JASMINE

Japan Astrometry/photometry Satellite Mission for INfrared Exploration

R. Kano (NAOJ) and JASMINE team

(see also Kawata et al. (PASJ, submitted; astroPh))

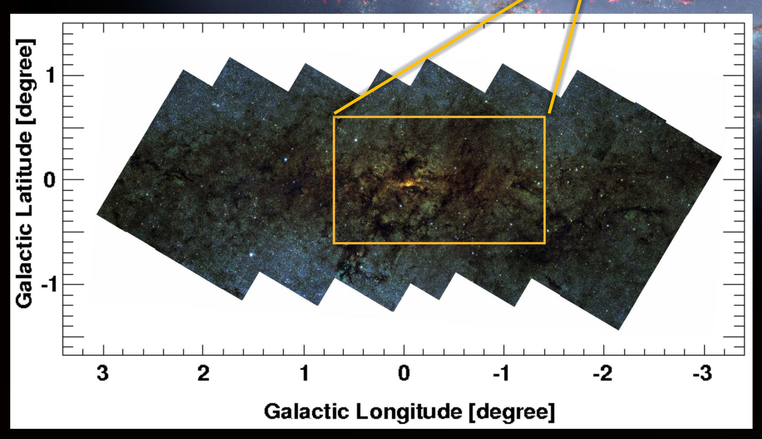
How did the Milky Way Galaxy form and evolve?
How did the Earth, the planet that nurtures life, form and evolve?

For these grand questions, JASMINE will tackle the following 2 science objectives with a satellite mission for near-infrared observations.

Science Objective 1:

Exploration of the Structure of the Galactic Nuclear Region

By measuring the position and motion of stars, we will explore the structure of the Galactic nuclear, which plays a key role in the formation of the Milky Way Galaxy.



Credit:NASA/JPL-Caltech/ESO/R. Hurt

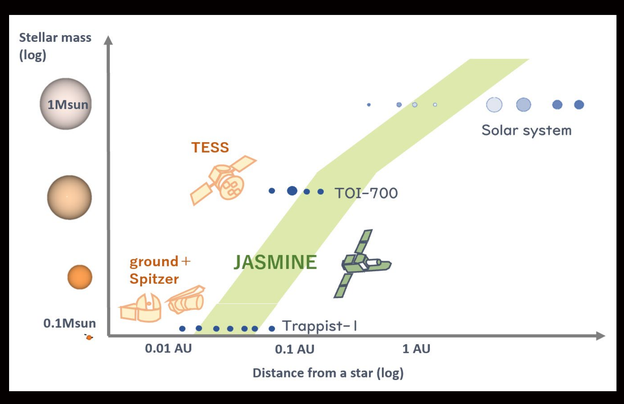
JASMINE observation area for the Galactic Center (G.C.) astrometry. From the dynamics in the Galactic nuclear region, the dynamics/history of the entire Galaxy is also investigated:
"Galactic Center Archeology".

Bulge, bar and inner disk along the line-of-sight are also important targets.

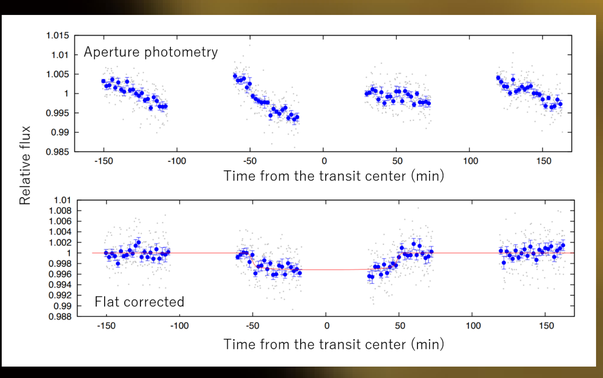
Science Objective 2

Search for Terrestrial Exoplanets

By time-series photometric observations, we will search terrestrial exoplanets in habitable zone whose atmospheres can be observed, around stars that are promising candidates for future life exploration.



JASMINE's targets are exoplanets around mid-M class stars, whose smaller radius gives deeper transit signals, and whose lower surface temperature gives more advantage in infrared wavelengths.

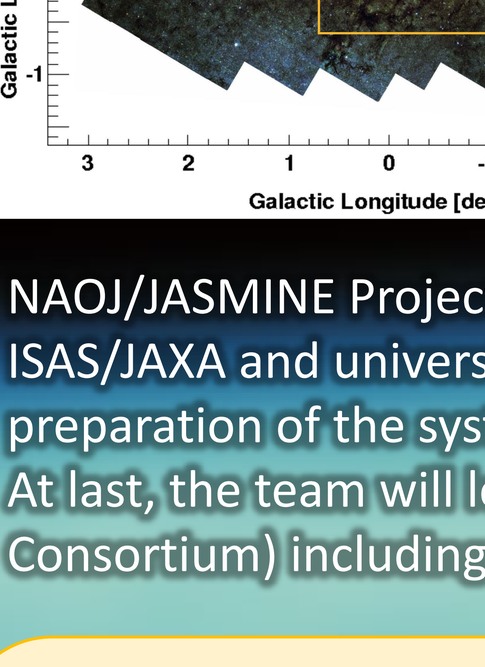


Simulated transit signal assuming the stellar radius of 0.2 R(sun), the planet radius of 1.2R(earth) and the stellar magnitude Hw = 10.5 mag. The light curve for simple aperture photometry with expected performances (upper panel) and that with the flat-correction (lower panel).

