Galaxy Formation Research Hub:

Advancing Galaxy Formation Studies through Projects and Interdisciplinary Research

銀河形成研究拠点:
プロジェクト・分野横断研究に基づく新しい銀河形成研究の展開

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Collaborators

(Listed only those at the faculty level)

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If you are interested in it, you are very welcome to join us. Email to masami.ouchi@nao.ac.jp

1. Summary of the proposal

- Science goals and objectives:
  - To understand the evolution from the birth of the first stars and first galaxies to the present-day galaxies (incl. MW).

- Science investigations, instrumentation and data:
  - Establishing a research hub with core functionality within NAOJ DS
  - Aiming for interdisciplinary instrument/field studies
    - Instruments and Data: Subaru, ALMA, TMT, CfCA computers, SKA, JASMINE, LAPYUTA -> HWO, GREX-PLUS, JWST, EUCLID, Roman, etc.
    - Fields: Galactic archaeology, nearby galaxy studies, distant galaxy studies, theoretical research, and more, focusing 5 major questions (cf. Conventioal galaxy formation research: studies within one field/ one type of instruments)

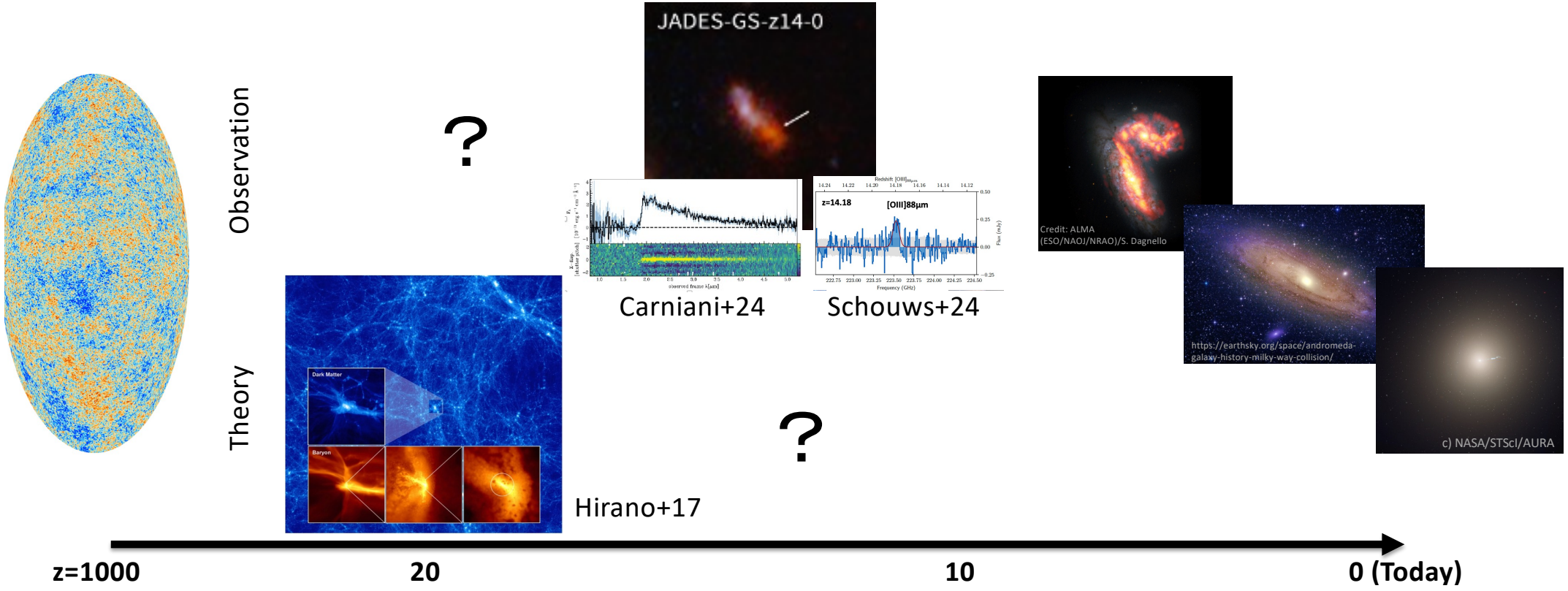
- Threshold science:
  - Creation of new research fields or trends through the integration of three or more fields (instrumentation projects)

