Contribution ID: **44** Type: **not specified**

Ab Initio Predict Phase Separation of Planetary Ices and Explain the Unusual Magnetic Fields of Uranus and Neptune

Tuesday 24 June 2025 09:40 (40 minutes)

This talk will review of results from experiments and computer simulations of planetary ices in the regime of warm dense matter. Large quantities of these ices are assumed to by stored in the mantles of Uranus and Nepune. Both planets have unusual, nondipolar magnetic fields. Existing observation and models for the interior structures of these ice giant planets are discussed before results from recent computer simulations are presented that predict mixtures of H2O, CH4 and NH3 to phase separate under the pressure-temperature condition in the interiors of Uranus and Neptune [1], which implies that their icy mantles have two separate fluid layers: an upper H2O-dominated layer and stably stratified mixture of hydrocarbons below. The magnetic fields of Uranus and Neptune are primarily generated in the upper layer, which is convective and electrically conducting. Because this layer is comparatively thin, it gives rise to the generation of disordered magnetic fields, which offers an explanation for why the Voyager 2 spacecraft measured these two ice giant planets to have nondipolar magnetic fields, while strong dipolar fields had been expected. The lower mantle layer is predicted to be stably stratified. A signature of the stratification can be detected in normal modes, which lends support to placing a Doppler imager on a future space mission to Uranus.

[1] B. Militzer, “Phase Separation of Planetary Ices Explains Nondipolar Magnetic Fields of Uranus and Neptune”, PNAS (2024) DOI: 10.1073/pnas.240398112.

Interior structure of Uranus with four layers: 1) hydrogen (light blue), 2) water (dark blue), 3) hydrocarbons (red), and 4) rocky core (yellow). The planet has a disordered magnetic field that originates primarily from its water layer.

Primary author: Prof. MILITZER, Burkhard (Department of Earth and Planetary Science, University of California, Berkeley, USA)

Presenter: Prof. MILITZER, Burkhard (Department of Earth and Planetary Science, University of California, Berkeley, USA)