

## VII Graduate Course Education

### 1. Department of Astronomical Science, School of Physical Sciences, SOKENDAI (the Graduate University for Advanced Studies)

SOKENDAI (The Graduate University for Advanced Studies) was established as an independent graduate university without undergraduate courses via partnerships with inter-university research institutes for the sake of advancing graduate education.

There used to be four schools – Cultural and Social Studies, Mathematical and Physical Sciences, Life Science, and Advanced Sciences before the reorganization of the School of Mathematical and Physical Sciences into the schools of Physical Sciences, High Energy Accelerator Science, and Multidisciplinary Sciences in April 2004. Now the total of six schools are offering doctoral education and research opportunities.

NAOJ has been accepting three-year doctoral course students since FY 1992 and five-year students since FY 2006 for the Department of Astronomical Science at the School of Physical Sciences. (The School of Mathematical and Physical Sciences was reorganized into the School of Physical Sciences in April 2004.)

#### (1) Objective of the Department of Astronomical Science

The Department of Astronomical Science aims to train students, through observational, theoretical or instrument development research in astronomy or in related field, in an environment with the most advanced observational instruments and supercomputers, as researchers who work at forefront of world-class research; experts who carry out the development of advanced technology; and specialists who endeavor in education and public outreach activities equipped with advanced and specialized knowledge.

Numbers of students to be admitted:

Two (per year in five-year doctoral course)

Three (per year in three-year doctoral course)

Degree: Doctor of Philosophy

#### (2) Admission Policy

The Department of Astronomical Sciences seeks students with a strong interest in astronomy and the Universe; a passion for unraveling scientific questions through theoretical, observational, and instrument development research; and students who have not only basic academic skills, but who also have the needed theoretical and creative aptitude for advanced research.

#### (3) Department Details (Course Offerings)

Optical and Near Infrared Astronomy

[Educational and Research Guidance Field]

Ground-based astronomy / Optical and infrared telescope system / Planets / Sun, stars and interstellar matter / Galaxies and cosmology

Radio Astronomy

[Educational and Research Guidance Field]

Ground-based astronomy / Radio telescope system / Sun, stars and interstellar matter / Galaxies

General Astronomy and Astrophysics

[Educational and Research Guidance Field]

High-precision astronomical measurement / Astronomy from space / Data analysis and numerical simulation / Earth and planets / Sun, stars and interstellar matter / Galaxies and cosmology

#### (4) Course-by-Course Education Program to Cultivate Researchers in Physical Sciences with Broad Perspectives

The School of Physical Sciences began its “Course-by-Course Education Program to Develop Student Research Capability and Aptitude” in FY 2009 as part of MEXT’s Program for “Enhancing Systematic Education in Graduate Schools”. Currently the School is carrying out its succeeding program, “Course-by-Course Education Program to Cultivate Researchers in Physical Sciences with Broad Perspectives” since FY2012, offering four specific courses to the students: the Basic Course, the Advanced Research Course, the Project Research Course, and the Development Research Course. In FY 2014, the Department of Astronomical Science accepted four students in the Basic Course and four students in the Advanced Research Course. The Department also offered the e-learning class “Introduction to Observational Astronomy II” as a school-wide common basic subject, as well as the “Exercise in Scientific English” class, in order to provide a good foundation for students at the graduate school.

In order to better prepare students for the international stage, the Department hosted the Asia Winter School during February 10 to 13, 2015, as well as the 2014 Summer Student program at Mitaka, Mizusawa, Nobeyama and Hawaii campuses to allow undergraduate students a chance to experience research at the Department of Astronomical Science. In addition to the existing Research Assistant system, the Department also provided Associate Researcher positions for the students of the Department of Astronomical Science.

**(5) Number of Affiliated Staff (2015/3/31)**

Chair of the Department of Astronomical Science	1
Optical and Near Infrared Astronomy Course	
Professors	10
Associate Professors	13
Lecturer	1
Assistant Professors	10
Radio Astronomy Course	
Professors	6
Associate Professors	8
Assistant Professors	18
General Astronomy and Astrophysics Course	
Professors	8
Associate Professors	11
Assistant Professors	15
<hr/> Total	<hr/> 101

**(6) Graduate Students (30 students)**

1st year (3 students)

