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The effect of compositional buoyancy on dynamo action in the ice giant planets

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Abstract

The internal structure and material composition of a planet plays an important role in determining the topology of that planet's magnetic field. Dynamo theory predicts that complex fluid motions within planetary interiors sustain their magnetic fields, which in turn affect the dynamics of these fluid motions. Giant planets, like Jupiter, maintain mostly dipole dominated magnetic fields by convective motion with a highly-conductive liquid metal core. However, planets like Uranus and Neptune are believed to maintain multi-polar magnetic fields through motions with a mantle of metallic ices—water, ammonia, and methane. At planetary interior conditions, these different species of ices adopt exotic phases, and may undergo different chemical processes. Using the magnetohydrodynamic code MagIC, we provide a set of several numerical models, attempting to reproduce the general features of the Uranian and Neptunian magnetic fields, as well as ascertain the sensitivity of the topology of the magnetic fields to the underlying physical processes within the interior.