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Particle-in-cell simulations of Earth-like magnetosphere during a magnetic field reversal ()

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The geologic record shows that hundreds of pole reversals have occurred throughout Earth's history. The mean interval between the poles reversals is roughly 200 to 300 thousand years and the last reversal occurred around 780 thousand years ago. Pole reversal is a slow process, during which the strength of the magnetic field decreases, become more complex, with the appearance of more than two poles for some time and then the field strength increases, changing polarity. Along the process, the magnetic field configuration changes, leaving the Earth-like planet vulnerable to the harmful effects of the Sun. Understanding what happens with the magnetosphere during these pole reversals is an open topic of investigation. Only recently PIC codes are used to modeling magnetospheres. Here we use the particle code iPIC3D [Markidis et al, Mathematics and Computers in Simulation, 2010] to simulate an Earth-like magnetosphere at three different times along the pole reversal process. The code was modified, so the Earth-like magnetic field is generated using an expansion in spherical harmonics with the Gauss coefficients given by a MHD simulation of the Earth's core [Glatzmaier et al, Nature, 1995; 1999; private communication to L.E.A.V.]. Simulations show the qualitative behavior of the magnetosphere, such as the current structures. Only the planet magnetic field was changed in the runs. The solar wind is the same for all runs. Preliminary results show the formation of the Chapman-Ferraro current in the front of the magnetosphere in all the cases. Run for the middle of the reversal process, the low intensity magnetic field and its asymmetrical configuration the current structure changes and the presence of multiple poles can be observed. In all simulations, a structure similar to the radiation belts was found. Simulations of more severe solar wind conditions are necessary to determine the real impact of the reversal in the magnetosphere.

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