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High-resolution UV/optical/IR imaging of Jupiter in 2016–2019 with HST/WFC3 and Gemini/NIRI

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Abstract

Imaging observations of Jupiter with high spatial resolution were acquired beginning in 2016, with an approximate cadence period of 53 days to coincide with the atmospheric observations of the Juno spacecraft during each perijove (PJ) pass. The Wide Field Camera 3 (WFC3) aboard the Hubble Space Telescope (HST) imaged Jupiter in scattered sunlight from 236 nm to 889 nm in 9 distinct filters. The Near-Infrared Imager (NIRI) at Gemini-North collected images of Jupiter's thermal emission using a lucky imaging approach, in the M' filter centered at 4.7 microns. An archive collection hosts science products from this effort (doi:10.17909/T94T1H).

In this presentation, we will examine changes in Jupiter's equatorial zone (EZ) during the span of the Juno mission. We will use stable HST photometry to measure changes in EZ color and cloud structure, and correlate high-resolution 4.7-micron and visible data to study the morphology of specific bright equatorial features in the thermal infrared.

EZ disturbances

EZ disturbances are discussed in Orton et al. abstracts (ODA2 and OPS4 sessions at this meeting), consisting of a long duration (3-5 year) color change at visible wavelengths, and a nested, shorter-duration (<2 years) phase with high 5-µm thermal brightness. Antuñano et al. [1] collected a 5-µm imaging dataset spanning 33 years, which revealed an irregular 6- to 7-year periodicity in the infrared-bright phases.

High-resolution imaging data

The stable HST photometry quantitatively demonstrates that the initial (visible-wavelength) EZ disturbance phase is in full swing. We will present a full photometric time series at available wavelengths during the meeting (Fig. 1), in an attempt to quantify the progression from a normal EZ state (Fig. 2 top) to its current reddened and darkened state (bottom). Observations during and after the disturbance may enable new insights into the composition and formation mechanism of upper-tropospheric haze [2].

Although the dramatic 5-µm brightening of a full EZ disturbance has not yet erupted, Juno-era imaging shows the early presence of moderately IR-bright features within the normally dark EZ (Fig. 3). Several of the IR-bright features are associated with "festoons" that are connected to well-known hot spots near 8°N, but no extended east-west features are seen at 3-4°S, as would be seen in a full-blown infrared EZ disturbance [1]. These observations—like 5-µm spectroscopic observations presented by Bjoraker et al. (OPS4 session this meeting)—provide a key baseline of conditions in the quiescent EZ prior to the outbreak of a full disturbance.

Acknowledgements

Based on observations obtained at the Gemini Observatory (GN-2016B-FT-18/29, GN-2017A-Q-60, GN-2018A-Q-202, GN-2019A-Q-202) and the NASA/ESA HST (GO-14334, 14661, 14839, 14756, 15262, 15159, 15665), with NASA funding. We recognize the very significant cultural role and reverence that the summit of Maunakea has always had within the indigenous Hawaiian community. We are most fortunate to have the opportunity to conduct observations from this mountain.

References

[1] Antuñano, A., et al.: Infrared Characterization of Jupiter's Equatorial Disturbance Cycle, Geophys. Res. Lett., 45, pp.10987–10995, 2018.

[2] Wong, M. H.: Equatorial Clouds and Haze before, during, and after Jupiter's Global Upheaval, AGU Fall Meeting Abstract, P51A-0201, 2007.

[3] Tollefson, J., et al.: Changes in Jupiter's Zonal Wind Profile preceding and during the Juno mission, Icarus, 296, pp. 163–178, 2017.