Name	Principal Supervisor	Supervisor	Thesis
Sasahira, Rinko	Osuga, Ken	Tanaka, Masaomi	The co-evolution of galaxies and black holes
Michiyama, Tomonari	Iono, Daisuke	Kodama, Tadayuki	Observing Starburst Galaxies Using ALMA
Yamamoto, Moegi	Kodama, Tadayuki	Iwata, Ikuru	The peak epoch of galaxy formation explored by SWIMS-18 survey

2nd year (5 students)

Name	Principal Supervisor	Supervisor	Thesis
Okutomi, Koki	Aso, Yoichi	Flaminio, Raffael	Research for sensitivity improvement of gravitational wave detectors
Onoue, Masafusa	Kashikawa, Nobunari	Miyazaki, Satoshi	Studies on High-z quasars by wide-field imaging observation
Nagasawa, Ryosuke	Hanada, Hideo	Matsumoto, Koji	Development of software for precise LLR data analysis and study of Lunar rotation
Baba, Haruka	Aoki, Wako	Usuda, Tomonori	Development of infrared instruments and observational research for the search of earth-like planets
Ryu, Tsuguru	Hayashi, Saeko	Usuda, Tomonori	Study of exoplanets and brown dwarfs from optical and infrared observations

3rd year (9 students)

Name	Principal Supervisor	Supervisor	Thesis
Yang, Yi	Hayashi, Saeko	Usuda, Tomonori	Observation and Research on Circumbinary Planets
Ishikawa, Shogo	Kashikawa, Nobunari	Kodama, Tadayuki	Measurement of dark halo mass by clustering analysis of star-forming galaxies
Onishi, Kyoko	Iguchi, Satoru	Kuno, Nario	Observational study toward black-hole mass: resolving the coevolution process of black hole and galaxy
Onitsuka, Masahiro	Usuda, Tomonori	Takato, Naruhisa	The observational study of the atmospheres of the exoplanets and the brown dwarfs
Kobayashi, Hiroshi	Osuga, Ken	Tomisaka, Koji	Radiation Hydrodynamic Study of Gas Flow Around Black-Holes
Sakurai, Junya	Miyazaki, Satoshi	Kobayashi, Yukiyasu	Study of large scale structures in the universe through wide field imaging
Shimakawa, Rizumu	Kodama, Tadayuki	Arimoto, Nobuo	Physical properties and environmental dependence of galaxies at their peak epoch of formation
Suzuki, Taiki	Oishi, Masatoshi	Saito, Masao	Research on Organic Molecules in the Universe

Suzuki, Tomoko	Kodama, Tadayuki	Iono, Daisuke	Galaxy anatomy at the peak epoch of galaxy formation
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4th year (5 students)

Name	Principal Supervisor	Supervisor	Thesis
Aoki, Sumire	Arimoto, Nobuo	Kodama, Tadayuki	Origin of Morphology of Elliptical Galaxies
Saito, Yuriko	Imanishi, Masatoshi	Hayashi, Saeko	Investigating the supermassive black hole to spheroidal stellar mass ratio at $z \sim 3$
Matsuzawa, Ayumu	Iguchi, Satoru	Saito, Masao	Research of absorbing plasma around SMBH of M87 by cm and mm wavelength
Oh, Daehyeon	Aoki, Wako	Takami, Hideki	A study of extrasolar planets and their formation sites based on infrared observations
Giono, Gabriel	Suematsu, Yoshinori	Hara, Hirohisa	Study of Optical Tests in $Ly-\alpha$ for CLASP Instrumentation

5th year (8 students)

Name	Principal Supervisor	Supervisor	Thesis
Imase, Keisuke	Kodama, Tadayuki	Kashikawa, Nobunari	Near-Infrared Spectroscopic Observation of Broad Line Regions in Nearby Active Galactic Nuclei"
Kaithakkal, Anjali John	Suematsu, Yoshinori	Watanabe, Tetsuya	Study of Solar Spectro-polarimetry and Magnetic Reversal of the Sun's Poles
Kataoka, Akimasa	Tomisaka, Koji	Nakamura, Fumitaka	Theoretical modeling of the structure evolution of dust aggregates in the early stage of planet formation
Sako, Nobuharu	Watanabe, Tetsuya	Sekii, Takashi	Observational Investigation of Short-Lived Activity Creation Processes in the Solar Atmosphere
Shino, Nagisa	Honma, Mareki	Shibata, Katsunori	Testing the formation scenario of massive stars by CH <sub>3</sub> OH maser
Toshikawa, Jun	Kashikawa, Nobunari	Kodama, Tadayuki	Observational study on high-z clusters
Min, Cheul Hong	Honma, Mareki	Shibata, Katsunori	Research for a symbiotic star using VERA
Sukom, Amnart	Hayashi, Saeko	Izumiura, Hideyuki	Study of star and planetary formation process and the exoplanets based on infrared observations

