997 November 6, X9 Flare, *Adv. Space Res.,* **26–3**, 501–504.

Sawada, T., Hasegawa, T., Handa, T., Morino, J. I., Usuda, K. S., **Sorai, K.,** Oka, T., Seta, M., **Sakamoto, S.,** Hayashi, M., Booth, R., Bronfman, L., Luna, A. C., and Nyman, L.-Å.: 1999, Molecular Gas in the Galactic Center: Large-Scale Structure and Kinematics, Star Formation 1999, *Proc. of Star Formation 1999,* (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 104–105.

Sekiguchi, K.: 1999, Subaru Telescope and MCVs. Annapolis workshop on Magnetic Cataclysmic Variables, *ASP Conference series,* **157**, eds. C. Hellier and K. Mukai, 413–416.

Sekimoto, Y.: 1999, Millimeter and Submillimeter—Wave Observations of X-Ray Emitting Protostars, *Proc. the Symposium, Japanese-German Workshop* on "High Energy Astrophysics", (Kyoto, Japan, Oct. 19–21, 1998), eds. W. Becker and M. Itoh, *MPE Report* **270**, 44–48.

Sekimoto, Y.: 1999, SIS Receivers for the Mt. Fuji Submillimeter-Wave Telescope and Atacama Submillimeter Telescope Experiment, *Proc. IEEE 7th International Conference* on "Terahertz Electronics", eds. M. Hangyo and K. Sakai, 292–295.

Sekimoto, Y., Kawabe, R., Yamamoto, S., and Hasegawa, T.: 1999, The Atacama Submillimeter Telescope Experiment, Science with the Atacama Large Millimeter Array (ALMA), Associated Universities, Inc., (Carnegie Institution of Washington, October 6–8, 1999), 57.

Sekimoto, Y., Tatematsu, K., Arikawa, Y., Aso, Y., **Noguchi, T.,** Shi, S. C., Miyazawa, K., Yamamoto, S., Ikeda, M., Maezawa, H., Ito, T., Saito, G., Saito, S., Ozeki, H., Fujiwara, H., Inatani, J., and **Ohishi, M.**: 1999, Large-Scale CI and CO (J=3–2) Observations of the M17 Complex with the Mt. Fuji Submillimeter-Wave Telescope, Star Formation 1999, *Proc. Star Formation 1999,* (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 86–87.

Shibasaki, K.: 1999, Microwave Observations of the Quiet Sun, "Solar Physics with Radio Observations", *Proc. Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 1–9.

Shibasaki, K.: 1999, Observational Evidence of Ballooning Instabilities in a Solar Flare, "Solar Physics with Radio Observations", *Proc. Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 419–423.

Shibatsuka, T., **Kohno, K.,** Matsushita, S., and **Kawabe, R.**: 1999, NMA Observations of CO(2–1) and CO(1–0) Emission in the Starburst Region of NGC 4527. *Proc. of Star Formation 1999,* (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 46–47.

Shigeyama, T., and **Tsujimoto, T.**: 2000, A New Model for Chemical Evolution of the Galactic Halo: First Stars with Heavy Elements, in "The First Stars", eds. A. Weiss, T. Abel, and V. Hill (Heidelberg: Springer), 183–184.

Shigeyama, T., and **Tsujimoto, T.**: 2000, Inhomogeneous Chemical Evolution in the Galactic Halo: Supernova-Induced Formation of Field Stars and Globular Clusters, "Origin of Matter and Evolution of Galaxies", eds. T. Kajino and N. Kubono, (Singapore: World Scientific), in press.

Shigeyama, T., and **Tsujimoto, T.**: 2000, What Extremely Metal-Poor Stars Tell about Nucleosynthesis in Supernovae, "The Galactic Halo: From Globular Clusters to Field Stars", eds. A. Noels *et al.,* in press.

Shimizu, T.: 1999, Weak Transient Activities in the Corona, *Proc. Nobeyama Symposium* on "Solar Physics with Radio Observations", eds. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 123–128.

Shimizu, T., and the Solar-B working Group: 1999, Solar-B—The Next Japanese Solar Mission—, *Proc. Nobeyama Symposium* on "Solar Physics with Radio Observations", eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 459–469.

Slysh, V. I., Val'tts, I. E., Migenes, V., Fomalont, E., Hirabayashi, H., **Inoue, M.,** and **Umemoto, T.**: 1999, Protoplanetary Disk and/or Bipolar Outflow Traced by H_2O Maser, American Astronomical Society Meeting **194**, 50.10.

Soma, M.: 1999, Lunar Occultations Observed in Japan and Lunar Limb Profiles Derived, *Proc. 4th East-Asia Meeting* on "Astronomy Observational Astrophysics in Asia and its Future", ed. P.-S. Chen, 254–258.

Soma, M.: 1999, Grazing Occultation Observations, *Occultation Newsl.* **7–4**, 7–9.

Somov, B. V., Kosugi, T., **Sakao, T.,** Masuda, S., and Bogachev, S. A.: 1999, Coronal Hard X-rays in Solar Flares: YOHKOH Observations and Interpretation, Ninth European Meeting on Solar Physics: Magnetic Fields and Solar Processes. Ninth Meeting of the Solar Physics Section of the Joint Astrophysics Division of the European Physical Society (EPS) and of the European Astronomical Society (EAS). (Florence, Italy, Sept. 12–18, 1999). *Proc. published in ESA SP Series (SP-448)*, ed. A. Wilson, 142.

Somov, B. V., Merenkova, E. Y., Kosugi, T., **Sakao, T.,** Masuda, S., and Oreshina, A. V.: 1999, Three-dimensional Reconnection in the Solar Corona Related to YOHKOH Observations, Ninth European Meeting on Solar Physics: Magnetic Fields and Solar Processes. Ninth Meeting of the Solar Physics Section of the Joint Astrophysics Division of the European Physical Society (EPS) and of the European Astronomical Society (EAS). (Florence, Italy, Sept. 12–18, 1999). *Proc. published in ESA SP Series (SP-448)*, ed. A. Wilson, 177.

Soyano, T., and **Maehara, H.**: 1999, A Search for Cool Carbon Stars. VII. Vulpecula (l∼60°) Region, *Publ. Natl. Astron. Obs.,* **5**, 149–166.

Suematsu, Y.: 1999, Development of New Solar Optical Observaion System at Mitaka NAOJ, *Proc. the Nobeyama Symposium* on "Solar Physics with Radio Observations, eds. T. S. Bastian, N. Gopalswamy, and K.Shibasaki, *NRO Report* **479**, 443–446.

