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Spatial Variations on Neptune in the Radio

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Abstract

We present longitudinally-resolved and longitude-smeared VLA maps of Neptune between 0.9 and 9.7 cm taken on September 1-2, 2015. Near the South Pole, the brightness temperature is enhanced by up to 30 K compared to a uniform limb-darkened model. The southern mid-latitudes are 10 K colder than this same model (Fig. 1). These brightness temperature variations are due to differences in the opacity sources in the troposphere from 5 to 40 bar. In the centimeter, the opacity is dominated by H_2S, NH_3, the collision-induced absorption of H_2 with H_2, He, and CH_4, and ortho/para H_2 [e.g., 1]. We construct models for the abundance of these gases as a function of latitude that fit the observed brightness temperature distribution and compare these models to similar results from spatially resolved millimeter maps obtained with ALMA [2]. Since the ALMA mm-observations probe higher into the atmosphere than the VLA cm-maps, a more complete construction of Neptune's tropospheric composition can be made.

Tentative longitudinal variations are also detected. These maps predate the discovery of a Neptunian dark spot at 45 deg S on September 18, 2015 [3]. Using derived drift rates for the dark spot and its companion cloud [3,4], we predict the locations of these features at the time of the VLA observations. The brightness temperature at the these locations is a few degrees colder at four of the five observed wavelengths than the average temperature at the central latitude of the dark spot and companion cloud. If these local signatures are real and correlated with the dark spot, this implies that the dark spot originates deep in the troposphere, at least down to 40 bar, and is enriched in trace gases. This is consistent with an upwelling origin for the dark spot.

1. Figures

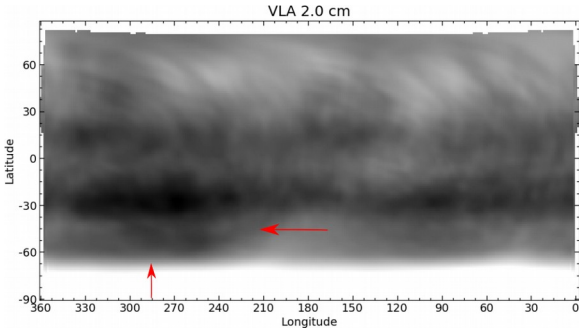

Figure 1: Longitudinal-resolved map of Neptune at 2.0 cm taken with the VLA. A uniform limb darkened model has been subtracted, revealing brightness temperature variations across the planet. The 2015 dark spot and companion would be near 45S Lat., 285 Lon. (red arrows) based on measured drift rates. This region is characterized by low temperatures (dark colors) compared to the average brightness at this latitude.

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References

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