NASA's James Webb Space Telescope:
Observations of Outer Planet Satellites (Except Titan)

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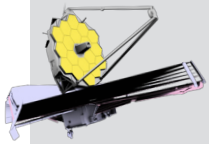
The suite of instruments aboard JWST will open new avenues in the exploration of the satellites of Jupiter, Saturn, Uranus, and Neptune through enhanced wavelength coverage and increased sensitivity compared to *in situ* spacecraft. Specific investigations include:

- Searching for evidence of ongoing plume activity on Europa and Enceladus
- Tracking volcanic activity on Io
- Understanding the composition and structure of satellite atmospheres
- Completing the infrared survey of major satellites
- Constraining surface compositions of irregular satellites for comparison to TNOs



The angular separation between the fields of view of two adjacent science instruments, or two apertures of one instrument, is comparable to the angular separation of some satellites from their primary. This can potentially result in cases where a very bright giant planet falls in an undesired location. In particular, satellite observations with the NIRSpec IFU could place a giant planet in the NIRSpec Micro-Shutter Array (MSA) and result in flux contamination on the IFU detector. In other instances, IFU observations of a satellite could result in a giant planet falling in one of the two fields of view of the Fine Guidance Sensor (FGS), preventing acquisition and guiding on stars in that half of the FGS.

Scattered light. Observations of giant planet satellites are likely to be affected by scattered light from the very bright giant planets themselves. Efforts should be taken to limit the amount of contamination in giant planet spectra by observing satellites at greatest elongation and/or by obtaining dedicated backgrounds to subtract off the giant planet contribution. Studies are ongoing to quantify the effect of scattered light from giant planets on observations of their satellites.

GTO & ERS programs. Three Guaranteed Time Observations (GTO) programs and one Early Release Science (ERS) program will observe giant planet satellites in GO Cycle 1: GTO 1247 (Saturn and small satellites), GTO 1250 (Europa & Enceladus), GTO 1272 (Triton and other TNOs), and ERS 1373 (Jupiter, Ganymede, and Io). Only GTO 1272 is proprietary; all other programs will immediately release data to the community and can be the focus of an Archival Research (AR) proposal.

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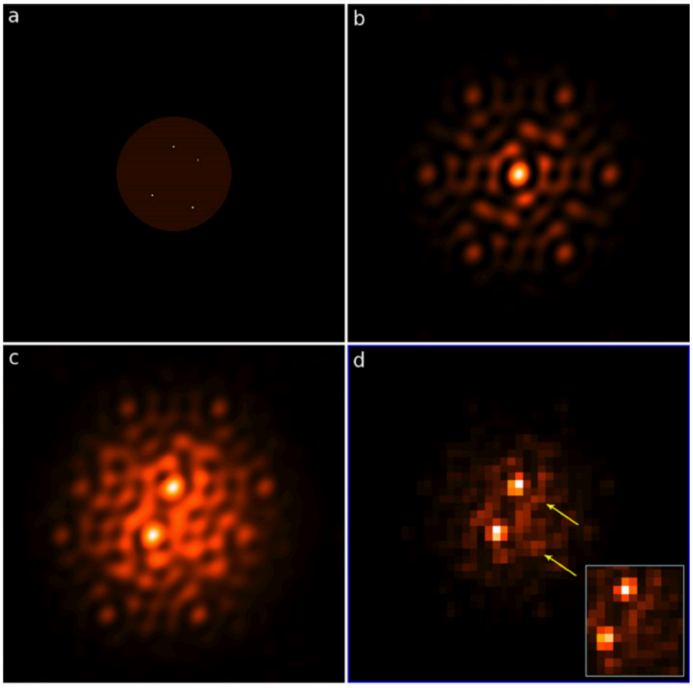
Observations of Io. An outstanding question from the Galileo mission is the eruption temperature of Io's lavas and by extension its composition. Imaging and spectral observations of Io when it is in Jupiter's shadow will remove the contribution of reflected sunlight. However, the difficulty in performing these observations is that viewing geometry requires the eclipsed satellite to have a small separation from the very bright giant planet. Care must be taken to remove the contribution of scattered light from these data. Spectral data obtained with the NIRSpec IFU (1-5 μm) and MIRI MRS (5-10 μm) can help constrain the thermal emission and composition of Io's lavas. Observations of Io with the NIRISS Aperture Masking Interferometry (AMI) mode will contribute to the study of the formation and evolution of active volcanic regions on the surface. These regions are 100s of km in diameter and are active on the timescale of a few months, so observations every ~6 months, when Jupiter is in JWST's field of regard, will help trace the evolution of these regions. The Early Release Science (ERS) program 1373 has planned observations of Io with NIRISS/AMI in Cycle 1.



Simulated JWST observations of Io with the NIRISS/AMI mode. (a) Model of Io with 4 volcanoes of varying brightness. (b) NIRISS/AMI PSF for the F430M filter. (c) Convolution of PSF with model of Io. (d) Simulated data showing two bright volcanoes; the two arrows point to fainter volcanoes. (From Keszthelyi et al., 2016)

Field of regard. The field of regard (FOR) is the range of allowed orientations for JWST that keeps the instruments and mirrors in the shadow of the sunshield. This range is from 85°-135° in solar elongation (Sun-Observer-Target) angle. The table on the right presents the approximate time that each giant planet, and its satellites, will be at quadrature (90° solar elongation angle) from 2021-2031.

Approximate Dates of Quadrature

	Jupiter	Saturn	Uranus	Neptune
2021	May,Nov	May,Nov	Jan,Aug	Jun,Dec
2022	Jul,Dec	May,Nov	Feb,Aug	Jun,Dec
2023	Aug	May,Nov	Feb,Aug	Jun,Dec
2024	Jan,Sep	Jun,Dec	Feb,Aug	Jun,Dec
2025	Mar,Oct	Jun,Dec	Feb,Aug	Jun,Dec
2026	Apr,Nov	Jul	Feb,Sep	Jun,Dec
2027	May,Dec	Jan,Jul	Feb,Sep	Jul,Dec
2028	Jun	Jan,Aug	Feb,Sep	Jul,Dec
2029	Jan,Jul	Jan,Aug	Mar,Sep	Jul,Dec
2030	Feb,Aug	Feb,Sep	Mar,Sep	Jul
2031	Mar,Sep	Feb,Sep	Mar,Sep	Jan,Jul

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See more at **jwst.stsci.edu** and **jwst-docs.stsci.edu**

https://arxiv.org/abs/1511.03735