Suematsu, Y. Imai, H., Yoshimura, K., Ishigaki, T., Ueno, S., Hayashi, T., and Ohtani, H.: 1999, Tridimensional Spectroscopic Observations of the Sun with Microlens-Array Spectrograph, "High Resolution Solar Physics: Theory, Observations, and Techniques", eds. T. R. Rimmele, K. S. Balasubramaniam, and R. R. Radick, *ASP Conf. Ser.,* **183**, 303–310.

Suematsu, Y., and Solar-B Working Group: 1999, Scientific Objectives and Design Concepts of the Optical Telescope and its Observing Instruments aboard Solar-B, "High Resolution Solar Physics: Theory, Observations, and Techniques", eds. T. R. Rimmele, K. S. Balasubramaniam, and R. R. Radick, *ASP Conf. Ser.,* **183**, 198–205.

Sunada, K., and Kitamura, Y.: 1999, High-Resolution $C^{18}O$ Mapping Observations of Heiles' Cloud 2—Statistical Properties of the Line Width—, *Proc. of the 2nd Guillermo Haro Conference,* "Interstellar Turbulence", (Puebla, Mexico, Jan. 12–16, 1998), eds. J. Franco, and A. Carraminana, 208–212.

Suzuki, T. K., Yoshii, Y., Kawanomoto, S., **Kajino, T.,** and Ando, H.; 1999, A New Model of Evolution of Light Elements in Galactic Halo and New Determination Method of Primordial Li^7 Abundance, *Proc. of Subaru HDS Workshop on Stars and Galaxies.*

Suzuki, T. K., Yoshii, Y., and **Kajino, T.**: 1999, Evolution of Light Elements in the Inhomogeneous Early Galaxy, *Proc. of IAU Symposium 198* "Light Elements and their Evolution".

Suzuki, T. K., Yoshii, Y., **Kajino T.,** and Beers, T. C.: 2000, A New Model of Evolution of Light Elements in Inhomogeneous Galactic Halo, *Proc. of International Conference* on "Origin of Matter and Evolution of Galaxy 2000".

Takahashi, J.: 2000, Theoretical Simulations of Grain-Surface Processes, *Proc. IAU Symposium 197* "Astrochemistry: from Molecular Clouds to Planetary Systems" (Cheju Island, Republic of Korea, August, 1999), eds. Y. C. Minh and E. F. van Dishoeck, 293–302.

Takahashi, J., and Williams, D. A.: 1999, Chemical Desorption of CO in the Vicinity of H_2 Forming Sites on Dust, *Proc. 3rd Cologne-Zermatt Symposium* "The Physics and Chemistry of the Interstellar Medium", (Zermatt, Switzerland, September, 1998), eds. V. Ossenkopf *et al.*, 375–378.

Takahashi, M., and **Watanabe, T.**: 2000, Filling Factor of Flare Loop in Decay Phase, *Adv. Space Res.*, **25–9**, 1805.

Takahashi, R., and The TAMA collaboration: 1999, Performance of Vibration Isolation System for TAMA300, *Proc. of 8th Marcel Grossmann Meeting* on "General Relativity", 1069–1070.

Takami, H.,Takato, N., Kanzawa, T., Kamata, Y., Nakashima, K., and **Iye, M.**: Subaru Adaptive Optics System: the System Desgin and the Current Status, "Astronomy with Adaptive Optics Present Results and Future Programs", ed. D. Bonaccini, 673–680 (1999).

Takano, S., Stutzki, J., and Winnewisser, G.: 1999, Observations of the High-Excitation Lines of HCN in *TMC-1, Abstract Book of the IAU Symposium 197*, "Astrochemistry: From Molecular Clouds to Planetary Systems", 107–108.

Takata, T.: 2000, STARS: Current Status and Future Plan, *Proc. of ADASS-IX*.

Takata, T., Ogasawara, R., Kosugi, G., Mizumoto, Y., Ichikawa, S., Yasuda, N., Taga, M., Yagi, M., Horaguchi, T., Baba, H., **Watanabe, M., Ozawa, T.**, Hamabe, M., Yamamoto, T., and Kawarai, K.: 2000, STARS (Subaru Telescope Archive System) for the effective return from Subaru Telescope, *SPIE proc.*, 4010–21.

Tang, Y. H., and **Sakurai, T.**: 1999, Activation of a Disappearing Filament and Flare Eruption, "The Sun and Human Environment", eds. H. Q. Zhang, K. Y. Tang, *et al.*, (Science Press, Beijing), 62–66.

Tanikawa, K.: 2000, The Proceedings of the Symposium on Outflows from Astrophysical Objects—Present Status and Future Prospect, eds. K. Tanikawa *et al.*.

Tanikawa, K., Handa, T., and **Ito, T.**: 2000, Lifespan of Organisms and the Secular Change of the Environment, *Proc. 32nd Symposium* on "Celestial Mechanics", 179–193.

Tanikawa, K., and Mikami, Y.: 2000, Space Occultation, *Proc. 32nd Symposium* on "Celestial Mechanics", 228–233.

Tanikawa, K., and Mikkola, S.: 2000, Multiple Collisions in the One-Dimensional Free-Fall Four-Body problem, *Proc. 32nd Symposium* on "Celestial Mechanics", 297–310.

Tatematsu, K.: 1999, Structure of Molecular Clouds and Properties of Cloud Cores, Star Formation 1999, Proceedings of Star Formation 1999, (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 72–75.

Terasawa, M., Sumiyoshi, K., **Kajino, T.**, Tanihata, I., and Mathews, G.: New Nuclear Reaction Flow towards *r*-Process Nucleosynthesis in Supernovae: A Critical Role of the Light Neutron-Rich Nuclei $1 \leq Z \leq 10$, International Symposium, "Origin of Matter and Evolution of Galaxies 2000"(CNS, University of Tokyo, January 21, 2000), in press.

Tomisaka, K.: 1999, Outflows from YSO's and the Angular Momentum of New-Born Stars, *Proc. of 33rd ESLAB Conference* on "Star Formation from the Small to the Large Scale" (ESTEC, Noordwijk). in press.

Tsuboi, M., Miyazaki, A., and **Tsutsumi, T.**: 1999, Flare of Sgr A^+ at Short Millimeter Wavelengths, *Proc.* of "The Central Parsecs of the Galaxy; Galactic Center Workshop", eds. H. Falcke, A. Cotera, W. J. Duschl, F. Melia and M. J. Rieke, *ASP Conf. Ser.* **186**, 105–112.

Tsuchiya, T., and **Gouda, N.**: 2000, Relaxation of One-Body Distribution Function and KS Time in Gravitating Sheet Systems, "The Chaotic Universe", eds. V. G. Gurzadyan and R. Ruffini, (World Scientific), 259–267.

Tsuchiya, T., **Gouda, N.**, and Konishi, T.: 1999, Relaxations and Long Time Evolutions of One-Dimensional N-Body Systems Recent Developments in Theoretical and Experimental General Relativity, "Gravitation, and Relativistic Field Theories", eds. T. Piran and R. Ruffini, (World Scientific), 637.

