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Birotor Dipole for Saturn's Magnetic Field Model Derived From Cassini Radio and Magnetic Observations

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Since the insertion of Cassini in Saturn's system, the radio data from the RPWS (radio and plasma wave science) experiment on board the spacecraft have 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. These radio data also allowed a continuous and accurate follow-up of the rotation phases, linked with the two periods, 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. The rotation phases associated to the main two periods allow us to define a North and South longitude system essential for such a study. In this context, 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. 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. An average of the birotor dipole magnetic potential is performed on the azimuthal angle revealing an average axisymmetrical component which can be compared with the published zonal models proposed for Saturn's magnetic field. The difference between the model and the observed magnetic field, along orbits the perikrone of which is close enough to Saturn, clearly suggests a quadrupolar variation. As a consequence, the presence of a "birotor quadrupole" is required in the present model to improve the agreement for the third order Gauss coefficient.