| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (i) | (j) |
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| No. | | Project Research Description | Research subject Requirement | Project | Location | Research Environment | Host Researchers | Contact | Effort (own:project rese |
| 1 | Research and operat on duty at the Nobeyama Radio Observatory | Research on star forming regions w th the Nobeyama 45-m radio telescope; development of antenna, millimeter-wave receiver, or software etc of the radio telescope; operat on of the observatory | Capability of wrighting competitive refereed journal papers, experience in sc ence operat on and/or technical experience with the radio telescope, good command of English | Nobeyama Radio Observatory | Minamimaki, Minamisaku, Nagano, Japan | The observatory has an enviromnent suitable for development of antenna, receiver or software. The observatory carries out researches on star forming reg ons intensively. | Ken' chi Tatematsu | k.tatematsu_AT_nao.ac.jp | 50 : 50 |
| 2 | Observational research using VLBI, or research and development for promoting future project | The successful cand date is expected to promote observat onal astronomy research using VLBI arrays related to Mizusawa VLBI Observatory (such as VERA, KaVA, EAVN, EHT). Alternatively, he/she will conduct research related to SKA, which is being promoted as the future project of the observatory. | Knowledge and experience on VLBI as well as observational astronomy using radio interferometery | Mizusawa VLBI Observatory | Ohshu, Iwate or Mitaka, Tokyo | necessary research enviornment will be provided | Mareki Honma, H deyuki Kobayashi, Tomoya Hirota, Kazuhiro Hada | mareki.honma_AT_nao.ac.jp | 50 : 50 |
| 3 | Study of energy transport and heating in the solar atmosphere with space and ground-based telescopes | The successful cand date is expected to study mechanisms of energy transport and plasma heating by investigating 3D magnetic f eld structures and their dynamics in the solar atmosphere using spectro-polarimetric data taken with the Hinode satellite, the CLASP2.1 rocket (to be launched in 2021), and the SUNRISE-3 balloon (to be launched in 2022). In addition, it is expected to contribute to the development of collaborative research between the next solar satellite Solar-C and large ground-based telescopes such as DKIST. | Achievement in data analysis of solar observations and/or numerical simulations. High motivation and English capabil ty to conduct joint-research with internat onal researchers. | Solar Science Observatory | Mitaka, Tokyo | Observat on data and necessary analysis environment will be provided by the project. | Yukio, Katsukawa | yukio.katsukawa_AT_nao.ac.jp | 50 50 |
| 4 | Instrument development for the next Solar Observation Satell te Solar-C (EUVST) and study on solar magnet c activity phenomena through spectroscopic observations | 1. Instrument development through basic studies and performance evaluation measurements for achieving the target performance of the EUV Spectroscopic Telescope onboard Solar-C (EUVST).<br>2. contribut on to the preparation for observational research using EUVST by sc entif c research using spectroscop c data from solar observat on satell tes. | It is desirable to have exper ence in feasibility studies or measurement evaluations related to developing observational instruments. Good communicat on skills to collaborate with Japanese domestic manufacturers and research institutes as well as overseas collaborating institutes. | SOLAR-C Project | Mitaka, Tokyo | To belong to the SOLAR-C project. The necessary environment for development and research will be provided to the researcher. | Hirohisa Hara | hirohisa.hara_AT_nao.ac.jp | 50 : 50 |

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| 5 | Research and development of the JASMINE instrument and/or its sub-systems | The infrared astrometry satellite, JASMINE, is a project to explore the dynamical evolution of the Milky Way Galaxy by precisely measuring the positions and motions of stars in the galactic core bulge. For this purpose, we need a structurally and thermally stable instrument, and we are currently working on the optical, thermal, and structural design of the instrument system including a telescope. As for the detector system, the Japanese infrared detector developed by NAOJ has been further developed for space use to be installed in JASMINE. In this research