Tsuji, T., **Aoki, W.**, and Ohnaka, K.: 2000, Red Supergiant Stars: Infrared Spectra and their Modelling, *Proc. 2nd ISO workshop* on "Analytical Spectroscopy ISO Beyond the Peaks", 82.

Tsujimoto, T., Shigeyama, T., and Yoshii, Y.: 2000, A New Model for Chemical Evolution of the Galactic Halo: Formulation and Applications, "The First Stars", eds. A. Weiss, T. Abel, and V. Hill (Heidelberg: Springer), 181–182.

Tsujimoto, T., Shigeyama, T., and Yoshii, Y.: 2000, Chemical Evolution of the Galactic Halo through Supernova-induced Star Formation, "The Galactic Halo: From Globular Clusters to Field Stars", eds. A. Noels *et al.*, in press.

Tsujimoto, T., Shigeyama, T., and Yoshii, Y.: 2000, Inhomogenous Chemical Evolution of the Galactic Halo, "The Chemical Evolution of the Milky Way: Stars versus Cluster", eds. S. Fabrizio and F. Matteucci (Kluwer), in press.

Tsujimoto, T., and Yoshii, Y.: 1999, The Absolute Magnitude of RRLyrae Stars derived from the Hipparcos Catalogue, "Harmonizing Cosmic Distance Scales in a Post-HIPPARCOS Era", eds. D. Egret and A. Heck, 332–335.

Tsuno, K., Itoh, Y., Kosugi, T., Matsuzaki, K., Ninomiya, K., and **Shimizu, T.**: 1999, Ultra Fine Sun Sensor with Sub-arcsecond Resolution for SOLAR-B, *Proc. of 4th Internatinal Conference* on "Spacecraft Guidace, Navigation and Control Systems" (ESTEC, 18–21 Oct. 1999).

Tsuribe, T., and **Inutsuka, S.**: 1999, Fragmentation and Core Formation in Dynamically Collapsing Rotating Clouds, "Numerical Astrophysics" eds. S. Miyama, K. Tomisaka, and T. Hanawa (Tokyo: Kluwer), 75.

Tsuribe, T., and **Inutsuka, S.**: 1999, Criteria for Fragmentation of Collapsing Rotating Isothermal Clouds, "Star Formation 1999", ed. T. Nakamoto (Nobeyama Radio Observatory), 367–368.

Uehara, H., and **Inutsuka, S.**: 1999, Does Deuterium Enable the Formation of Primordial Brown Dwarfs?, "Star Formation 1999", ed. T. Nakamoto (Nobeyama Radio Observatory), 30–31.

Uehara, H., and **Inutsuka, S.**: 1999, Does Deuterium Enable the Formation of Primordial Brown Dwarfs?, "The First Stars", eds. A. Weiss, T. G. Abel, V. Hill, 279–280.

Umehara, H., and **Tanikawa, K.**: 2000, Slingshot-Escape Condition in the Planar Three-Body Problem, "The Chaotic Universe" eds. V. G. Gurzadyan and R. Ruffini, (World Scientific), 568–578.

Umemoto, T., Saito, M., Yang, J., and Hirano, N.: 1999, A Rotating and Infalling Molecular Envelope around the H_2O Maser in L1287, *Proc.* on "Star Formation 1999", (Nagoya, Japan, June 21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 227–228.

Uralov, A. M., Nakajima, H., Zandanov, V. G., and Grechnev, V. V.: 1999, Magnetic Neutral Line-Associated Radio Sources and Evolution of the Active Region NOAA 7321, "Solar Physics with Radio Observations", *Proc. Nobeyama Symposium,* (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 93–97.

Usuda, K. S., Hasegawa, T., Handa, T., Morino, J.-I., Sawada, T., **Sakamoto, S.,** Oka, T., Seta, M., **Sorai, K.,** Hayashi, M., Booth, R., Nyman, L. A., Bronfman, L., May, J., Luna, A., Shaver, P., and White, G. J.: 1999, Low Density Molecular Gas in the Galaxy, The Physics and Chemistry of the Interstellar Medium, *Proc. 3rd Cologne-Zermatt Symposium,* (Zermatt, September 22–25, 1998), eds. V. Ossenkopf, J. Stutzki and G. Winnewisser, (GCA-Verlag Herdecke), 96.

Usuda, T., Itoh, Y., Akiyama, M. **Hayashi, S. S., Yamashita, T., Hayashi, M.,** Maihara, T., Iwamuro, F., Motohara, K., Iwai, J., Tanabe, H., **Inutsuka, S.,** and **Kaifu, N.**: 1999, High-Resolution H_2 Observations of Orion KL with SUBARU, *H_2 in Space Meeting Proc., in press.*

Usuda, T., Itoh, Y., Akiyama, M., **Hayashi, S. S., Yamashita, T., Hayashi, M.,** Maihara, T., Iwamuro, F., Motohara, K., Iwai, J., Tanabe, H., **Inutsuka, S.,** and **Kaifu, N.**: 1999, High-Resolution H_2 Observations of Orion KL with SUBARU "H_2 in Space", eds. F. Combes and G. Pineau des Forets (Cambridge UP), 69.

Usuda, T., Sugai, H., Takami, M., Kawabata, H., Inoue, M. Y., **Suto, H.,** Kataza, H., Geballe, T. R., and Tanaka, M.: 2000, The Excitation Mechanism of NIR H_2 Emission Lines in PDRs, *H_2 in Space Meeting Proc.,* in press.

Vorobyov, E. I., Korchagin, V. I., and Mayya, Y. D.: 2000, The Radial Abundance Gradients [Fe/O] in the Star Burst Ring Galaxies as a Tool to Constrain the Nature of SNIa Progenitors, *Proc. of 33rd ESLAB Symp.* "Star Formation from the Small to the Large Scale", eds. F. Favata, A. A. Kaas, and A. Wilson, **ESA SP-455.**

Vorobyov, E. I., Korchagin, V. I., and Mayya, Y. D.: 2000, Optical Color Gradients in the Starburst Ring Galaxies, *Proc. of 33rd ESLAB Symp.* "Star Formation from the Small to the Large Scale", eds. F. Favata, A. A. Kaas, and A. Wilson, **ESA SP-455.**

Wada, K.: 1999, Stellar Feedback to Global Structure of the Interstellar Matter, *RIKEN Review* **25**, 106.

Wada, K., and Norman, C.: 1999, Global Evolution of a Self-Gravitating Multi-Phase ISM in the Central Kpc Region of Galaxies, "The Formation of Bulges", eds. C. M. Carollo, H. C. Ferguson, and R. F. G. Wyse, (Cambridge University Press, Cambridge), 152–156.

