

NAOJ Future Planning Symposium 2023: Science Roadmap of NAOJ

Division of Science

Its activities and strategies

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Director of the Division of Science

Missions



DIVISION
OF
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国立天文台 科学研究部

- Foster research based on individual unique ideas and achieve world-leading astronomical results.
- Expand the horizons of astronomy by combining theory and observation with a focus on multi-wavelength/multi-messenger astronomy.
- Maximize the potential of NAOJ's large observational instruments and supercomputers to carry out our research and observations.
- Contribute to the future planning of NAOJ from a scientific perspective with groundbreaking discoveries.
- Promote the development of early-career researchers worldwide and provide a foundation for their future careers in astronomy.
- Advance astronomical research in Japan through collaboration with national researchers.

Research Fields & Members



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宇宙論

Cosmology

Hamana (Asst)

銀河形成

Galaxy Formation

宇宙磁場

Cosmic Magnetism

宇宙化学

Astrochemistry

ブラックホール

Black Hole

活動的銀河核

Active Galactic Nuclei

星形成

Star Formation

ガンマ線バースト

Gamma-ray Burst

超新星爆発

Supernova Explosion

惑星形成

Planet Formation

原始惑星系円盤

Protoplanetary Disks

系外惑星

Exoplanets

Kohri (Prof)

Ouchi (Prof)

Behroozi (Assoc)

Machida (Assoc)

Morino (Asst)

Dainotti (Asst)

Nomura (Prof)

Harada (Asst)

Takahashi (Asst)

Nakamura (Assoc)

*Iwasaki (Asst)

*Kokubo (Prof)

Kataoka (Asst)

Tominaga (Prof)

*Takiwaki (Assoc)

Moriya (Asst)

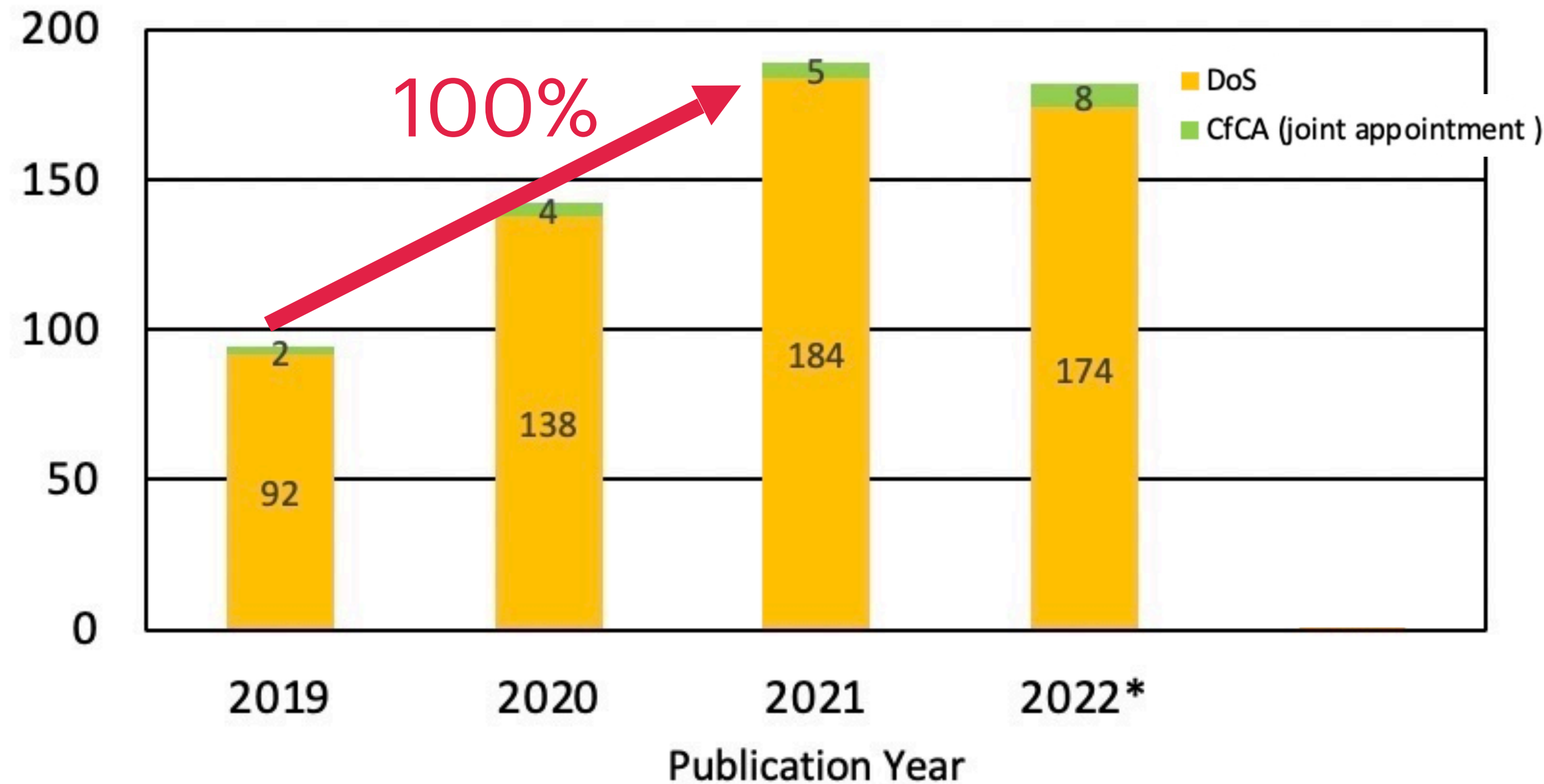
Ikoma (Prof)