Research Student (1 student)

Name	Supervisor	Thesis
Yang, Yongzhang	Hanada, Hideo	Research of the interior of the moon and the planet based on an application of rotation theory

## 2. Education and Research Collaboration with Graduate Schools

Name	Affiliated Institute	Supervisor	Thesis
Isoe, Mari	The University of Tokyo	Kokubo, Eiichiro	Theoretical Study of Planet Formation
Ito, Yuta	The University of Tokyo	Gouda, Naoteru	Galactic structure and evolution
Kimura, Yasuhisa	The University of Tokyo	Hara, Hirohisa	Studies on sub-arcsecond transition-region structures at the footpoints of coronal loops in the active-region plage
Kuramochi, Kazuki	The University of Tokyo	Kobayashi, Hideyuki	Millimeter VLBI studies on astronomical observation with the KVN and VERA Array and the VERA
Kuwahara, Sho	The University of Tokyo	Mizuno, Norikazu	The Study of Star Formation and Interstellar Medium in the Galactic Plane
SHU, Shibo	The University of Tokyo	Sekimoto, Yutaro	Development of MKID camera
Okada, Takashi	The University of Tokyo	Sekimoto, Yutaro	The development of submm-camera for observing CMB
Kasuga, Megumi	The University of Tokyo	Hara, Hirohisa	An observational study on coronal heating through investigation of photospheric properties at the footpoints of coronal loops
Kato, Yuta	The University of Tokyo	Mizuno, Norikazu	Herschel Protocluster Survey
Sakai, Daisuke	The University of Tokyo	Kobayashi, Hideyuki	Study for revealing dynamics in the Galactic Center region with VLBI
Tezuka, Kenjiro	The University of Tokyo	Gouda, Naoteru	Resolving degeneracy with regard to gravitational microlensing by astrometry
Baba, Fuko	The University of Tokyo	Hara, Hirohisa	A case study of energy transfer in the chromosphere with IRIS and Hinode
Hirai, Yutaka	The University of Tokyo	Kajino, Toshitaka	Chemodynamical evolution of dwarf galaxies
Lee, Minju	The University of Tokyo	Kawabe, Ryohei	Environmental effects on galaxy evolution from the JVLA continuum observation towards a protocluster 4C23.56
Aso, Yusuke	The University of Tokyo	Ohashi, Nagayoshi	Formation and growth of protoplanetary disks
Ohashi, Satoshi	The University of Tokyo	Mizuno, Norikazu	Chemical evolution of the star-forming cores in the giant molecular clouds
Saito, Toshiki	The University of Tokyo	Kawabe, Ryohei	Starburst and SMBH Formation in Merging Galaxies
Shibagaki, Shota	The University of Tokyo	Kajino, Toshitaka	r-process nucleosynthesis
Shibata, Takashi	The University of Tokyo	Kokubo, Eiichiro	Study of Planet Formation
Sekiguchi, Sigeyuki	The University of Tokyo	Sekimoto, Yutaro	Development of MKID camera for wide field millimeter-wave observations
Tagawa, Hiromichi	The University of Tokyo	Gouda, Naoteru	The study of merge process of primal galaxy black holes with the dynamical friction by gas
Koyamatsu, Shin	The University of Tokyo	Ohashi, Nagayoshi	Formation and Evolution of Protoplanetary Disks
Sekine, Masakazu	The University of Tokyo	Sekimoto, Yutaro	Development of Bi-layer MKID camera
Hara, Takuji	The University of Tokyo	Gouda, Naoteru	Construction of a galactic dynamical model with astrometric data
Hara, Chihomi	The University of Tokyo	Kawabe, Ryohei	Structures and Kinematics of Dense gas and Molecular Outflow in YSOs
Fujii, Kosuke	The University of Tokyo	Mizuno, Norikazu	The effects of stellar feedbacks on the molecular cloud formation in the Large Magellanic Cloud
Akiyama, Kazunori	The University of Tokyo	Kobayashi, Hideyuki	Millimeter VLBI studies on the innermost region of AGNs with the KVN and VERA Array and the Event Horizon Telescope
Kiyokane, Kazuhiro	The University of Tokyo	Mizuno, Norikazu	Research of kinematic structure of low-mass star formation process with Radio telescope
Fujii, Akihiko	The University of Tokyo	Kokubo, Eiichiro	Theoretical study on the formation and the evolution of spatial structure in dense planetary rings
Kasai, Miho	Toho University	Matsuo, Hiroshi	Establishment of stable operation of SIS photon detectors
Kubo, Daiki	Toho University	Matsuo, Hiroshi	Experimental studies on readout electronics for SIS photon detectors
Takano, Akihiro	Kobe University	Ohashi, Nagayoshi	Radio Observations of Star Forming Regions