Wada, K., Spaans, M., Kim, S., and Norman, C.: 1999, Global Star Formation in the Multi-Phase ISM, "Star Formation 1999", ed. T. Nakamoto, (Nobeyama Radio Observatory, Nobeyama), 36–37.

Wanajo, S., Ishimaru, Y., **Terasawa, M.**, and **Kajino, T.**: 1999, The *r*-Process in the Explosions of 8–10 Solar mass Stars, *Proc. Int. Symp.* on "Nuclei in the Cosmos V" (Greece), ed. N. Prantzos (Editions Frontieres), 321–324.

Wanajo, S., Ishimaru, Y., **Terasawa, M.**, and **Kajino, T.**: 1999, The *r*-Process Elements in Metal-poor Stars and Nucleosynthesis in Supernovae, *Proc. Subaru HDS Workshop* on "Stars and Galaxies" (Tokyo), in press.

Wanajo, S., Otsuki, K., and **Kajino, T.**: 1999, The *r*-Process in Neutrino Winds of Core-collapse Supernovae: Effects of General Relativity and Neutrino Capture, *Proc. 4th Int. RESCEU Symp.* on "Particle Cosmology" (Tokyo), eds. K. Sato, T. Yanagida, and T. Shiromizu (Universal Academy Press), in press.

Wanajo, S., Otsuki, K., and **Kajino, T.**: 1999, The Quest for a Gold Mine in the Galaxy: Origins of *r*-Process Elements, *Proc. Subaru HDS Workshop* on "Stars and Galaxies" (Tokyo), in press.

Wanajo, S., Otsuki, K., Kajino, T., Terasawa, M., and **Mathews, G. J.**: 2000, The *r*-Process in Neutrino Winds of Core-collapse Supernovae, *Proc. Int. Symp.* on "Origin of Matter and Evolution of Galaxies" (Tokyo), eds. T. Kajino, S. Kubono, K.-I. Nomoto and I. Tanihata (World Scientific), in press.

Wang, H. N., Sakurai, T., Yan, Y., and Liu, Y.: 1999, The Extrapolated 3-D Solar Magnetic Fields in AR 7321, "Numerical Astrophysics", eds. S. M. Miyama, K. Tomisaka, and T. Hanawa, (Kluwer Academic Publishers), 333–334.

Watanabe, T., and Schwenn, R.: 2000, Coronal Structure ad Dynamics Near Solar Activity Minimum, *Ad. Space Res.*, **25–9**.

Yagi, M., Mizumoto, Y., Nishihara, E., **Yoshida, M.**, Asai, R., **Chikada, Y., Kosugi, G., Takata, T., Ogasawara, R.**, Ishihara, Y., Yanaga, H., Morita, Y., and Nakamoto, H.: 1999, DASH—Distributed Analysis System Hierarchy Astronomical Data Analysis Software and Systems VIII, *ASP Conference Series,* **172**, ed. D. M. Mehringer, R. L. Plante, and D. A. Roberts, 357–360.

Yamaguchi, Y., and **Tanikawa, K.**: 2000, A Condition for the Existence of Homoclinic Intersection in the C^2 Standard-like Mappings, *Proc. 32nd Symposium* on "Celestial Mecanics", 261–271.

Yamaguchi, Y., and **Tanikawa, K.**: 2000, Symmetrical Non-Birkhoff Period-3 Orbits in the Standard-like Mappings, *Proc. 32nd Symposium* on "Celestial Mecanics", 272–282.

Yamamoto, N., Ohtsuka, K., Fukushima, H., **Watanabe, J., Kawabata, K.**: 1999, Lightcurve of 22010l Jato from Dec. 1995 to Jan. 1996, *Proc. 32nd ISAS Lunar and Planetary Symposium,* 83–84.

Yamashita, T., Kaifu, N., Hayashi, M., Akiyama, M., Itoh, Y., Nakajima, Y., **Usuda, T., Hayashi, S. S., Tamura, M., Miyama, S.**, Hasegawa, T., and **Inutsuka, S.**: 1999 Studies of Star Forming Regions with SUBARU, *Proc.* on "Star Formation 1999", (Nagoya, Japan, June21–25, 1999), ed.: T. Nakamoto, (Nobeyama Radio Observatory), 391–394.

Yano, T., and **Gouda, N.**: 1999, Scale-Invariant Correlation Functions of Cosmological Density Fluctuations in the Strong Clustering Regime and the Stability, "Cosmological Parameters and the Evolution of the Universe". ed. K. Sato, (Kluwer Academic), 274.

Yokono, Y., Inutsuka, S., Miyama, S. M., Ogasawara, R., Takeuchi, T., and **Chikada, Y.**: Development of a Special Purpose Computer for Cosmic Hydrodynamics Using the SPH Method. "Numerical Astrophysics", eds. S. Miyama, K. Tomisaka, and T. Hanawa (Tokyo: Kluwer), 429.

Yokoyama, T.: 1999, MHD Simulations of Flares, *Proc. the Nobeyama Symposium,* "Solar Physics with Radio Observations", (Kiyosato, Japan, Oct. 27–30, 1998), eds. T. S. Bastian, N. Gopalswamy and K. Shibasaki, *NRO Report* **479**, 391–396.

Yokoyama, T.: 2000, MHD Simulations of Magnetic Reconnection in Solar Flares and Jets, *Adv. Space Res.*, **26–3**, 511–520.

Yokoyama, T., and Shibata, K.: 1999, Theory of Coronal X-ray Jets, Solar Wind Nine, *Proc. 9th International Solar Wind Conference,* (Nantucket, MA, October 1998). Eds. S. R. Habbal, R. Esser, J. V. Hollweg, and P. A. Isenberg, *AIP Conference Proc.*, **471**, 61.

Yokoyama, T., Tanuma, S., Kudoh, T., and Shibata, K.: 2000, Magnetic Reconnection Model of X-Ray Plasmas in the Galactic Center, *Adv. Space Res.*, **25**, 505–508.

Yoshida, H.: 1999, From Singular Point Analysis to Rigorous Results on Integrability: A dream of S. Kowalevskaya, "Hamiltonian Systems with Three or More Degrees of Freedom", ed. C. Simo, (Kluwer Academic Publishers), 270–282.

Yoshida, M., Shimizu, Y., Sasaki, T., Kosugi, G., Takata, T., Sekiguchi, K., Kashikawa, N., Aoki, K., Asai, R., **Ohyama, Y., Kawabata, K., Inata, M.**, Saito, Y., Taguchi, T., Ebizuka, N., Yadoumaru, Y., Ozawa,T., and **Iye, M.**: 2000, Software Structure and its Performance on FOCAS Instrument Control, a MOS Design, and an Analyzing Package, *SPIE sympo.*, "Astronomical Telescopes and Instrumentation 2000", 4009–24, in press.

