Geophysical Research Abstracts
Vol. 16, EGU2014-8838, 2014
EGU General Assembly 2014

Recent Insights into the Intrinsic Magnetic Fields of Jupiter and Saturn

Hao Cao (1,2), Christopher Russell (1,2), and Michele Dougherty (3)

(1) Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, CA 90095, USA (haocao@ucla.edu), (2) Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90095, USA, (3) Blackett Laboratory, Imperial College London, SW72AZ, UK

The gas giant planets, Jupiter and Saturn, not only played important roles in the evolution of our solar system but also are representative of many exoplanets of this type. Many similarities are shared by these two planets. The major compositions of both planets are hydrogen and helium. In the atmosphere of both planets, helium mass ratios are found to be smaller than proto-solar value; most of the measured heavy elements, other than neon, are found to be enhanced compared to the proto-solar value. Both planets emit as much as twice the power they receive from the Sun respectively. Whether these two planets possess a central core and what is the mass and size of the core is still under debate given all the observational data.

Both Jupiter and Saturn possess global-scale magnetic fields. Dynamo actions in the convecting metallic hydrogen layers are believed to be responsible for these observed magnetic fields. Measuring and characterizing magnetic fields can enhance our understandings of the interior structures and dynamics of the host planets. We will present our characterization of the intrinsic magnetic fields of both planets in terms of field strength, non-axisymmetry, secular variation, high-degree moments based on in-situ magnetic field measurements made by space missions (Pioneer 11, Voyager 1 and Galileo for Jupiter and Pioneer 11, Voyager 1 & 2 and Cassini for Saturn), traceable "ground" features – Auroral footprints of Io and Enceladus will also be considered. For Saturn, we find not only no evidence for any departure from axisymmetry but also that the magnetic flux inside Saturn is strongly concentrated near the spin-poles, in contrast to the well-defined polar field minima observed at the surface of the Earth's core and in geodynamo models. For Jupiter, the departure from axisymmetry is evident but currently available measurements cannot discern whether the magnetic fields at the polar regions of the dynamo surface are at maxima or minima. However, auroral features indeed indicate strong north-south asymmetries in Jupiter's surface magnetic field.

Solid-body rotation of the dynamo region can be monitored by the tracing the non-axisymmetric magnetic fields and radio emissions of Jupiter. A similar procedure has not yielded unambiguous results for Saturn due to the extreme axisymmetry of the magnetic field. Large-scale circulation (e.g. differential rotation) at the surface of the dynamo region of Jupiter will produce magnetic signals expressed as secular variations. We seek to put upper-bounds on the velocity of large-scale circulation at the surface of the dynamo region of Jupiter by comparing forward modeling and magnetic field measurements made in the inner Jovian magnetosphere from different epochs.

Helium re-distribution likely has occurred inside both Jupiter and Saturn, as a result of the crossing of the adiabats and hydrogen-helium immiscibility curve. The possible effects on dynamo action will also be discussed.