- Cost estimation:
  - 10,000 K yen (annual budget)

- Project Organization:
  - NAOJ: DS, Subaru, ALMA, CfCA, TMT, JASMINE, ATC, ADC etc.
  - Outside NAOJ: ISAS, Kanazawa Univ, Kumamoto Univ, Nagoya Univ, Tohoku Univ, Univ Tokyo, Tsukuba Univ, Osaka Univ, NIT Suzuka, and more

2. Science goals

- Uncovering how the first galaxies (and stars) in the early universe form and evolve over the cosmic time into present-day galaxies?



3. Scientific objectives

- Galaxy formation study (today)
  - Highly specialized within specific methods (wavelengths, telescopes, theory) and fields (galactic archaeology, local galaxies, low-z galaxies, and high-z galaxies)

    → Majority of studies are tied to particular methods or fields

- This Program:

  Establishing a research hub at NAOJ to connect various fields & intrument projects for galaxy formation studies →
  - Creation of new research fields or trends through the integration of multiple fields
    - Example: Galactic archaeology × high-z galaxy studies × theoretical research
  - Initiation of major new projects through the integration of multiple instrumentation projects
    - Example: Subaru/PFS × Roman/grism × JASMINE × JWST

  Combining perspectives and methods not conventionally used together, the study aims to address 5 major features of galaxy evolution: 1. Galaxy structure, 2. Dynamical evolution, 3. Star formation, 4. Chemical evolution 5. CGM/IGM-galaxy relation

4. Science Investigations

- 4.1 Science Investigations until 2033
  - Combining instruments/telescopes and computers
    - NAOJ-led projects: Subaru, ALMA*, CfCA computers, JASMINE etc.
    - Other projects: JWST, EUCLID, SKA, Roman, LAPYUTA → HWO etc.

    → Studies with no boundaries in wavelengths (messengers), observation, and theory.

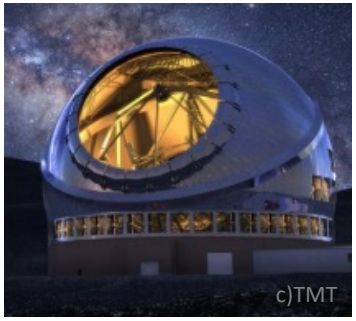
  - Establishing a hub for galaxy formation studies in NAOJ DS:
    - Employing two joint-assistant professors with ~50% effort shared with universities/institutions (matching funds from the universities/institutes are required. If no matching funds/mechanisms are available, one full-time assistant professor is emproyed at NAOJ for the hub function)
      - Fostering new collaborative researches involving researchers in wider Japan and the world
      - Bridging between domestic /international and telescope/instrumentation projects
      - Acting as a liaison to contribute NAOJ resources (e.g., project data archives, technology, computational resources) to external projects

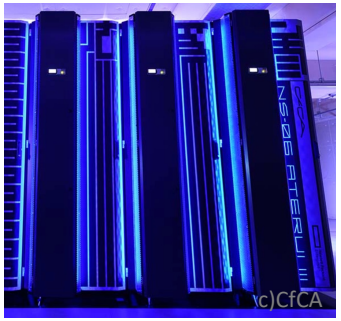
- 4.2 Science Investigations beyond 2034
  - Studies connecting projects including TMT, GREX-PLUS, and LAPYUTA → HWO.