theme, for any of these instrument development topics, you will be responsible for designing the instruments, establishing their evaluation methods, or promoting their basic experiments including detector evaluat on in collaborat on with manufacturers in each top c. | It is desirable to have a basic background in optics, mechanics, thermodynamics, rad ation physics, or circuit technology, depending on the specif c research theme. In addition, a good command of Japanese is required for close communicat on with Japanese manufacturers. | JASMINE project | Mitaka, Tokyo | Working on the research and development of observat onal instruments in the JASMINE project. We provide the necessary environment for design and development. | Ryouhei Kano | ryouhei.kano_AT_nao.ac.jp | 50 | : 50 |
| 6 | Research and development of JASMINE's data analysis method, development of analysis software and simulat on software, and construction of mathematical modeling of signals and systematic errors arising from various factors including the instruments, wh ch is necessary for the development of the analysis software | JASMINE will create and publish a catalog of about 100,000 stars containing their astrometr c parameters such as annual parallaxes after hundreds of thousands of times observations for a star. To obtain high-precision astrometr c parameters, t is crucial to perform post processing of the observed data to remove var ous systematic errors, correct bias effects due to the instruments, and also construct and optimize a mathematical modeling of the instruments, by utilizing the self-calibration techn ques.<br>Based on this principle, a successful candidate is required to research and develop a data analysis method that can funct on properly even in realist c situations. The successful candidate is required to research and develop the actual analysis software, and also create simulated data catalog necessary for evaluating the valid ty of the analysis software.<br>In add t on, these research and development will be carried out jointly w th the members in charge of the JASMINNE team. | A successful candidate is expected to have experience in developing astronomical data analysis or control software for astronomical instruments. | JASMINE project | Mitaka, Tokyo | A successful cand date will be engaged in the research and development of data analysis and system simulation research in the JASMINE project. The successful cand date will be provided necessary environment for the software development and necessary information of mission instruments. | Naoteru Gouda | naoteru.gouda_AT_nao.ac.jp | 50 | : 50 |
| 7 | Research and development of millimeter and terahertz instruments | Research and Development on ultra-high sensitiv ty receiver technolog es for next generat on wideband or multibeam instruments including optics, superconducting mixers, low-noise amplif ers and high-speed analog-digital converters. | -Design of RF circuit and receiver system wtih simulator tools<br>-Understanding of basic microwave circuits<br>-Evaluation of RF devices and receiver system with high frequency instrument | Advanced Technology Center | Mitaka, Tokyo | We will prov de the necessary softwares and hardwares in each development team. | Takafumi, Kojima | t.kojima_AT_nao.ac.jp | 50 | : 50 |

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| 8 | Research and development of opt cal and infrared instruments for projects conducted by NAOJ | Research and development on astronom cal instruments for ground-based telescopes such as Subaru and TMT and for space telescopes such as small-JASMINE, optical/infrared detectors, and so on. | ・Exper ences in development of astronomical instruments | Advanced Technology Center | Mitaka, Tokyo | We will prov de the necessary softwares and hardwares in each development team. | Yutaka, Hayano etc. | y.hayano_AT_nao.ac.jp | 50 : 50 |
| 9 | Reserch and development of an integral f eld unit | Reserch and development (R&D) on an integral f eld unit (IFU) allowing us to obtain spectra over two-dimens onal field in one exporsure. The R&D includes such as basic technology development, specifica ton consideration and performance verif caition. | ・Exper ences in development of astronomical instruments | Advanced Technology Center | Mitaka, Tokyo | We will prov de necessary measurement instruments for the development. | Shinobu, Ozaki | shinobu.ozaki_AT_nao.ac.jp | 50 : 50 |