Yoshiike, H., and **Nakajima, H.**: 2000, Microwave Enhancement in Low-latitude Coronal Holes, *Adv. Space Res.*, **25**, 119–122.

Yoshiike, H., and **Nakajima, H.**: 2000, Microwave Enhancement in Low-Latitude Coronal Holes, *Adv. Space Res.*, **25**, 1757–1760.

Yoshioka, K.: 1999, Long-term Periodic Variations in Polarization of Three RV Tauri Stars, SU Gem, U Mon, and RV Tau, 放送大学研究年報, 16号, 211–228.

Yoshioka, K., Saijo, K., and **Satoh, H.**: 2000, Polarization Observations of RV Tauri Stars at the Dodaira Station of the National Astronomical Observatory in Japan, "The Impact of Large-Scale Surveys on Pulsation Star Research", *ASP Conference Series*, **203**, 112–113.

Zhang, H. Q., **Sakurai, T.**, Shibata, K., **Shimojo, M.**, Kurokawa, H., Morita, S., and Uchida, Y.: 1999, Magnetic Reconnection in an Active Region Inferred by Homologous Soft X-ray Flares in February 1992, "The Sun and Human Environment", eds. H. Q. Zhang, K. Y. Tang, *et al.*, (Science Press, Beijing), 58–61.

3. Presentations

Abe, S., Boice, D. C., Watanabe, H., and **Watanabe, J.**: 1999, Radio and Optical Observations of Plasma Tail of Comet Hale-Bopp, Asteroids, Comets, Meteors Conference (Cornell University, July 26–30, 1999), 05.19-P.

Abe, S., Ebizuka, N., **Watanabe, J.**, Murayama, H., and Ohtsuka, K.: 1999, Spectrum of Meteor Persistent Train of Leonids, Asteroids, Comets, Meteors Conference (Cornell University, July 26–30, 1999), 20.13-P.

Agata, H.: 1999, Astronomical Education with ISS, The International Workshop, Space Factory on JEM/ISS.

Agata, H.: 1999, Astronomical Education with the Internet in Japan, Global Hands—On Universe Workshop (Australia).

Agata, H.: 1999, International Leonids '99 Project with High-school Students All Over the World, HOU TRA Workshop (Hawaii).

Akiyama, M.: 1999, Optical Identification of the ASCA Large Sky Survey—AGN survey in the 2–10 keV band. Japan-German Workshop on AGN and the X-ray Background, (ISAS, Nov. 1–3 1999).

Akiyama, S., Hori, K., **Nakajima, H.**, and **Hara, H.**: 1999, Relationship of CMEs and N-S AR-interconnecting Loops Observed by SXT and Nobeyama Radioheliogrph, The Yohkoh 8th Anniversary Symposium, "Explosive Phenomena in Solar and Space Plasmas" (Sagamihara, Japan, Dec. 6–8).

Aoyama, Y., and **Naito, I.**: 1999, Seasonal-scale Three Dimensional Angular Momentum Budgets for Atmosphere-mantle System, IUGG. (Birmingham, U. K., July).

Arai, K.: 1999, New Signal Extraction Scheme with Harmonic Demodulation for Power-recycled Fabry-Perot Michelson Interferometers, The 2nd TAMA Workshop on Gravitational Wave Detection (Tokyo, Japan, Oct. 19–22).

Aschwanden, M. J., Kosugi, T., **Hanaoka, Y.**, Nishio, M., and Melrose, D. B.: 1999, Quadrupolar Magnetic Reconnection in Solar Flares, American Astronomical Society Meeting 194, 31.07.

Balasubramaniam, K. S., **Suematsu, Y.**, Smaldone, L. A., Yoshimura, K., Hegwer, S., and Otani, H.: 1999, Simultaneous 2-D Spatial Spectra Using a Microlens Array, American Astronomical Society Meeting 194, 93.06.

Beers, T. C., **Chiba, M.**, Yoshii, Y., Platais, I., Hanson, R., Fuchs, B., and Williamson, R. II.: 1999, Space Motions For a Large Sample of Non-Kinematically Selected Metal-Poor Starsin the Thick Disk and

Halo of the Galaxy, American Astronomical Society Meeting 194, 84.12.

Boehnhardt, H., Hainaut, O., Barucci, A., Birkle, K., Delahodde, C., Marsden, B., Meech, K., Sekiguchi, T., Tozzi, G., **Watanabe, J.**, and West, R.: 1999, Physical Studies of TNOs at the European Southern Observatory, Asteroids, Comets, Meteors Conference, (Cornell University, July 26–30, 1999), 27.04.

Boice, D. C., and **Watanabe, J.-I.**: 1999, Dusty Gas Flow in the Inner Coma of Comet Hale-Bopp, American Astronomical Society, DPS meeting 31, (Padova, Italy, Oct. 10–15), 17.15.

Boice, D. C., **Watanabe, J.**, Tanabe, R., and Cochran, A. L.: 1999 Modeling Chemistry in the Dusty Coma of Comet Hale-Bopp, Asteroids, Comets, Meteors Conference, (Cornell University, July 26–30, 1999), 09.18-P.

Fujimoto, M.-K.: 1999, Overview of TAMA300. The 2nd TAMA Workshop on Gravitational Wave Detection (Tokyo, Japan, Oct. 19–22).

Hanada, H., Heki, K., Kawano, N., Ooe, M., Tsubokawa, T., Tsuruta, S., Ishikawa, T., Araki, H., Matsumoto, K., Yakanezawa, T., Kono, Y., **Karoji, H.,** Iwata, T., Kaneko, Y., and Yokoyama, T.: 1999, Advanced Observations of Lunar Physical Librations and Gravitational Fields in Japanese Lunar Missions in the Near Future, IAU Colloquium 178, Polar Motion: Historical and Scientific Problems (Cagliali, Italy, Sep. 27–30).

Hanaoka, Y., Sakurai, T., Sato, J., and Gopalswamy, N.: 1999, CMEs Caused by Emerging Flux Activity, The Yohkoh 8th Anniversary Symposium, "Explosive Phenomena in Solar and Space Plasmas" (Sagamihara, Japan, Dec. 6–8).

Hayano, Y., **Takami, H., Takato, N., Kanzawa, T., Kamata, Y., Nakashima, K., Iye, M.,** and Oya, S.: 2000, Preliminary Experiments of Prototype Laser Guide Star System for Subaru Telescope. SPIE: Astronomical Telescopes and Instrumentation 2000.

Heinzel, G.: 1999, Electronic Noise in Interferometers, The 2nd TAMA Workshop on Gravitational Wave Detection (Tokyo, Japan, Oct. 19–22).