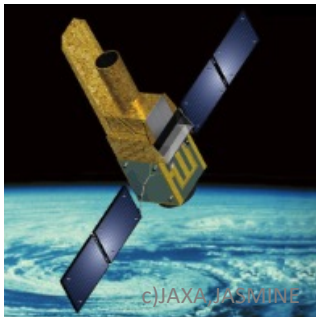
- 4.3 Threshold Science
  - Creation of new research fields or trends through the integration of 3 or more fields (instrumentation projects)

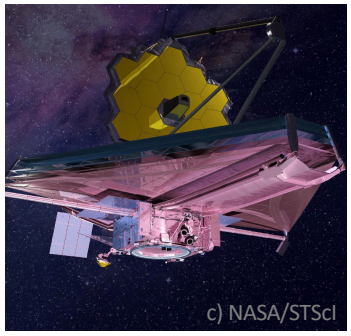
5. Instruments and data to be returned

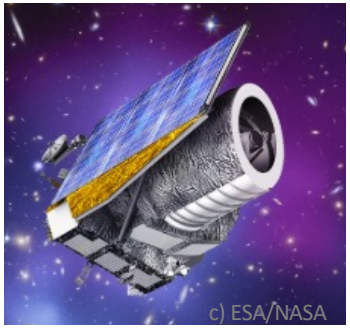
- NAOJ-Led Projects / International Projects
  - Subaru、ALMA、TMT、CfCA computers、JASMINE、
    SKA、LAPYUTA→HWO, GREX-PLUS, JWST, EUCLID, Roman etc

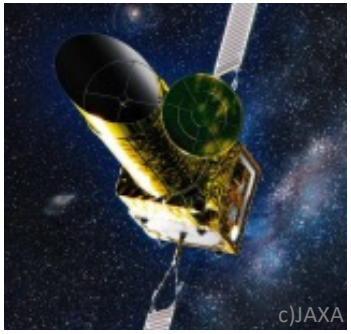


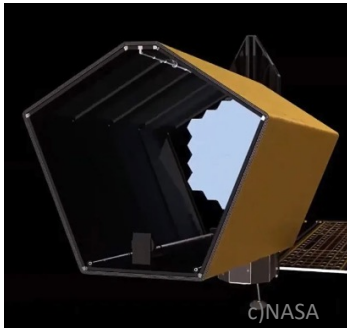


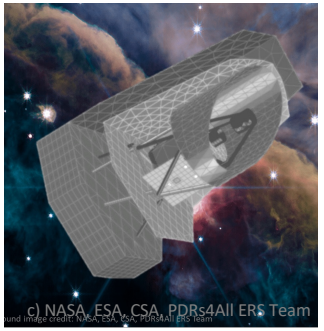












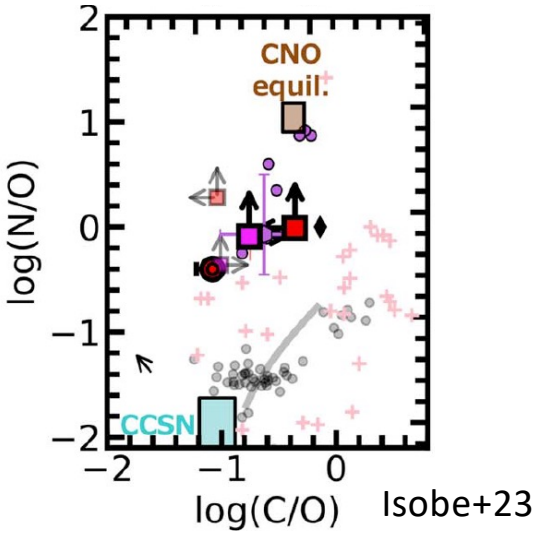
6. Originality and international competitiveness

- Today
  - Studies with multi-wavelength data (or theoretical models)
    → Various examples already exist to date

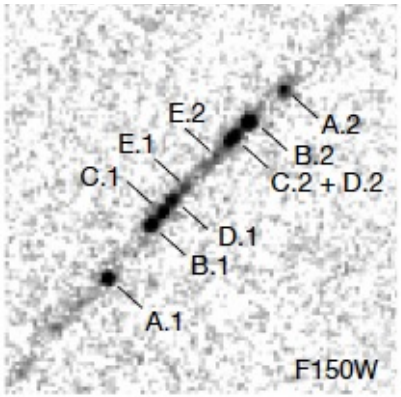
- This program
  - Systematic initiative for galaxy formation research spanning multiple methods, fields, and projects (Such a program does not exist in the world)
  - Establishing new research fields or trends for galaxy formation studies

