3D Global MHD Simulations of Uranus’　Variable Interaction with the Solar Wind

*Xianzhe Jia[1], Yash Sarkango[1]

1. University of Michigan, Ann Arbor

The Voyager-2 spacecraft visited Uranus in 1986 and acquired our only in-situ measurements from which we learned about the basic characteristics of its space environment. The aspect that sets Uranus’ magnetosphere apart from those of the other planets in the solar system is perhaps its internal magnetic moment, which has a rather large tilt from the rotation axis and a significant offset from the planetary center. As a result, Uranus’　magnetospheric configuration relative to the incident solar wind flow continually changes, leading to reconfiguration of the magnetosphere every rotation. The strongly asymmetric internal magnetic field combined with complex, time-varying geometry of the rotation and dipole axes with respect to the orbital plane result in a highly dynamic magnetosphere at the ice giant that undergoes significant diurnal and seasonal variations. The single flyby through the magnetosphere by Voyager along with limited telescopic observations of its atmosphere and aurora provide us with only hints of how such magnetospheric reconfiguration takes place. Here we apply the Univ. of Michigan BATSRUS magnetohydrodynamics (MHD) code to Uranus to investigate the global structure of its magnetosphere and examine how it varies through a rotation cycle. Our global MHD simulation incorporates realistic internal field model and adopts a high-resolution numerical grid that allows us to resolve fine structures of key magnetospheric boundaries. We have performed global simulations for the Voyager-2 flyby conditions, and comparisons of our simulation output with the Voyager data suggest that our MHD model is able to reproduce the global structure of Uranus’　magnetosphere with high fidelity. In this presentation, we will show how the magnetosphere periodically changes its configuration as the internal dipole rotates, including the structure and temporal variation of the tail plasma sheet that has been sampled by the Voyager spacecraft. We will also discuss the morphology and physical origin of the large-scale current systems extracted from our simulation, and their implications for understanding available auroral observations.

Keywords: Uranus, Ice giant, magnetosphere, solar wind, aurora, plasma