Heki, K.: 1999, Japanese PBO: 5 years of GEONET Observations—What We Anticipated to See and What We Saw. Plate Boundary Observatory Workshop (Snowbird, Utah, U.S.A., Oct. 3–5).

Heki, K.: 1999, Impact of Space Geodesy to Global, Regional and Local Tectonic Studies. American Geophysical Union Fall Meeting (San Francisco, California, U.S.A., Dec. 13–17).

Heki, K., Hanada, H., Tsubokawa, T., Kawano, N., Ooe, M., Namiki, N., and Iwata, T.: 1999, Advanced Space Technologies for Geodesy of the Moon: Selenodetic Missions in SELENE and SELENE2. IAG General Meeting, Symposium G2, Advanced Space Technology (Birmingham U.K., July 18–30).

Hori, K.: 1999, Statistical Study of Solar Decimetric Bursts with a Pair of Cutoff Frequencies, High Energy Solar Physics Workshop (Maryland University, U.S.A., Oct. 18–20).

Hori, K.: 2000, Origin of Helical Coronal Disturbances from the Sun, International Conference on Solar Eruptive Events (The Catholic University of America, U.S.A., March 6–9).

Hori, K., Akiyama, S., Morimoto, T., and Kurokawa, H.: 1999, The Solar Tornado —Rotating Prominences and CMEs Observed with Nobeyama Radioheliograph and LASCO/SoHO, International Workshop on Space Weather Research and Operation in the 23rd Solar Activity Maximum (Ibaraki, Japan, Nov. 15–17).

Hori, K., Akiyama, S., Morimoto, T., and Kurokawa, H.: 1999, Solar Tornado—Rotating Prominences and CMEs Observed with Nobeyama Radioheliograph and SoHO, The Yohkoh 8th Anniversary Symposium, "Explosive Phenomena in Solar and Space Plasmas". (Sagamihara, Japan, Dec. 6–8).

Ishii, M., Hirao, T., Nagashima, C., Nagata, T., Sato, S., and Yao, Y.: 1999, "A survey of Near Infrared Nebulosity surrounding Luminous Young Stellar Objects", in 'Star Formation 1999', (Nagoya University, Japan).

Iwabuchi, T., and **Naito, I.**: 1999, A Close Relationship between Temporal Anomalies in Site Coordinate and Zenith Tropospheric Delay in GPS Array over the Japanese Islands in Summer, IUGG. (Birmingham, U.K., July).

Iwabuchi, T., and **Naito, I.**: 1999, Behaviors of GPS Retrieved Precipitable Water Vapors over the Japanese Islands, IUGG. (Birmingham, U.K., July).

Iwabuchi, T., and **Naito, I.**: 1999, Ten-yearly Polar Motion Connected with Precipitation Changes over North American and Eurasian Continents, IUGG. (Birmingham, U.K., July).

Kano, R.: 1999, Heating of Coronal Loops, Yohkoh 8th Auniversary Int. Sympo.

Katsukawa, Y., **Tsuneta, S.,** and **Vekstein, G.**: 1999, Signatures of a nanoflare heated corona. Yohkoh 8th Anniversary Int. Sympo.

Kawamura, S.: 1999, Overview of the Detector and Data Taking. The 2nd TAMA Workshop on Gravitational Wave Detection (Tokyo, Japan, Oct. 19–22).

Kawano, N., Hanada, H., Iwata, T., and Koyama, Y.: 2000, Differential VLBI Observations among a

Lunar Orbiter, the Moon, and QSOs, First IVS General Meeting (Kotzing, Germany, Feb. 21–24).

Kinoshita, D., Yamamoto, N., Sekiguchi, T., and **Watanabe, J.**: 1999, Survey for Large Edgeworth-Kuiper Belt Object. Asteroids, Comets, Meteors Conference, (Cornell University, July 26–30, 1999), 27.12-P.

Kono, Y., **Hanada, H., Iwadate, K., Araki, H., Kawano, N.**, Koyama, Y., and Fukuzaki, Y.: 2000, Differential VLBI Observations of the Lunar Prospector. First IVS General Meeting (Kotzing, Germany, Feb. 21–24).

Kundu, M. R., Nindos, A., Raulin, J.-P., **Shibasaki, K.**, White, S. M., Nitta, N., Shibata, K., and Shimojo, M.: 1999, A Microwave Study of Coronal Ejecta. American Astronomical Society Meeting 194, 17. 04.

Matsuo, H.: 1999, Nobeyama Bolometer Array and a Design of a Superconducting Submillimeter-Wave Camera, Imaging at Radio through Submillimeter Wavelengths. (National Radio Astronomical Observatory, Tucson, Arizona, Jun. 6–9).

Matsuo, H.: 1999, ASTRO-F All Sky Survey of Far-Infrared Galaxies and their Submillimeter-wave Follow-up Observations, Science with the Atacama Large Millimeter Array. (Associated Universities Incorporated, Washington D.C., Oct. 6–9).

Matsuo, H.: 1999, Wide Field Imaging in Far-Infrared and Submillimeter-Waves, The 4th RESCEU International Symposium on "The Birth and Evolution of the Universe", (University of Tokyo, Nov. 16–19).

Matsuo, H., Akahori, H., Takeda, M., and Noguchi, T.: 2000, Development of Submillimeter-wave Camera for Atacama Submillimeter Telescope Experiment. SPIE's International Symposium on "Astronomical Telescopes and Instrumentation 2000". (Munich, Germany, Mar. 27–31).

Matsushita, S., **Matsuo, H., Sakamoto, A.**, and Pardo, J. R.: 2000, FTS Measurements of Submillimeter Opacity and Other Site Testing at Pampa la Bola, SPIE's International Symposium on "Astronomical Telescopes and Instrumentation 2000". (Munich, Germany, Mar. 27–31).

Mazaki, S., **Iwabuchi, T., Heki, K.**, and **Naito, I.**: 1999, Spatio-Temporal Ariation of Atmospheric Delay Gradient Retrieved by a Dense GPS Array and its Relationship with Site Coordinate Variations. IUGG. (Birmingham, U.K., July).

Miyazaki, S., and **Heki, K.**: 1999, Crustal Deformation by Plate Subduction and Interarc Collision in Southwest Japan, International Symposium on GPS-Application to Earth Sciences and Interaction with Other Space Geodetic Techniques. (Tsukuba International Congress Center, Ibaraki, Oct.18–22).

Murakawa, K., **Tamura, M.**, Nagata, T., and Sato, S.: 1999, Water Ice Distribution in the Taurus Molecular Cloud, "Star Formation 1999" (Nagoya).

Nagai, T.: 1999, Hubble Space Telescope, International Workshop: Space Factory on JEM/ISS. (Tsukuba Space Center of NASDA, Japan, Jun. 7–9, 1999).

