Geophysical Research Abstracts
Vol. 13, EGU2011-1638, 2011
EGU General Assembly 2011

Implications for the Interiors of Jupiter and Saturn from their Very Different Magnetic Fields

Christopher Russell (1,2), Hao Cao (1,2), Steve Joy (1,2), Ulrich Christensen (3), and Michele Dougherty (4)

(1) University of California, Earth and Space Sciences, Los Angeles, CA, United States (ctrussell@igpp.ucla.edu, 001 310 206-3051), (2) University of California, Institute of Geophysics and Planetary Physics, Los Angeles, CA, United States (ctrussell@igpp.ucla.edu, 001 310 206-3051), (3) Max Planck Institute for Solar System Research, 37191 Katlenburg-Lindau, Germany, (4) Imperial College, London, UK

The gas giants, Jupiter and Saturn, have been magnetically well observed. These measurements can be used to derive the intrinsic magnetic field, which provide important constraints on the interior properties of these planets. Pioneer 10 and 11, Voyager 1 and 2, Ulysses, and Galileo have made in-situ measurements of the Jovian magnetic field. Several internal field models have been derived based on different ways of inverting these measurements. For Saturn, the measurements of Pioneer 11, Voyager 1 and 2 have provided preliminary models of the magnetic field of this planet, but only an axisymmetric field could be robustly determined. Since 2004, the Cassini spacecraft has been orbiting the planet, making nearly continuous measurements of the magnetic field, allowing us to improve the earlier models and to look for secular variation.

For Jupiter, none of the widely used models, O6, VIP4, JPL/P11, are consistent with the Pioneer 11 measurements obtained close to the planet. We interpret this deviation as the effects of the higher degree moments of the intrinsic field that are relatively stronger at low altitudes. Yu and Russell [2009] analyzed all available data through 2002, and concluded that the internal magnetic field of Jupiter exhibits little if any secular variation other than a simple rotation of the dipole moment. This analysis was based on the O6 model and used measurements from 6 to 15 jovian radii where currents are produced by the mass loading of the volcanically-derived plasma at Io. Thus, these measurements may be affected by the dynamics in the Jovian magnetosphere.

To avoid these effects, we restrict all our analysis inside 5.8 Rj (well inside Io's orbit), and derive a 4th degree model from Pioneer 11 observations. Our model has no systematic deviation from the near-planet measurements. This new model indicates that the dipole moment of Jupiter is about 2% weaker than estimated from the widely used previous models, O6 and VIP4. To investigate the evolution of the Jovian magnetic field from the Pioneer 11 epoch to the Galileo epoch, we first need to determine a more accurate rotation rate for Jupiter than the period defined by the IAU for the 1965 epoch. This analysis results in a 9 ms correction to the IAU 1965 defined rotation period. When this correction is made, there is no significant secular variation in the jovian magnetic field.

For Saturn, Cao et al [2010] have shown that the internal field of the planet is extremely axisymmetric. The magnetic dipole tilt to the spin axis is confined to be within 0.06 degrees. They also find that the internal field of Saturn exhibits no detectable secular variation from the Pioneer epoch to the Cassini epoch. We are now analyzing the measurements provided by Cassini since the end of the previous analysis [Cao et al, 2010]. High latitude measurements are being examined to explore the existence of localized non-axisymmetric moments.

[1] Cao, H., Russell, C. T., Christensen, U. R., and Dougherty, M. K. (2010), American Geophysical Union, Fall Meeting 2010.
[2] Yu, Z.J., and Russell, C.T. (2009), Geophys. Res. Lett., 36, L20202.