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Interconnection between Saturn's polar caps

E. S. Belenkaya (1), S. W. H. Cowley (2), V. V. Kalegaev (1), I. I. Alexeev (1), O. G. Barinov (1), and W. O. Barinova (1)

(1) Lomonosov Moscow State University Skobeltsyn Institute of Nuclear Physics (MSU SINP), 1(2), Leninskie gory, GSP-1, Moscow 119991, Russian Federation, (2) Department of Physics & Astronomy, University of Leicester, Leicester LE1 7RH, United Kingdom (elena@dec1.sinp.msu.ru / Fax: +7 495 939 3553)

Abstract

The interconnection between Saturn's polar regions is studied, with the main attention being paid to the influence of the interplanetary magnetic field (IMF) on this process. The most complex case arises for southward IMF. For an example event in February 2008 (DOY 43) when we have both the UV image of the southern polar region obtained by the Hubble Space Telescope and the IMF at the nose of the kronian magnetosphere measured by Cassini, we calculate the field-aligned projections of the bright emissions in the southern polar region to the magnetospheric equatorial plane and to the northern Saturn's hemisphere. For this purpose we use our paraboloid magnetospheric model which has newly been modified by taking into account the multipole terms of the internal planetary magnetic field and the spheroidal form of the planet's conducting ionosphere. Our results show that there should be rather similar patterns of bright spots in both polar caps. However, the whole magnetic field structure and consequently the character of the emission in the high latitude ionosphere depend on the IMF component along the planetary dipole direction.

1. Short description

Calculations were performed in the modified kronian paraboloid magnetospheric model (Alexeev et al., 2006) in which the quadrupole, and octupole terms of the internal planetary magnetic field are included. The spheroidal form of the conducting kronian ionosphere is also taken into account. In Figure 1 the calculations for the southern (top panel) and northern (bottom panel) Saturn's polar caps are shown for the studied case at ~21:47:38 UT at HST on DOY 43, 2008. On the corresponding UVI image in the southern hemisphere three bright spots are seen (dusk, day, dawn). From the points with step ~30 min along each spot boundary the field lines are started and go

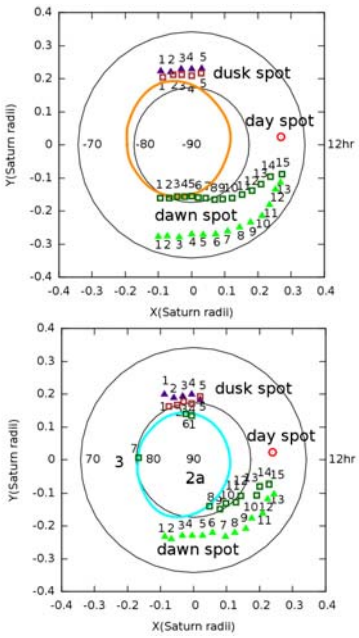

Figure 1: Top panel. Bright emission regions on the southern polar cap. Bottom panel. Magnetically conjugated regions in the northern polar cap.

into the magnetosphere and to the opposite hemisphere. For each spot, their "ends" in the southern and northern polar caps are shown in the top and bottom panels, respectively, by the same numbers. Points on the outer boundary of the bright auroral spot are shown by triangles, while on the inner one by squares. Day spot is marked by a small red circle. It is seen that the boundaries of the southern dawn spot are mapped to the northern polar region forming a figure which, probably, could

bound the northern dawn spot (more narrow than the southern one with the outer boundary located on the higher latitudes). We have no image of the northern polar cap for the studied case, so this conclusion has a prognostic character.

Orange and blue ovals in the top and bottom panels of Fig. 1 mark the calculated open field line region boundaries which depend on the simultaneously measured IMF {0.2, -0.85, -0.24} nT. Due to the multipole terms the angular radius of the open flux area is less for the northern kronian hemisphere than for the southern one by ~1^{o}. Asymmetry in the dawn-dusk direction in the form of the ionospheric open field line regions (Fig. 1) is due to the IMF B_y-component.

Our calculations show that emission on the inner part of the southern large bright dawn spot for the studied case could be generated by the velocity shifts at the boundaries of the northern and southern open fluxes and at the dawn-noon equatorial magnetospheric flank, while the outer part of this southern dawn auroral bright emission as well as the day spot are connected by the field lines with the dawn-noon sector of the ring current. As it is seen from Fig. 1, the dusk southern spot and its projection to the northern polar region are located close to the boundary between the open and closed field lines in the dusk sector. It should be noted that for the studied case the northern (southern) magnetic field neutral point is projected to the ionospheric open-closed boundary at ~18 MLT (6 MLT).

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