Saturn's new magnetic field model from Cassini radio observations and magnetometers measurements

Patrick H. M. Galopeau* [1]
(1) LATMOS-CNRS, UVSQ Université Paris-Saclay, Guyancourt, France

1. Extended Abstract

The radio and plasma wave science (RPWS) experiment on board the Cassini spacecraft, orbiting around Saturn since July 2004, revealed the presence of two distinct and variable rotation periods in the Saturnian kilometric radiation (SKR) which were attributed to the northern and southern hemispheres respectively. We believe that the periodic time modulations present in the SKR are mainly due to the rotation of Saturn's inner magnetic field. The existence of a double period implies that the inner field is not only limited to a simple rotation dipole but displays more complex structures having the same time periodicities than the radio emission. In order to build a model of this complex magnetic field, it is absolutely necessary to know the accurate phases of rotation linked with the two periods. The radio observations from the RPWS experiment allow a continuous and accurate follow-up of these rotation phases, since the SKR emission is permanently observable and produced very close to the planetary surface. A continuous wavelet transform analysis of the intensity of the SKR signal received at 290 kHz between July 2004 and June 2012 was performed in order to calculate in the same time the different periodicities and phases. A dipole model ("birotor dipole") was proposed for Saturn's inner magnetic field: this dipole presents the particularity to have North and South poles rotating around Saturn's axis at two different angular velocities; this dipole is tilted and not centered. 57 Cassini's revolutions, the periapsis of which is less than 5 Saturnian radii, have been selected for this study. For each of these chosen orbits, it is possible to fit with high precision the measurements of the MAG data experiment given by the magnetometers embarked on board Cassini (see example in Figure 1). A nonrotating external magnetic field completes the model. This study suggests that Saturn's inner magnetic field is neither stationary nor fully axisymmetric. These results can be used as a boundary condition for modelling and constraining the planetary dynamo and they can be a starting point for the study of Saturn's inner structure and the comparison with the interior of Jupiter.

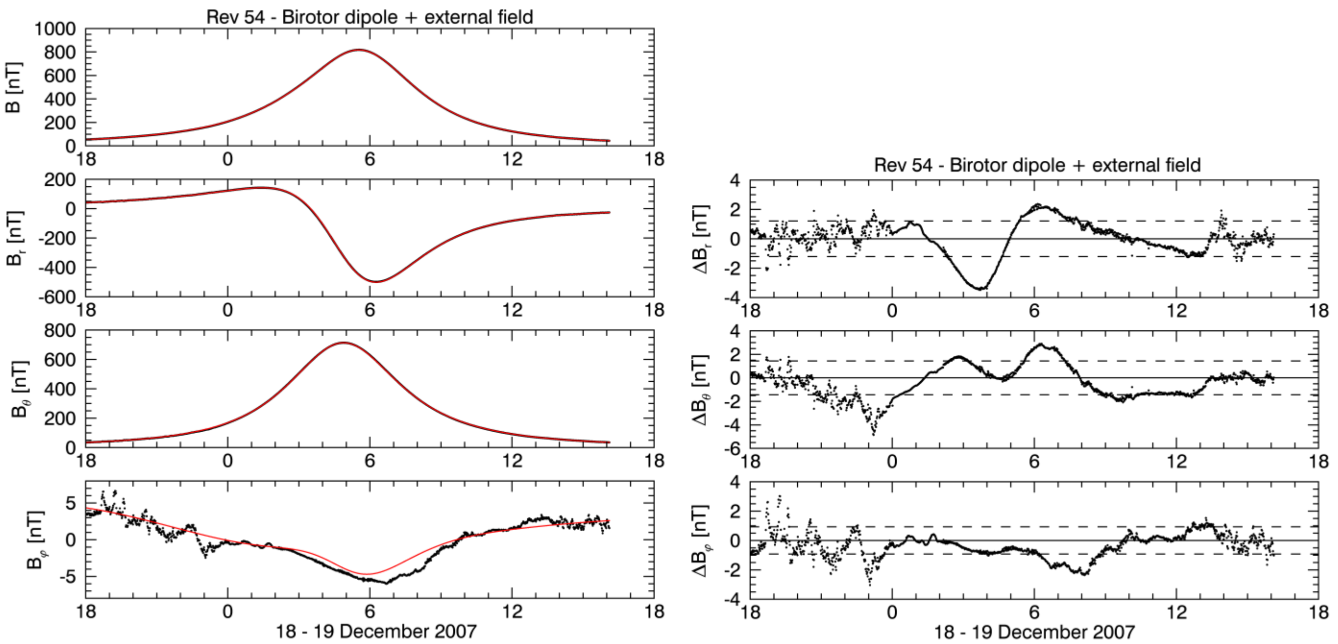

Figure 1. Comparison between the magnetic field components observed by Cassini/MAG and the best fit of the birotor dipole model (red line) along Cassini's trajectory during revolution #54 (left plots). An external non-rotating field is modelled too. In the right plots the difference $\Delta \mathbf{B} = \mathbf{B}_{\text{model}} - \mathbf{B}_{\text{obs}}$ is plotted for the three components B_r, B_θ, B_φ; the dashed lines represent the 1-σ standard deviation.