Nagai, T., Inutsuka S., and **Miyama, S. M.**: 1999, Formation and Evolution of Filamentary Structure in Molecular Clouds, "Star Formation 1999", (Nagoya University, Japan, Jun. 21–25, 1999).

Nagashima, C., Nagayama, T., Nakajima, Y., **Tamura, M.**, Sugitani, K., Nagata, T., Hirao, T., Nakaya, H., **Yanagisawa, K.**, and Sato, S.: 1999, Development of SIRIUS—A Simultaneous-Color Infrared Imager for Unbiased Survey—"Star Formation 1999" (Nagoya).

Naito, I., Zhou, Y.-H., Sugi, M., Kawamura, R., and Nobuo, N.: 1999, Three-Dimensional Atmospheric Angular Momentum Simulated by the Japan Meteorological Agency Model for the Period of 1955–1994, IUGG, (Birminghan, U.K., July).

Nakajima, H., and Grechnev, V.: 1999, Spatial and Temporal Characteristics of Microwave Flares with Sub-second Structures, The Yohkoh 8th Anniversary Symposium, "Explosive Phenomena in Solar and Space Plasmas". (Sagamihara, Japan, Dec. 6–8).

Nakakubo, K., and **Hara, H.**: 1999, Variation of XBP Number in the Solar Activity Cycle and Deviation from a Uniform Latitude Distribution. Yohkoh 8th Anniversary Int. Sympo.

Nindos, A., Kundu, M. R., White, S. M., Gary, D. E., **Shibasaki, K.**, and Dere, K. P.: 1999, Microwave and Extreme Ultraviolet Observations of Solar Polar Regions. American Astronomical Society Meeting 194, 32. 07.

Nishikawa, J., Sato, K., Yoshizawa, M., Fukushima, T., Machida, Y., Honma, Y., **Suzuki, S., Torii, Y., Matsuda, K., Kubo, K., Iwashita, H.**: 2000, Mitaka Optical and Infrared Array First Stage (MIRA-I. 1) Instruments, SPIE Conference 4006 (Munich, Germany, Mar. 27–31).

Nishio, M., Lui, Q., Miyazaki, T., Omodaka, T., Morimoto, M., **Kawaguchi, N., Sasao, T.**, and **Kuji S.**: 2000, Real-time VLBI System Using Telephone Network for On-line System Diagnosis, SPIE's International Symposium (Munchen, Germany, Mar. 3).

Nitta, S.: 1999, Statistical Properties of Kerr BH Fly-Wheel Model of QSOs/AGNs, IAU Symposium 195, "Highly Energetic Physical Processes and Mechanisms for Emissions from Astrophysical Plasmas" (Montana, U.S.A.).

Nitta, S., Tanuma, S., Shibata, K., and Maezawa, K.:

2000, Fast Magnetic Reconnection in Free Space: Self-similar Evolution Process, University of Tokyo Symposium in 2000, "Magnetic Reconnection in Space and Laboratory Plasmas" (Tokyo, Japan).

Oasa, Y., **Tamura, M., Itoh, Y.**, and Nakajima, T.: 1999, Deep Near Infrared Survey of Nearby Star-Forming Regions—Luminosity Function of Very Low-Mass YSOs—"Star Formation 1999", (Nagoya).

Ohishi, M: 2000, Observational Astrochemistry, 1st Chemistry Symposium. (Cairo University, Cairo, Egypt. Mar.).

Ohishi, M.: 1999, Protection of Millimeter-wave Astronomy, IAU symposium 196 "Preserving the Astronomical Sky". (Viena, Austria, July).

Ohishi, M.: 1999, Chemical Evolution of Molecular Clouds, Bioastronomy symposium (Kona, Hawaii, Aug.).

Ohtani, R., and **Naito, I.**: 1999, Measuring Regional Precipitable Water Vapor Variations using the Japanese Dense GPS Network, IUGG, (Birminghan, U.K., July).

Ohtani, R., and **Naito, I.**: 1999, Evaluations of the Accuracy of Precipitable Water Vapor Estimated from GPS Observations with Radiosonde Measurements in Japan, IUGG. (Birminghan, U.K., July).

Okoshi, K.: 1999, Workshop for the HDS (NAO) QSO Absorption Systems に関して期待される HDS の成果について, Yohkoh 8th Anniversary Int. Sympo.

Omata, K., Usuda, T., Yutani, M., Noguchi, T., Nishimura, T., and Sawada, S.: Control of the Subaru Telescope Instrument Exchanger System. SPIE, Astronomical Telescopes and Instrumentation 2000 (Munich, Germany).

Saito, Y., Horikoshi, G., **Takahashi, R.**, and **Fukushima, M.**: 1999, Operational Status of the Vacuum System of the 300 m Gravitational Wave Laser Interferometer TAMA300. 6th European Vacuum Conference (Lyon, France, Dec. 7–10).

Sato, K.-H., Hara, T., Kuji, S., Asari, K., Nishio, M., and **Kawano, N.**: 1999, Development of an Ultra Stable Fiber Optic Frequency Distribution System using an Optical Delay Control Module. XXVIth General Assembly of the International Union of Radio Science. (Aug. 13–21), A6.

Sato, K., Nishikawa, J., Yoshizawa, M., Fukushima, T., Torii, Y., Matsuda, K., Kubo, K., Iwashita, H., Suzuki, S., and Saint-Jacques, D.: 2000, Experiments of the Fiber-connected Interferometer for MIRA Project. SPIE Conference 4006 (Munich, Germany, Mar. 27–31).

Sekiguchi, T., Ukita, N., Hasegawa, H., **Watanabe, J., Fuse, T.**, and Boice, D. C.: 1999, Radio Observations of (2060) 95P/Chiron using NRO 45m Telescope. Asteroids, Comets, Meteors Conference (Cornell University, July 26–30, 1999), 27.16-P.

Shibasaki, K.: 1999, High-beta Disruption in the Solar Corona, The Yohkoh 8th Anniversary Symposium, "Explosive Phenomena in Solar and Space Plasmas" (Sagamihara, Japan, Dec. 6–8).

Shibasaki, K.: 1999, Ballooning Instability in the Solar Corona, A Workshop "Physics of the Solar Corona and Transition Region" (Monterey, California, U.S.A., Aug. 24–27).

Shimizu, T.: 1999, Magnetic Activities at Photosphere Responsible for Loop-like Transient Brightenings (SXR microflares), Yohkoh 8th Anniversary In. Sympo.

Soma, M.: 2000, Examination of the Hipparcos Proper Motion System from Lunar Occultation Analysis, IAU Colloquium 180. "Towards Models and Constants for Sub-Microarcsecond Astrometry" (Washington D. C., U.S.A., March 27–30).