### 3. Commissioned Graduate Students

Doctoral Course	Affiliated Institute	Period	Supervisor	Thesis
Ono, Yoshito	Tohoku University	2014/4/1 ~ 2015/3/31	Iwata, Ikuru	Verifications of Multi-Object AO system using RAVEN
Oya, Masahito	Nihon University	2014/4/1 ~ 2015/3/31	Watanabe, Junichi	Development of Interferometer for direct observations of exoplanets
Sekiguchi, Takanori	The University of Tokyo	2014/4/1 ~ 2015/3/31	Flaminio, Raffaele	Development of Vibration Isolation System for Large-Scale Cryogenic Gravitational Wave Telescope KAGRA
Mizuno, Izumi	Kagoshima University	2014/4/1 ~ 2015/3/31	Saito, Masao	Polarization calibration method for single-dish radio observations.

Master's Course	Affiliated Institute	Period	Supervisor	Thesis
Kurahashi, Takuya	Meisei University	2014/4/1 ~ 2015/3/31	Iono, Daisuke	Observing Distant Galaxies Using the NRO 45m and ALMA
Okuyama, Yasushi	Tokyo University of Agriculture and Technology	2014/4/1 ~ 2015/3/31	Watanabe, Junichi	Development of precise spectrograph and studies of exoplanets
Kajita, Satoshi	Tokai University	2014/4/1 ~ 2015/3/31	Watanabe, Tetsuya	Study of non-thermal particles in the precursory phenomena of solar flares
Kawauchi, Kiyoe	Tokyo Institute of Technology	2014/4/1 ~ 2015/3/31	Aoki, Wako	The high resolution transmission spectroscopy of the Earth atmosphere using the lunar eclipse data
Sato, Kazuma	Tokyo University of Agriculture and Technology	2014/4/1 ~ 2015/3/31	Watanabe, Junichi	High Contrast Optics for direct observations of exoplanets
Taniguchi, Kotomi	Toho University	2014/4/1 ~ 2015/3/31	Saito, Masao	<sup>13</sup> C isotopic fractionation of HC <sub>5</sub> N in TMC-1
Nakahara, Satomi	Kagoshima University	2014/4/1 ~ 2015/3/31	Honma, Mareki	VLBI multi-epochs observations of the low-luminosity AGN M84
Aoki, Misa	International Christian University	2014/10/1 ~ 2015/3/31	Aoki, Wako	Origins of r-process studied by chemical abundances of metal-poor stars with Subaru/HDS
Sunaga, Naoki	Shizuoka University	2014/10/1 ~ 2015/3/31	Kajino, Toshitaka	High Energy Astrophysics Phenomena and the Origin of Elements

### 4. Degrees Achieved with NAOJ Facilities

Name	Degree	Thesis
Sako, Nobuharu	Doctor of Philosophy, SOKENDAI	Statistical Study of X-ray Jets using Hinode/XRT
Anjali John Kaithakkal	Doctor of Philosophy, SOKENDAI	A Study on the Photospheric Polar Magnetic Patches of the Sun
Kataoka, Akimasa	Doctor of Philosophy, SOKENDAI	Planetesimal Formation via Fluffy Dust Aggregates
Toshikawa, Jun	Doctor of Philosophy, SOKENDAI	Growth History of Galaxy Clusters Traced by Protoclusters at $z \sim 3-6$
Imase, Keisuke	Master of Science, SOKENDAI	Near-Infrared Spectroscopic Observation of Broad Line Regions in Nearby Active Galactic Nuclei