Fujii (Assoc)

*CfCA

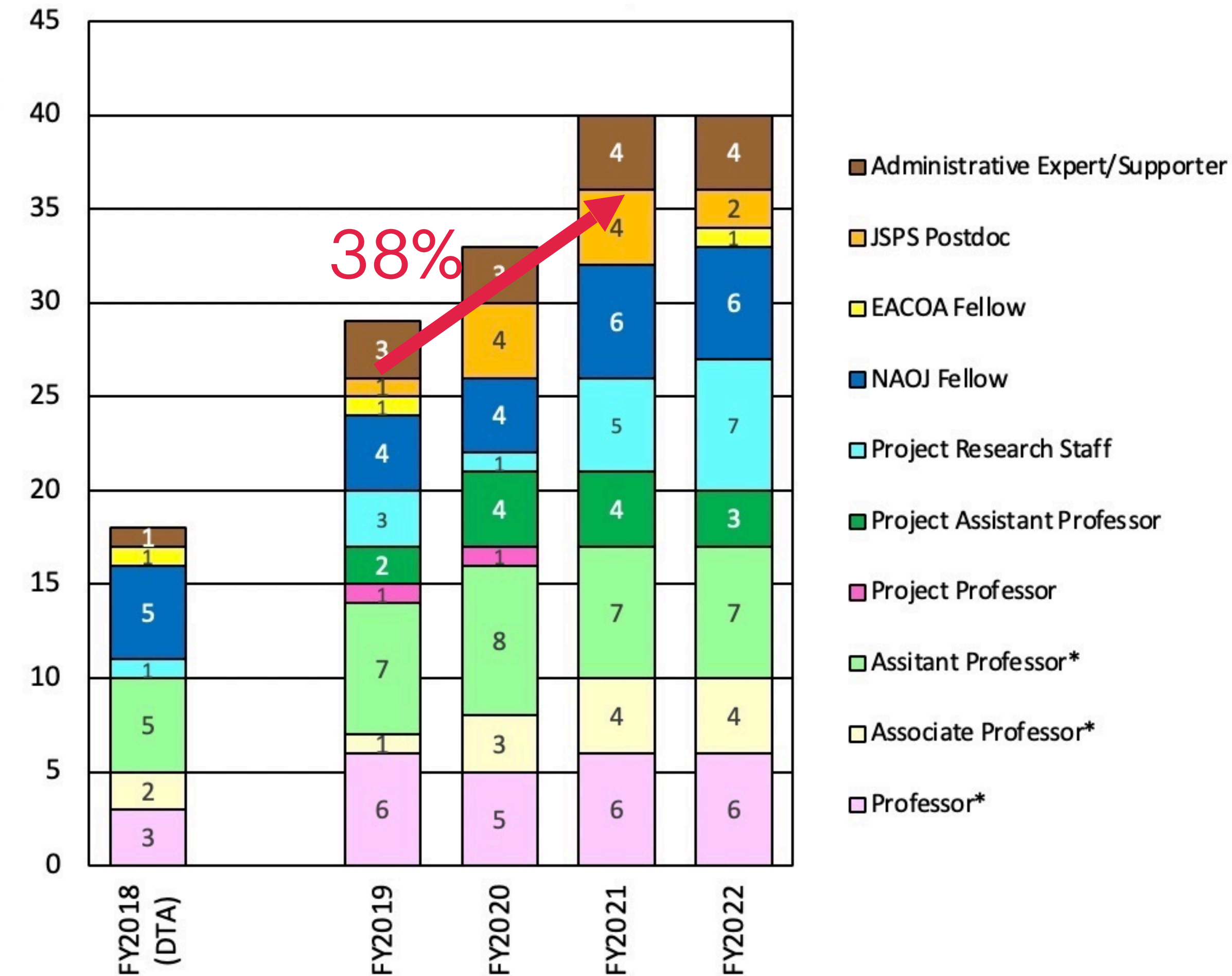
Publication Statistics

of referred articles each year



- During the first 4 years since its establishment, **600+ articles** were published in refereed journals.
- Many were done through **collaborations between theory and observation**.
- The increase in publications is greater than in members, indicating **higher activity** levels.

of the staff members & postdocs each year



NAOJ Projects (Selected)



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• Subaru Telescope

- **Galaxy and Time-domain Astronomy** — A Subaru intensive program with SWIMS and FOCAS was conducted (PI: *Ouchi*) by the team with *Moriya*+ (DoS), Dr. Koyama+ (Subaru), and Dr. Ozaki+ (ATC). With *Moriya* as a Science PI and Profs. Tokoku and Motohara from ATC as Instrument PIs, the development of near-IR spectroscopic instruments (NINJA) for a wide range of scientific applications is underway, with a focus on the promotion of time-domain astronomy (*Tominaga*). *Moriya* also serves as a lead scientist of the time-domain astronomy science investigation team of the ULTIMATE-WFI project.
- **Exoplanet science** — Many members (*Kokubo* et al.) have made scientific contributions to the Subaru Strategic Program for searching Earth-like planets orbiting M dwarfs with the infra-red high-dispersion spectrograph (IRD). *Ikoma* also serves as a co-PI of a Subaru Intensive Program for IRD follow-up observations for TESS planet candidates.

• Astronomy Data Center (ADC)

- **Time-domain astronomy** — Establishing a high-speed data transfer system between the Subaru telescope and the Subaru building and an efficient data analysis system (*Tominaga*).

• ALMA Project

- **Star formation, protoplanetary disk, nearby galaxy, galaxy formation, and supernova explosion** — Many members have been collaborating with ALMA science staff members. They have regular joint seminars between the ALMA project and the DoS to discuss future extension and development of scientific research using ALMA. A new framework of a joint post-doctoral position bridging the ALMA project and DoS activities was established on the basis of joint funding.

• Gravitational Wave Science Project

- **Multi-messenger astronomy** — In order to promote the fusion between observation and theory associated with gravitational waves in the context of multi-messenger astronomy, *Iwata* from the DoS and Dr. Washimi from the Gravitational Wave Project started regular informal meetings for knowledge exchanges. From the DoS, some members of the supernova explosion group, including *Tominaga*, *Takiwaki*, *Moriya*, and *Dainotti*, have participated and introduced their research in order to generate new ideas by sharing points of view based on their respective specialties, especially gravitational wave observation, electromagnetic wave tracking observation, and theory. *Kohri* leads collaboration for new particle search.