NAOJ/JASMINE Project Office is promoting JASMINE as members of the JASMINE team together with members in ISAS/JAXA and universities. The team is investigating/developing the instrument together with NAOJ/ATC. In the preparation of the system for data analysis and catalog release, the team starts to have the support of NAOJ/ADC. At last, the team will lead the JASMINE science with supports from the science community (e.g., the JASMINE Consortium) including science collaborations and joint observations.

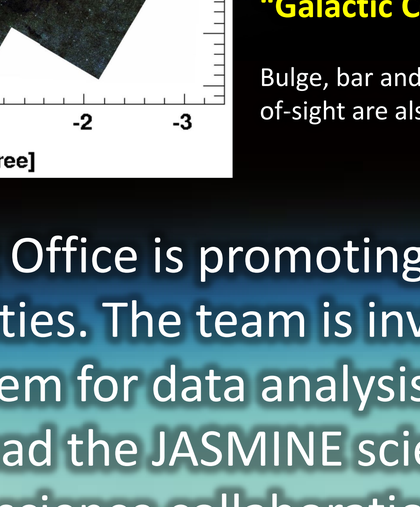
Instrument

Satellite



Satellite mass:	~ 600 kg
Orbit: Sun Synchronous with h > 550 km	
Launch Vehicle :	JAXA Epsilon-S
Satellite bus:	Small Standard Bus
Observations	
Spring/Autumn:	Astrometry for G.C.
Summer/Winter:	Exoplanet survey

Telescope
"Korsch optics"

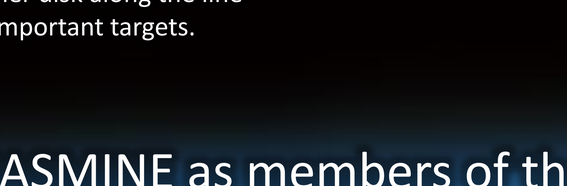


Telescope	
aperture	360 mm
focal length	4370 mm
Filter	
bandpass	1.0～1.6 μm
Focal plane	
FOV	0.52 deg□
Plate scale	0.4 arcsec/pixel

Detector Subsystem

IR sensors in space are being developed based on the InGaAs sensor developed by NAOJ/ATC with the domestic company in FY 2019.

Sensor developed in FY2019



The cooling system is now being designed by NAOJ/ATC, and the performance of candidate Peltier coolers are also being performed in ATC.

Sensors	
Material	InGaAs
Sensor size	19.2 × 19.2 mm
Pixel format	1920 × 1920
Pixel size	10 × 10 μm
Longer cut-off	1.6 μm
# on focal plane	4 sensors
Cooling system without vibration down to 200K by Radiator and then to 170K by Peltier	
Flat-calibration light source system	

Time Schedule

Fisical Year	2023 R5	2024 R6	2025 R7	2026 R8	2027 R9	2028 R10	2029 R11	2030 R12	2031 R13	2032 R14	2033 R15
JASMINE instrument	Developing instrument/satellite				Launch	Observations			(continue observations)		
Data Analysis	Developing the system for data analysis & star catalog					Analysing data & Preparing star catalog				Catalogue Release	
Science	Preparing sciece analysis & Coordinating science collaborations					Science analysis					
	Joint observation: preliminary, coordinated, and follow-up observations										

Data Analysis

Steps for Astrometry

400 mas (pixel size) → (1/100) → 4 mas → (1/3) → 1.5 mas → (1/100) → 25 μas

Step-1: for 1 image
Because of very far away,
Stars look point sources.
The extent of the star image is caused by telescope aberrations and attitude perturbations.
1. **Modeling** a PSF from many star images.
2. **Calculating** the star position by applying the modeled PSF to each star image.

Step-2: for some images
During short periods,
Stars appear to stop.
Different star spacing in different images must show the image distortion by the instrument deformation.
1. **Modeling** image distortion from many images.
2. **Removing** the modeled image distortion from each image.

Step-3: for all images
Even over long periods,
Star's motion is simple.
Only a few parameters for astrometry are derived.
1. **Modeling/removing** long-term instrumental systematic errors from entire images (N).
2. Reducing random errors in the 1/√N rule by **fitting an astrometry model** to entire images.