Sugitani, K., **Tamura, M.**, and Ogura, K.: 1999, Small-Scale Sequential Star Formation in Bright-Rimmed Clouds, "Star Formation 1999" (Nagoya).

Takahashi, J.: Theoretical Simulations of Grain-Surface Processes. IAU symposium 197 "Astrochemistry: from Molecular Clouds to Planetary Systems", (Cheju Island, Republic of Korea, August, 1999).

Takahashi, R.: 1999, Improvement of Vibration Isolation System for TAMA300, The 2nd TAMA Workshop on "Gravitational Wave Detection" (Tokyo, Japan, Oct. 19–22).

Tamura, M.: 1999, Submillimeter Polarimetry of Star Forming Regions: From Cloud Cores to Circumstellar Disks, "Star Formation 1999" (Nagoya).

Tamura, Y.: 1999, GPS Observations at Tide Gauge Stations in Tohoku area, Japan, International Symposium on GPS, (Tsukuba, Oct. 18–22).

Terada, S.: 1999, Calibration and its Error Estimation Method, The 2nd TAMA Workshop on "Gravitational Wave Detection" (Tokyo, Japan, Oct. 19–22).

Tomono, D., Doi, Y., and **Nishimura, T.**: 2000, Test Observation Results from the Mid-infrared Imager MIRTOS for the Subaru Telescope, SPIE conference: Optical and IR Telescope Instrumentation and Detectors, (Munich, Germany).

Totani, T.: 1999, A Unified Picture for Various Total Energies of GRBs, Talk given at the 5th Huntsville Gamma-Ray Burst Symposium, (Huntsville, U.S.A., October).

Totani, T.: 2000, Dust versus Supernova Cosmology, Invited talk to appear in the proceedings of the

Dark Matter 2000 conference, (Los Angeles, U.S.A., February).

Tsuneta, S.: 1999, Magnetic reconnection seen in Yohkoh (tentative). Yohkoh 8th Anniversary Int. Sympo.

Uehara, H., and **Inutsuka, S.**: 1999, Does Deuterium Enable the Formation of Primordial Brown Dwarfs? Star Formation 1999, (Nagoya University, Japan, Jun. 21–25, 1999).

Uehara, H., and **Inutsuka, S.**: 1999, Does Deuterium Enable the Formation of Primordial Brown Dwarfs? The First Stars 1999, (Garching, Germany, Aug. 4–6, 1999).

Usuda, T., Omata, K., Yutani, M., Torii, Y., Mikami, Y., Nishino, T., Noguchi, T., Nishimura, T., and Sawada, S. Ciax: Cassegrain Instrument Auto Exchanger for the Subaru Telescope. SPIE, Astronomical Telescopes and Instrumentation 2000 (Munich, Germany).

Wada, K.: 1999, Bubbly Structure of the Multi-phase ISM without Star Formation, 194th American Astronomical Society Meeting (Chicago).

Watanabe, J., Abe, S., Nakamura, T., Yano, H., and Iiyama, O.: 1999, The Leonids 1998 over Japan—Storm Component or Not?—Asteroids, Comets, Meteors Conference, (Cornell University, July 26–30, 1999), 07.10-P.

Watanabe, J., Fukushima, H., Nakamura, A., Boice, D. C., and Sugawara, K.: 1999, The Morphology of Comet C/1998K5 Linear—Intermittent Fragmentation of the Nucleus?— Asteroids, Comets, Meteors Conference, (Cornell University, July 26–30, 1999), 5.11.

Yamashita, T., Kaifu, N., Hayashi, M., Akiyama, M., Itoh, Y., Nakajima, Y., Usuda, T., Hayashi, S. S., Tamura, M., Miyama, S., Hasegawa, T., and **Inutsuka, S.**: 1999, Studies of Star Forming Regions with SUBARU, "Star Formation 1999" (Nagoya).

Yang, J., and Yao, Y.: 1999, Optical and Near Infrared Imaging of Jets and Outflows, IAU Symposium 197, "Astrochemistry: From Molecular Clouds to Planetary Systems" (Sogwipo, Cheju Island, Korea).

Yano, H., Bretz, D., Abe, S., **Watanabe, J.**, Iiyama, O., Fujii, Y., and Nakamura, R.: 1999, The Faintest Visual Meteors of the 1998 Leonids: Airborne Observation with the High-Definition Digital Video Cameras over the East China Sea. Asteroids, Comets, Meteors Conference (Cornell University, July 26–30, 1999), 07.05.

Yokoyama, T.: 1999, MHD Simulations of Solar Flares and Magnetic Reconnection, IPELS '99 (Interrelation between Plasma Experiments in Laboratory and Space) (Kreuth, Germany, Aug. 9–11).

Yokoyama, T., Akita, K., Morimoto, T., Inoue, K., and Newmark, J.: 1999, Clear Evidence of Reconnection Inflow of a Flare, Yohkoh 8th Anniversary Symposium, "Explosive Phenomena in Solar and Space Plasmas" (Sagamihara, Japan, Dec. 6–8).

Yokoyama, T., Akita, K., Morimoto, T., Inoue, K., Newmark, J.: 2000, Clear Evidence of Reconnection Inflow of a Flare, University of Tokyo Symposium in 2000 on Reconnection in Space and Laboratory Plasmas (Tokyo, Japan, Feb. 29–Mar. 4).

Yokoyama, T., Nakajima, H., and **Shibasaki, K.**: 1999, Discovery of Sub-second-time-scale Propagation of a Nonthermal Source by Nobeyama Radio Heliograph, Yohkoh 8th Anniversary Symposium, "Explosive Phenomena in Solar and Space Plasmas" (Sagamihara, Japan, Dec. 6–8).

Yokoyama, T., and Shibata, K.: 1999, Numerical Simulations of Solar Flares, IAU Symposium 195, "Highly Energetic Physical Processes and Mechanisms for emission from Astrophysical Plasma" (Montana State University, U.S.A., July 6–10).

Yoshida, F.: 2000, Photopolarimetry of Asteroids. Seoul-Kobe workshop on Small Particles in Space (Seoul University, Korea March 27–29).

Yoshida, F., Ishiguro, M., Takahashi, S., Shinokawa, K., Mukai, T., **Kawabata, K.**, and Furusho, R.: 2000, Photopolarimetry of Asteroids. Seoul-Kobe Workshop on Small Particles in Space (Seoul National University, Korea, March 27–29).

Yoshida, H.: 1999, Painleve Analysis for Hamiltonian Systems and its Justification by Differential Galois Theory. (Galipoli, Italy, July 1–10).

Yoshida, H. : 1999, Justification of Painleve Analysis for Hamiltonian Systems by Differential Galois Theory. (Hong Kong, China, July 13–16).

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