Question from the SOC

•Question

- It appears that certain members are involved in various projects, while others are not mentioned; those contributions seem to be only individual activities. Is the Division of Science currently conducting any organized activities or studies?

•Reply

- Firstly, the DoS is not a project, and it respects individual research; therefore, it is not structured in such a way that everyone participates in a single research project.
- Meanwhile, regarding current collaborations with “projects” within NAOJ, some are done individually, while others are done as a group of several people within the DoS.
- The DoS has encouraged its members to propose ideas for exploratory research and has financially supported excellent ones. One successful example is NINJA (see the next page).
- In addition, the DoS arranges regular meetings with the ALMA project, the Gravitational Wave project, and the Hawaii Observatory for future collaborations, which will be used for future planning of NAOJ.
- The DoS has jointly employed a postdoc with ALMA.

NAOJ Projects: An example

Near-IRfrared and optical Joint spectrograph with Adaptive optics (NINJA)

PI: M. Yoshida (Subaru), Project Manager: C. Tokoku (ATC), Project Scientist: *Moriya*

Optical-to-NIR spectrograph optimized for the Laser Tomography Adaptive Optics (LTAO) system at Subaru Telescope
VLT/X-Shooter-like spectrograph with higher sensitivities achieved by LTAO
main science objectives: kilonovae (GW follow-up), high-redshift galaxies and AGNs

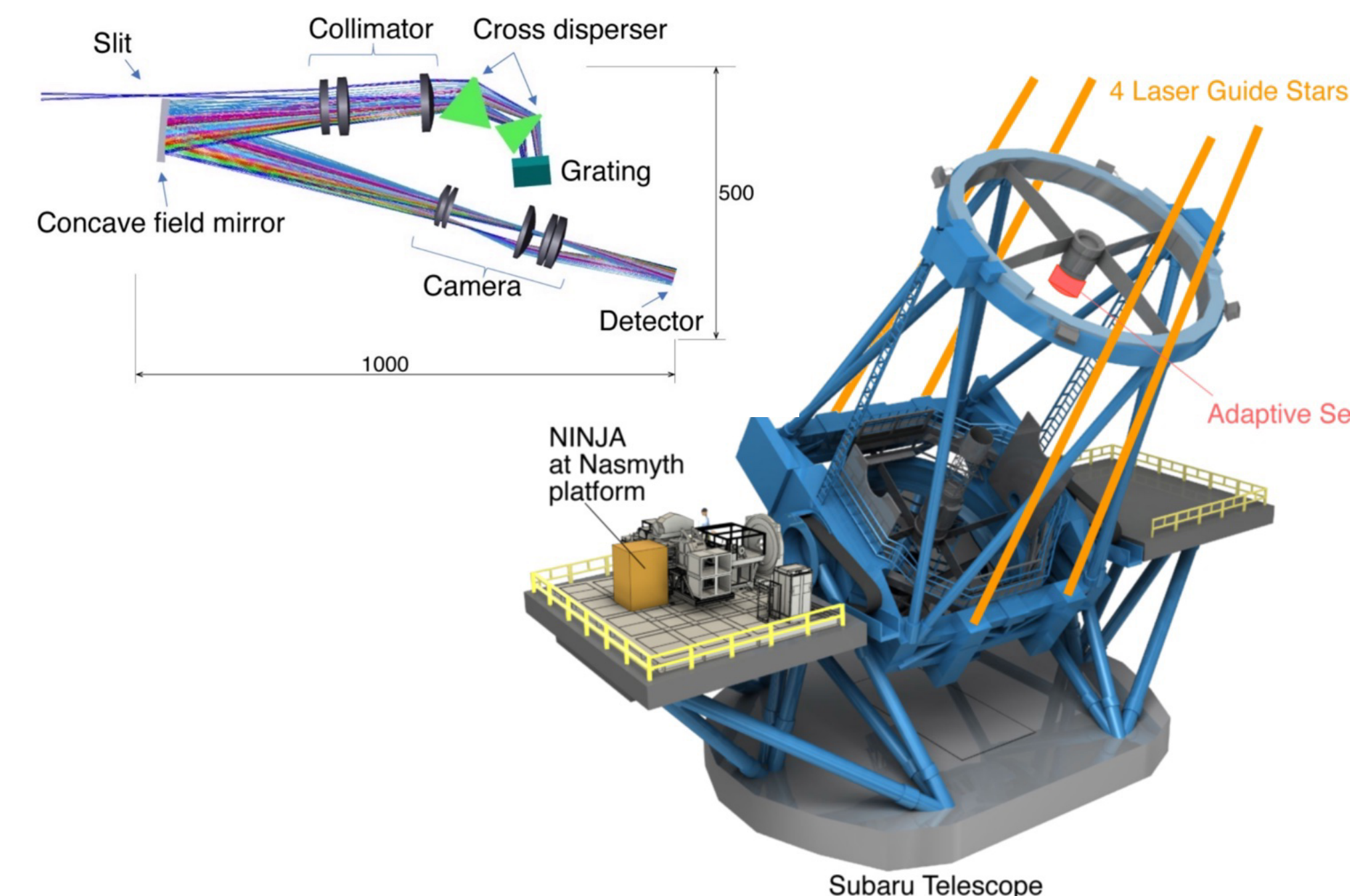
Initial concept developed by *Ouchi* and Koyama (Subaru)

