The First Dark Spot Detection in the Atmosphere of Uranus: Properties and Comparison with Dark Spots in Neptune

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October 27, 2010

1 Abstract

In late January 1986, the spacecraft Voyager 2 made its closest approach to Uranus. During the several months that followed this event, the spacecraft acquired more than 7000 images revealing new ringlike features, nine new small satellites orbiting between Uranus rings and Miranda, and the complete absence of detections of dark spots in the atmosphere (Smith et al. 1986). Three years later, the Voyager 2 visited Neptune, and in contrast to the lack of atmospheric features found in Uranus, the spacecraft made the first detection in the system of a great dark spot (GDS) in the northern hemisphere that we know today as GDS 1989 (Smith et al. 1989). After the revealing observations provided by the Voyager 2, the spatial resolution and time coverage in the study of atmospheric features has been significantly improved thanks to the combined work of the Hubble Space Telescope (HST) and ground based facilities. In the case of Neptune, Sromovsky et al. (2002) analyzed the dynamics of several northern dark spots detected between 1993 and 2000. Their observations confirmed the presence of at least two great dark spots (NGDS) located at latitudes of 32.3 ± 0.7^o N (NGDS 32) and 14.2 ± 0.8^o N (NGDS 15). Surprisingly, these NGDS were very stable in latitude and drift rate. While NGDS 32 showed no reasonable drift in latitude during its 6 years lifespan, NGDS 15 drifted only 1.7 ± 1.7^o towards the equator between 1996 and 1997. In the case of Uranus, combined observations using HST and Keck II 10-m telescope began in 1993, however, the first confirmed Uranus dark spot (UDS) detection did not occur until August 2006 (Hammel et al. 2006). The latitude of the observed UDS was 27 ± 0.8^o N with an extension of 2.4^o in latitude and 5.7^o in longitude (approximately 1600 by 3000 km). The average zonal velocity was 43.12 ± 0.09 m s^{-1}, value that is higher than all the other velocities measured to date near that latitude. Hammel et al. (2009) also detected bright structures spatially associated to the UDS. These bright features exhibited considerable variability compared to the relatively stable dark spot, which was observed at least from June through October. None of the numerical simulation results trying to reproduce the UDS were able to survive more than a month. This suggest that structure in the zonal wind profile may be a critical factor in the emergence of large sustained vortices (Hammel et al. 2009).

In this talk we will describe the properties of the first confirmed dark spot detected in Uranus, comparing these observations with fluid dynamic simulated vortices and dark spot features observed in the atmosphere of Neptune.

2 References

Hammel, H.B., Sromovsky, L.A., Fry, P.M., Rages, K., Showalter, M., de Pater, I., van Dam, M.A., Lebeau, R.P. and Deng, X., 2009. Icarus 201, 257 - 271.

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Uranus is slightly larger in diameter than its neighbor Neptune, yet smaller in mass. It is the second least dense planet; Saturn is the least dense of all. Uranus gets its blue-green color from methane gas in the atmosphere. Sunlight passes through the atmosphere and is reflected back out by Uranus' cloud tops. Methane gas absorbs the red portion of the light, resulting in a blue-green color. Formation. Formation. Uranus took shape when the rest of the solar system formed about 4.5 billion years ago, when gravity pulled swirling gas and dust in to become this ice giant. Like its neighbor Neptune, Uranus likely formed closer to the Sun and moved to the outer solar system about 4 billion years ago, where it is the seventh planet from the Sun. Kid-Friendly Uranus. Dark Spot Simulation. Raymond Lebeau. View project.Â The four giant planets - Jupiter, Saturn, Uranus and Neptune - have common properties which make them very different from the terrestrial planets: located at large distances from the Sun, they have big sizes and masses but low densities; they all have a ring system and a large number of satellites. These common properties can be understood in the light of their formation scenario, based upon the [Show full abstract] accretion of protosolar gas on an initial icy core. Giant planets have been explored by space missions (Pioneer 10 and 11, Voyager 1 and 2, Galileo and Cassini) but also by Earth-orbiting satellites and ground-based telescopes. In this talk we will describe the properties of the rst conrmed dark spot detected in Uranus, comparing these observations with uid dynamic simulated vortices and dark spot features observed in the atmosphere of Neptune. 2 References. Hammel, H.B., Sromovsky, L.A., Fry, P.M., Rages, K., Showalter, M., de Pater, I., van Dam, M.A., Lebeau, R.P. and Deng, X., 2009. Icarus 201, 257 - 271. Smith, B.A., and 40 colleagues, 1986. Science 233, 43 - 64. Smith, B.A., and 64 colleagues, 1989. Images of Uranus reveal for the first time a dark spot inthe planet's northern hemisphere. During the past decade, many bright spots have been seen on Uranus,in both red and near-infrared filters. But this is the first dark spot everseen on the planet. A team led by Lawrence Sromovsky of the University ofWisconsin and including Kathy Rages of the SETIInstitute, Heidi Hammel of the Space Science Institute (Boulder, CO), andPatrick Fry of U. Wisconsin, observed the dark spot on Aug. 23 using the HubbleSpace Telescope (HST).Â They probably remember theVoyager images of Neptune'sGreat Dark Spot and its associated Bright Companion. It would be veryexciting to see similar features forming on Uranus as spring comes to thenorthern hemisphere after decades of winter darkness.