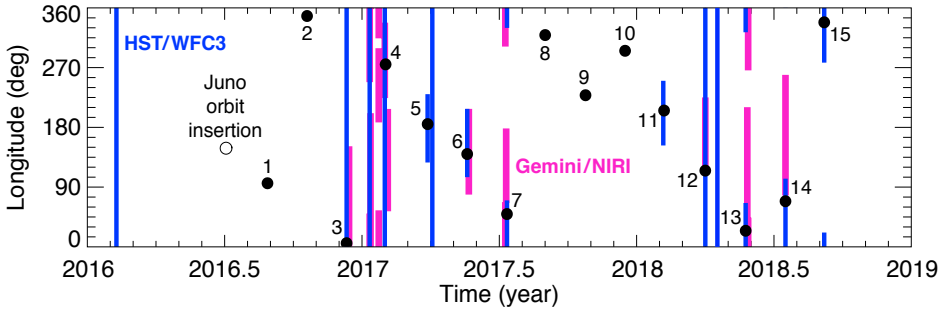

Fig. 1 – We present a comprehensive imaging campaign using 5-µm lucky imaging with Gemini/NIRI and UV-visible-NIR imaging with HST/WFC3. Longitudinal coverage varies with each perijove. Additional 2019 data (not shown on timeline) will be presented at the meeting (e.g., Fig. 2 bottom).

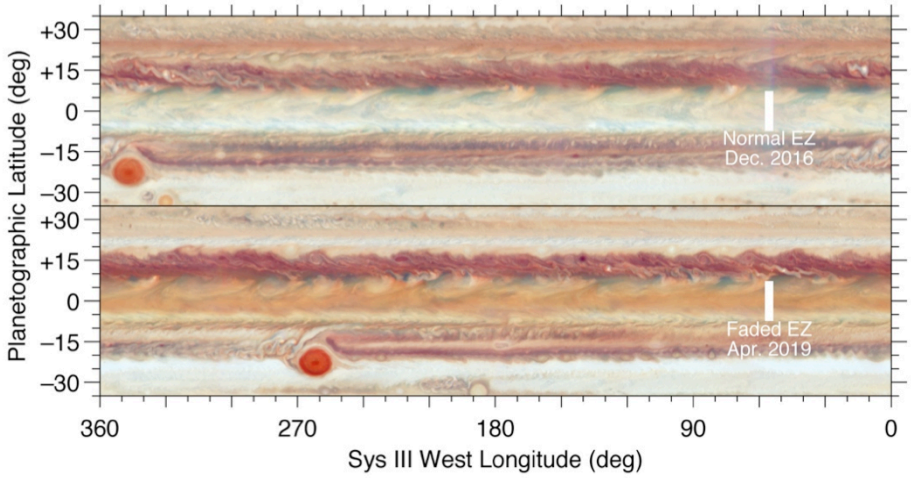

Fig. 2 – Coloration in the EZ has changed between the first maps early in the Juno mission in 2016 (top), compared to the most recent map (bottom). RGB color is from 631/502/395-nm filters, and the photometric scaling is identical in both panels. Significant color changes are also apparent in the 20°–30°N range, a condition that may indicate a major convective eruption within the next 1–3 years [3].

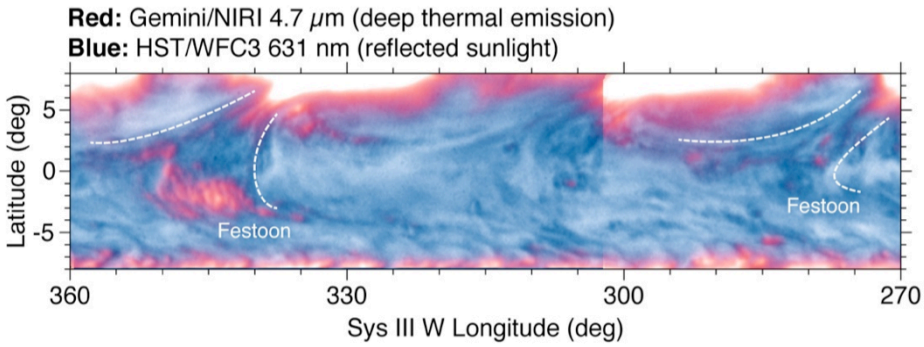

Fig. 3 – Bright tthermal features in the EZ are related to "festoons" attached to 5-µm hot spots, as seen in simultaneous visible and infrared imaging (Jan. 2017).