



Time-varying dynamo models consistent with Uranus' and Neptune's magnetic fields

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Uranus and Neptune present unique non-dipole-dominated magnetic fields that are also strongly non-axisymmetric (i.e., peak power for $m > 0$). Their distinctly high power in the $m = 1$ component appears to be a persistent feature and, therefore, a key diagnostic for determining the mechanisms underlying magnetic field generation within these planets. Here, we highlight numerical dynamo models that successfully reproduce the large-scale features of ice giant magnetic fields, with the profile of radially varying electrical conductivity being a critical ingredient. Moreover, the magnetic fields in these dynamo models evolve rapidly with time. We thus hypothesize that Uranus' and Neptune's magnetic fields may have changed in intensity and/or orientation since the Voyager 2 flybys. This secular variation has implications for telescopic observations of auroral features (e.g., via the James Webb Space Telescope) and provides essential groundwork for the Uranus Orbiter and Probe Flagship and Triton Ocean World Surveyor New Frontier mission concepts prioritized in the Origins, Worlds, and Life Decadal Survey.