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On the modeling of IMF influence on pressure balance at planetary obstacles in the flow of the solar wind

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Abstract

It is usually accepted and is generally valid that the solar wind pressure Π to the nose of planetary obstacles can be approximated as $\Pi \approx k\rho V^2$ with k being the function of solar wind specific heat ratio γ and sonic Mach number M_s ($k \approx 0.88$ for $\gamma = 5/3$ and $M_s \to \infty$), and ρV^2 being the solar wind ram pressure. Recently Dušík et al. [1] revealed in THEMIS data the dependence of the geomagnetopause nose position on the IMF cone angle ϑ. This dependence was interpreted by Verigin et al. [2] with the use of empirical relation between IMF and magnetosheath magnetic fields by Crooker et al. [3]. It was suggested to be a result of magnetic field additional pressure at the magnetopause nose:

$$\Pi = k\rho V^2\left(1+\frac{4Sin^2\vartheta}{kM_a^2}+\frac{4Sin^2\vartheta}{kM_a^2}\sqrt{1+\frac{kM_a^2}{2Sin^2\vartheta}}\right),$$

where M_a is the Alfvenic Mach number. This additional pressure is expected to be relatively more important for solar wind flow around giant planets, due to slower decrease of IMF ($\sim r^{-1}$) compared with decrease of solar wind density ($\sim r^{-2}$) with heliocentric distance r increase. Different approaches to the description of the additional pressure to the planetary obstacles, based on analytical consideration and 3-D MHD modeling are discussed.

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References

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