Science cases investigated by *Moriya*, *Tominaga*, *Ouchi*, Koyama (Subaru), Tanaka (Subaru), and other collaborators

The DoS Exploratory Research Fund was awarded to kick off the preliminary design of the optics.

Instrument developed by Tokoku (ATC), Ozaki (ATC), Motohara (ATC), Yanagisawa (Subaru), Ono (Subaru), Minowa (Subaru), Terao (Subaru), Hayano (Subaru), and other collaborators

JSPS KAKENHI Kiban-S to construct the NIR spectrograph has been awarded.
PI: M. Yoshida (Subaru), FY2021-2025



Space Missions (Selected)

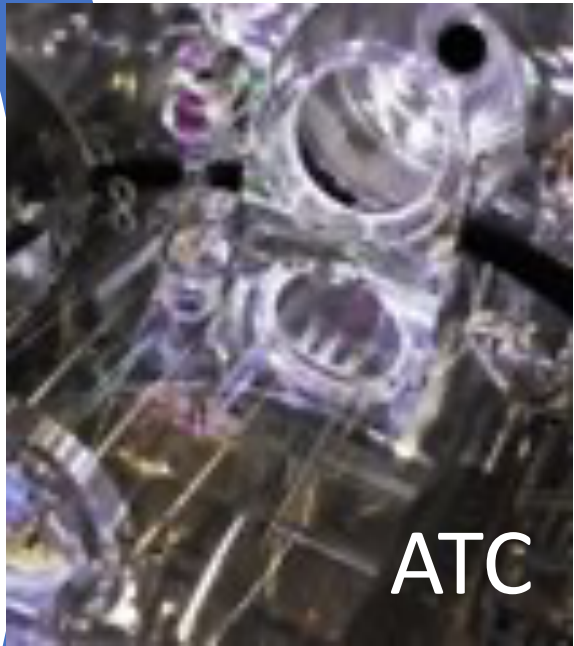
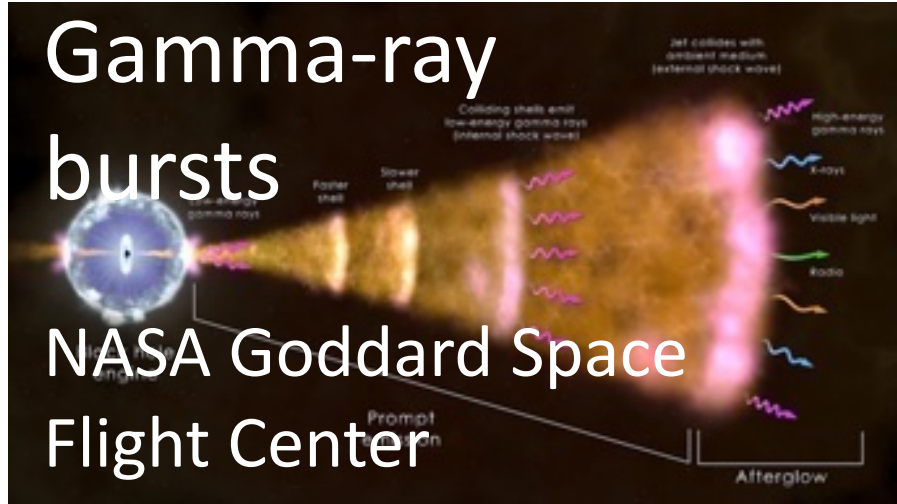
- **Ariel:** An ESA space mission dedicated to spectroscopic observations of **exoplanet atmospheres** in the IR. *Ikoma* serves as a co-PI and a science coordinator in the space mission.
- **Roman:** A NASA mission with a wide-field near-IR imager and coronagraph with the aim of probing dark energy and dark matter. *Ouchi* and *Moriya* are actively working in the mission consortium through **galaxy formation research and time-domain astronomy**.
- **Euclid:** An ESA space mission, which was launched this year, aiming to accurately probe the properties of dark energy and dark matter with a wide-field near-IR imager. *Moriya* leads the working group of the **supernova and transient science**.
- **LAPYUTA:** A competitive S-class mission proposed to JAXA with the aim of gaining a deep understanding of the diversity of **habitable environments** in and beyond our solar system and **the origins of the universe and matter** through UV observations. *Ikoma* and *Ouchi* lead two of the four major sciences in the mission. *Tomínaga* and *Moriya* also participate in the mission to study time-domain astronomy.
- **GREX-PLUS:** A strategic M-class mission proposed to JAXA for launch in the 2030s, aiming to revolutionize the understanding of **the evolution of galaxies and the formation of planetary systems** through infra-red high-resolution spectroscopic observations. *Nomura* leads the planetary science team. *Ouchi* serves as the galaxy science coordinator. Assoc. *Fujii* and *Moriya* participate in the mission consortium for investigating exoplanet and time-domain science cases, respectively.

A Focus Area:

Multi-Messenger Astronomy

See Lol [02]