| 10 | Research and development of new instruments for the Subaru Telescope based on model based systems engineering | Research and development of the next-generation near-infrared instruments for Subaru Telescope such as D-Shooter and ULTAIMTE W de-Feld Imager, by modelling the overall system utilizing model-based systems engineering. | Exper ences of instrumentation in astronomy. | Advanced Technology Center | Mitaka, Tokyo | We will prov de the necessary softwares and hardwares in each development team. | Kentaro, Motohara | kentaro.motohara_AT_nao.ac.jp | 50 : 50 |
| 11 | Research on m cro fabrication techniques | Research on the fabricat on of superconducting thin films, superconductor-insulator-superconducting tunnel junctions, or sil con m cromachining techniques for superconducting monolith c m crowave integrated circuits. | Exper ence in microfabrication | Advanced Technology Center | Mitaka, Tokyo | M crofabr cation cleanroom facil ty in ATC can be used. | Wenlei, Shan | Wenlei.shan_AT_nao.ac.jp | 50 : 50 |

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| 12 | Submillimeter astronomy with ASTE | The successful cand date will participate in Commissioning and Science Verification activ ties and operat on for the wide IF bandwidth 500 GHz receiver, the 800 GHz receiver, and the newly deployed spectrometer with IF downconverter. The CSV duty is related to e ther of the following two topics: (a) the verification of the observat on system in the aspect of data accuracy (ampl tude, freuqnecy, and pos tion) and the science verificat on, (b) the verification of data reduct on and data archive, espec ally in pipeline processing tests. The operation duty includes science operation and contribution to improve operation efficiencies (e.g. documentat on, improvement of telescope calibra ton, automat c observat on).<br>It is also expected to lead sc ence verificat on activities of the 500 GHz and 800 GHz receivers in order to promote simultaneous observations of CO(4-3) at 460 GHz in LSB and [CI](1-0) at 492 GHz in USB using the wide IF bandwidth 500 GHz receiver and high frequency observations at the 800 GHz receiver band. | Knowledge and experience of observation and data reduction in rad o astronomy, and/or operation experience using radio astronomy instruments.<br>Capability to join, discuss and collaborate in English-speaking teams. Python programming skill is preferable. | ASTE Project | Mitaka, Tokyo<br>Occasional business trip to Chile | Working with the ASTE team | Takeshi, Kamazaki | kamazaki.takeshi_AT_nao.ac.jp | 50 | : | 50 |
| 13 | Research and development for the JVO system | An appl cant should conduct one of the following subjects:<br>(1) Improvement of the user interface for the JVO portal,<br>(2) Development of a data reduction pipe-line for Subaru telescope, and the release of the processed data at the JVO system,<br>(3) Development of database of emiss on lines detected by ALMA and its integration to the JVO ALMA FITS archive. | The following skills are required to conduct each of the above subjects:<br>(1) A bas c famil arity with the HTML, CSS, JavaScript, and Java languages is required. Having an experience of using database system is desirable.<br>(2) Having an experience of data reduct on and research activity using the data taken by opt cal and/or infrared telescopes is required. A bas c famil arity with python, C, and C++ is required.<br>(3) Having an experience of data analysis at a radio-astronomy domain is required. A basic famil arity w th python, C, and C++ is required. Having an exper ence of using database system is desirable. | Astronomy Data Center | Mitaka, Tokyo | A PC cluster is available for data analysis. An applicatn can purchase his/her own PC using the personal research expenses. | Yuji Shirasaki | yuji.shirasaki_AT_nao.ac.jp | 50 | : | 50 |