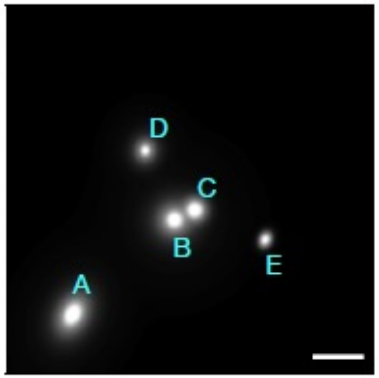
7. Current Status

- New momentum driven by JWST observations
  - Emerging interdisciplinary trends (e.g., Isobe+23, Adamo+24, Xu+24, Ferrara+24)
  - Research bridging high-z galaxy studies with various fields, including galaxy archaeology, local galaxy studies, and theory.

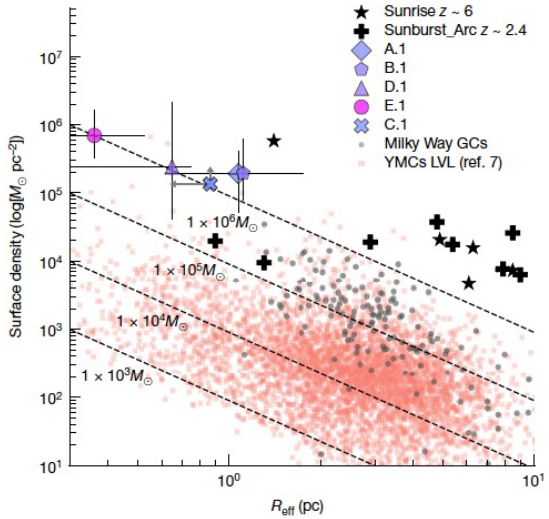


Isobe+23





Adamo+24



- Innovative discussion at the spring 2024 ASJ spring special session & the satellite workshop 'Galaxy and Galactic Formation and Evolution Explored by Subaru PFS' (at NAOJ)
- New research initiatives combining the dynamics of MW and high-z galaxies driven by the astrometry JASMINE project (e.g., Kawata+24)

8. Cost assessments, budget line and status

- Employment of two joint-faculty members (assistant Professors). Working with ~50:50 effort split between NAOJ and universities/institutions
  - Matching funds equivalent to ~50% effort required from the university/institute side
  - If matching funds (or mechanism) are unavailable, a single assistant professor affiliated 100% with NAOJ will be hired instead

- Responsibibilities of the joint-faculty members
  - Creation of new research projects through collaborations with researchers in Japan and the world via a core of the appointed university/institution and NAOJ
  - Bridging contributions from NAOJ (e.g., data archives, technology, computing resources) to external projects
  - Promoting collaborations between different NAOJ projects, as well as expanding links domestically and internationally

- Annual Budget (for two ~50%-effort joint faculty members):
  - Per faculty: ~5,000 K yen (salary/pension insurance + research expenses + multiple travel costs between institutions).
  - For two faculties → ~10,000 K yen

9. Project Organization

- Establishing a hub function in NAOJ DS for galaxy formation research
- In NAOJ
  - Dedicated faculty: One professor (from existing DS human resources)
  - Joint faculty: **Two joint-assistant professors** with ~50% effort (new positions)
  - Member faculty: Current NAOJ faculty participating in this program
  - NAOJ telescope/instrumentation projects tied to this project

- Outside NAOJ:
  - Joint faculty: **Two joint-assistant professors** with ~50% effort (at partner universities/institutes)
  - Member faculty: faculty participating in this program (Assistant, Associate, and Full Professors)

  --------Post-docs and students in Japan/the world are welcome to participate--------

- Contribution to nurturing the next generation of researchers
  - Enhancing personnel exchange between NAOJ projects and between NAOJ and universities/institutes
  - Increasing the number of assistant professor positions via the efforts to secure matching funds.
  - Providing next-generation researchers with opportunities to understand research and education at private and regional universities
  - Exposing the next-generation researchers to the community

10. Why NAOJ ?

- NAOJ
  - Promoting multiple telescope/instrument projects
  - Functions as a joint-use research institution

  → Requiring collaboration between projects and with universities/institutes nationwide

- This Project
  - representing the efforts to accomplish these NAOJ goals