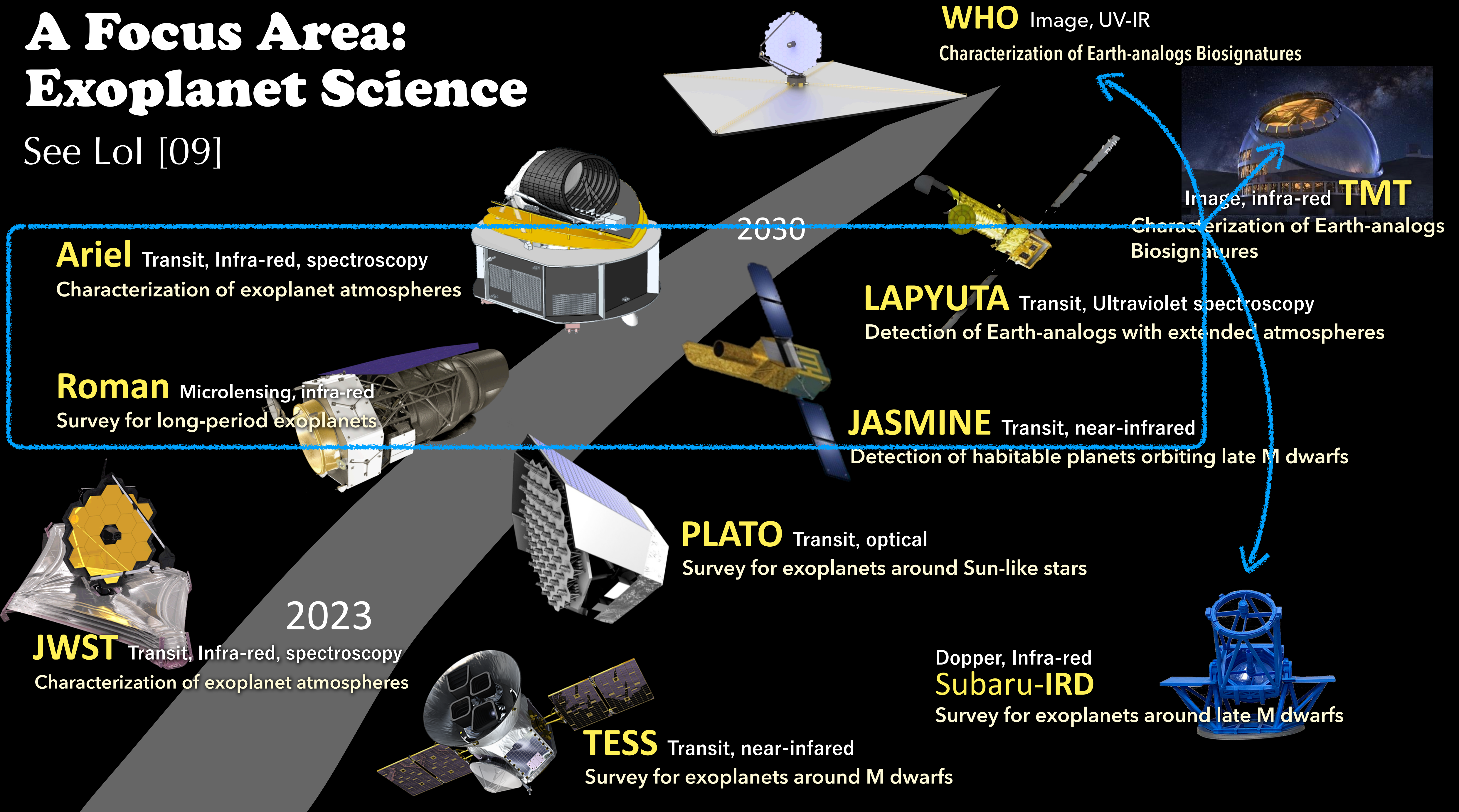
Improve large-scale cutting-edge facilities managed by NAOJ, Facilitating this area and enabling to lead this area.



Electromagnetic wave
Gravitational wave,
Neutrino, Cosmic rays

A Focus Area: Exoplanet Science

See Lol [09]



Question from the SOC

- **Question:**

- Time domain astronomy and exoplanet science are referred to as focus areas - how were these chosen in the Division? How will those be taken forward? What role will the members of the Division play in those sciences?
- Regarding the members of the DoS, distant galaxies/cosmology and star formation could also be a focus area. What is the opinion of the DoS?

- **Reply**

- Regarding the two focus areas, the LOIs were sent to the SOC. Please see each presentation for the details.
- As a matter of course, distant galaxies/cosmology and star formation are also of special interest to the DoS. However, the two areas growing rapidly are regarded as focus ones.

Question from the SOC



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- **Question**

- Specify how the DoS intends to be involved in planning the future of NAOJ.

- **Reply**

- Lead or commit to making the NAOJ's science roadmap
- Take a proactive role in the future planning cooperating with the Director of Research Coordination and also collaborating with “projects” in NAOJ and the astronomical community.
- Advance exploratory sciences in the DoS and thereby propose new flagship instruments and new “projects” in NAOJ.

How to Support NAOJ

- Maintain NAOJ as a world-leading research institute by achieving distinctive and high-impact research outcomes based on individual unique ideas.
- Expand the horizons of astronomy by combining theory and observation and maximize the potential of NAOJ's facilities.
- Lead large-scale astronomical projects, such as those to be listed on the science roadmap of Japanese astronomy, and develop synergies with NAOJ's projects.
- Foster collaborations and partnerships with overseas institutions to maintain the international level necessary to maintain the highest standard for world-leading institutions (NAO-INAF partnership, etc.)
- Lead or commit to making future plans for NAOJ, including the Science Roadmap, and play part of the role of the Director of Research Coordination.
- Cultivate competent human resources capable of effectively executing the NAOJ's science roadmap.