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| 14 | Research of the universe based on mathematical statistics with large astronomical catalogs and hyper speed database | Using huge astronomical catalogs that include large numbers of parameters for a large number of celestial objects, we will promote research to explore various new findings and insight by analyzing data using a mathematical statist cal approach. In part cular, research focusing on classificat on and dentification of rare objects by multivariate analysis using archive data (such as SDSS, PanSTARRS, GAIA, etc.) obtained by wide-f eld observat on in visible and infrared wavelengths.<br>It is assumed that the hyper-speed database currently under development will be used as needed, and that methods such as preprocessing by visualizat on, var ous machine learning, and Bayesian estimation will be used appropriately for actual research themes. | Programming skill based on Python is essential and that on C++ is prefferable.<br>Exper ence of query using SQL to database.<br>Exper ence of astronomical observation using optica/infrared 2-d array detectors is preferrable. | Astronomy Data Center | Mitaka, Tokyo | Prov de the access to the development system of hyper-speed database development project as a platform for the research environment. | Tadafumi Takata | tadafumi.takata_AT_nao.ac.jp | 50 | : 50 |
| 15 | Development of coupling model of Phobos orbital evolut on and tidal deformat on | T dal deformation by Mars grav ty has been accounted for its triax al ellipso dal shape of Phobos, and the formation and the orb tal evolution of Phobos have been investigated. On the other hand, it has been proposed that resonance between Phobos orbit and Mar rotation could have increased Phobos eccentricity and even caused a tumbling of ts rotation. In order to understand the history of Phobos, we develop a numer cal coupling model between orb tal evolution and tidal deformation. | Knowledge of astrodynamics and a numer cal computat onal method of sol d body deformation, such as SPH, DEM, and equivalent technique is desired. | RISE Project | Mitaka campus | The cand date will be requested to apply for MMX project of JAXA. | Noriyuki Namiki. Professor | nori.namiki_AT_nao.ac.jp | 50 | : 50 |
| 16 | Development of opt cal technology for gravitational wave telescopes | You will be involved in the development of frequency-dependent squeezing technology (FDS) promoted by the GWSP and the development of ultra-high performance mirrors for KAGRA. Specif cally,<br>1) As a member of the FDS team of the GWSP, you will improve the stable operation and squeezing level of the FDS, and also design and develop the FDS for KAGRA.<br>2) In cooperation with the Advanced Technology Center, you will measure the surface profile, transmitted wavefront, optical absorpt on coeff c ent, and birefringence of the ultra-high performance mirror used in KAGRA. | - Experimental experience in laser measurement<br>- Abil ty to commun cate in English | Grav tational-Wave Science Project (GWSP) | Mitaka, Tokyo | All the basic environment and measurement devices are available to carry out the research theme. | Yoichi Aso | yo chi.aso_AT_nao.ac.jp | 50 | : 50 |

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| 17 | Improvement of sens tivity and data analysis of the gravitational wave telescope KAGRA | You will contribute to experimental stud es to improve the sensitiv ty of the KAGRA gravitat onal wave telescope or to data analysis from an experimental point of v ew. For the former, you will work on improving the sensitiv ty of KAGRA through main interferometer control, vibrat on isolat on, noise evaluat on, and calibration. For the latter, you will analyze non-stat onary noise through noise evaluation and contribute to the analysis of burst gravitat onal waves. | - exper ence in Experimental research (regardless of field)<br>- Abil ty to commun cate in English | Grav tational-Wave Science Project (GWSP), Kam oka Branch | Kamioka, Gifu (M taka is also possible in some cases) | Collaborate with other members of KAGRA to promote research | Takayuki Tomaru | takayuki.tomaru_AT_nao.ac.jp | 50 | : 50 |
| 18 | Reproduction of real spatial distribution by analysis of pseudo-observation results using machine learning | Our science motivation is how to clarify a real spatial distribut on of the target polarized source from the observables. We carried out the pseudo-observation using the global MHD simulation data wh ch we can get the information where is the radiation points. To compare our pseudo-observables w th the real observat onal data, we can estimate the three-dimens onal distribution of the source. Therefore, we propose the clarificat on of the real space distribution using the new analysis methods, Faraday tomography. We focus on the QU f tting and neural network to div de the components ins de the observables. | Exper ence in development of numer cal codes and machine learning. | Center for Computat onal Astrophysics | Mitaka, Tokyo | ATERUI II (Cray XC50), PC cluster and general-purpose GPU server can be used. | Mami Machida | mami.machida_AT_nao.ac.jp | 50 | : 50 |
| 19 | Development of a simulation code for large-scale planetary accretion | Sol d planets are thought to be formed by the accumulat on of small bodies called planetesimals. We will develop a general-purpose simulation code for planetary accretion that can be run on ATERUI II and/or general-purpose GPU with high speed and eff ciency. We will adopt the P3T algorithm and use FDPS for the parallel calculation of grav ty. We will develop and release a general-purpose code with var ous phys cal processes of protoplanetary disks. | Exper ence in developing code for massively parallel computers. | Center for Computat onal Astrophysics | Mitaka, Tokyo | ATERUI II (Cray XC50) and general-purpose GPU server can be used. | Eiichiro Kokubo | kokubo.ei chiro_AT_nao.ac.jp | 50 | : 50 |

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| 20 | Development of the simulat on code on core-collapse supernovae | The most promising mechanism for core-collapse supernova explos ons is the neutrino heating mechanism, in wh ch neutrinos heat the outer layers of iron and silicon layers. On the other hand, the neutrino radiation transport method, which is the basis of this research, is not yet mature, especially when the effects of general relativity are incorporated. Therefore, we will develop a parallelized code that incorporates the effects of general relativ ty. First, we will test the feasibil ty of the code on ATERUI II, and if possible, we will perform a large scale calculat on in three dimensions on Fugaku. Another hot topic is to follow the cooling of a proto-neutron star for a long time after the explosion, wh ch is related to the question of the central object of supernova 1987A. The research related to this topic is highly welcome. I would also like to see the research on the use of GPUs to speed up calculations of nucleosynthesis, neutrino oscillations, and the stellar evolution. | Exper eces on development of simulation code | Center for Computat onal Astrophysics | Mitaka, Tokyo | ATERUI II (Cray XC50) and general-purpose GPU server can be used. | Tomoya Takiwaki | takiwaki.tomoya_AT_nao.ac.jp | 50 | : | 50 |
| 21 | ObservationalStud es for GalaxyFormation andCosmology | Appl cants can choose e ther of the following two studies. Galaxy formation studieswith galax es dentified in optical to rad o observational data such taken withSubaru, Hubble, and ALMA. Cosmology studies, exploiting these galaxies, thatmeasure dens ty fluctuations in the high-z universe with cosmic microwavebackground (CMB) radiation data or primord al light element abundance. | Either of the following capabilities.Analyzing observat onal data suchtaken with Subaru, Hubble, andALMA and writing refereed papers.Analyzing CMB data andunderstanding the bas c frameworkof the big bang cosmology. | Divis on of Sc ence | Mitaka, Tokyo | We will prov de facilit esand environmentsneeded for yourresearch at Division of Science. | Masami Ouchi | masami.ouchi_AT_nao.ac.jp | 50 | : | 50 |
| 22 | Multi-messenger astronomy or Galact c archaeology | Conduct research of multi-messenger astronomy using Subaru/Hyper Suprime-Cam or Galactic archaeology using numerical simulat ons or observat ons. The research top cs will be those such as but not be limited to: - nature of transient or var able objects - format on/evolut on of first stars or metal-poor stars - metal-enrichment in the early Universe | The successful candidate is expected to work on both of his/her own research and this research top c. Experiences in observations or numer cal simulat ons are favorable but not required. | Divis on of Sc ence | Mitaka, Tokyo | We will prov de facilit esand environmentsneeded for yourresearch at Division of Science. | Nozomu Tominaga | nozomu.tominaga_AT_nao.ac.jp | 50 | : | 50 |
| 23 | Research on the precis on cosmology | Phys cal cosmology is now becoming a precision science based on big data brought by on-going/planed cosmology-or ented survey projects (e.g. in Japan, HSC survey and PFS project). Accordingly, it is urgent issues to develop very accurate theoretical models and novel techniques to eff ciently extract cosmolog cal informat on from big data. A cand date is supposed to work on those issues and to apply a developed model/technique to an actual big survey data. | Spec al knowledge/technique related to research on the precision cosmology, for example, the physical cosmology, a numer cal simulat on of the large-scale structures, and the informat on sc ence. | Divis on of Sc ence | Mitaka, Tokyo | We will prov de facilit esand environmentsneeded for yourresearch at Division of Science. | Takashi Hamana | hamana.tk_AT_nao.ac.jp | 50 | : | 50 |

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| 24 | Probing the grain growth in protoplanetary disks w th rad ative transfer modeling | Grain growth in protoplanetary disks is the first step toward planet formation. The project researcher will persue rad ative transfer calculat ons with an open public code RADMC-3D to constrain the grain growth in protoplanteary disks. It may require comparison w th ALMA archival data. In addition, prediction at the wavlengths of 3 and 7 mm, which is designed to be equiped on the future ngVLA, is required. | Previous experience on radiative transfer calculations is plus but not mandatory. If the candidate has been persueing observational studies, some exper ence on the protoplanetary disks are good and high motivat on on trying on rad ative transfer calculations is required. If the candidate has been persueing theoretical work, the candidate will study how to interpret observationl data. In addition, programming skills on python and basic English skills are required. | Divis on of Sc ence | Mitaka, Tokyo | We will prov de facilit esand environmentsneeded for yourresearch at Division of Science. | Akimasa Kataoka | akimasa.kataoka_AT_nao.ac.jp | 50 : 50 |
| 25 | Multi-line d agnost cs of molecular interstellar medium in external galaxies | Astrochemistry is an important tool to study the physical condit ons of the molecular interstellar medium (ISM). Unusual ISM properties are expected in some external galaxies where there are extreme activities of star format on or active galactic nuclei; different astrochemistry from the Galaxy is also expected in these galax es.A successful candidate will be working on the study of multiple astrochem cal tracers in nearby galaxies, either on the ALMA observat onal data, or on the theoret cal interpretation of observations. Those who work on the observat onal data will have a choice to work on our ALMA data already at hand. | Either experience in data reduction of spectral lines w th radio interferometer espec ally ALMA or astrochem cal modeling is required. English commun cation skill is also essential. | Divis on of Sc ence | Mitaka, Tokyo | We will prov de facilit esand environmentsneeded for yourresearch at Division of Science. | Nanase Harada | nanase.harada_AT_nao.ac.jp | 50 : 50 |
| 26 | Material evolution in star and planet forming regions | This project aims to establish a method to derive the physical and chemical structures of star- and planet-forming reg ons by constructing models or observing molecular emiss on lines, including isotopologues, using ALMA and other instruments, in order to eluc date the evolution of gas, dust, and materials in the star- and planet-forming reg ons. | Exper ences of theoretical or observational studies on star and planet forming regions. | Divis on of Sc ence | Mitaka, Tokyo | We will prov de facilit esand environmentsneeded for yourresearch at Division of Science. | H deko Nomura | h deko.nomura_AT_nao.ac.jp | 50 : 50 |
| 27 | Cosmology with AGN and w th Gamma Ray Bursts v a a Machine Learning approach | The cand date will reconstruct quasar emission line profile var abil ty from the combination of the spectroscop c and photometr c measurements v a machine learning models. Similar models will be applied to reconstruct GRBs light curves in opt cal and X-rays to use both quasars and GRBs to constrain cosmolog cal parameters. The candidate will work on regression models to estimate the redshift of GRBs and use data from the SUBARU Telescope. He/She will build an automat c code to alert the community on the explos on of a high-z GRB through GCN. The goal is to observe the high-z GRBs w th the SUBARU. | The appl cant should have an experience of programing on R and python and have exper ence in appl cation of machine learning techniques in quasars and GRBs. It is desirable to have an exper ence of research works by using optical observational data. | Divis on of Sc ence | Mitaka, Tokyo | We will prov de facilit esand environmentsneeded for yourresearch at Division of Science. | Maria Dainotti | maria.dainotti_AT_nao.ac.jp | 50 : 50 |