REVIEW OF THE DOCTORAL THESIS

Author of the thesis: Kateřina Andréeová

Title of the thesis: The study of instabilities in solar wind and in magnetosheath and their interaction with the Earth's magnetosphere

Reviewer: RNDr. Andriy Koval, Ph.D., Heliospheric Physics Laboratory, NASA Goddard Space Flight Center, Greenbelt, MD 20771, U.S.A.

The thesis represents a study of propagation of solar wind fast shocks into the Earth's magnetosphere. Fast shocks were chosen as having the highest occurrence rate in the solar wind and as precursors of large solar wind structures, such as CMEs and CIRs. The main topics discussed in the thesis are:

(1) Interaction of fast forward shocks with the Earth's bow shock.
(2) Statistical analysis of the shock speeds in different parts of the magnetosphere, their comparison with the corresponding shock speeds in the solar wind, and their dependences on the solar wind parameters.
(3) Detailed investigations of the propagation through the magnetosphere of two fast shocks and comparison of observations with the results of two MHD models.

The thesis is divided into six chapters. After demonstrating the importance of the topic in chapter 1, chapter 2 presents introduction to the properties of the solar wind, interplanetary shocks and discontinuities, and structures near the Earth, as well as the current understanding of the interaction of interplanetary shocks and discontinuities with the Earth's bow shock and magnetopause. Chapter 3 shows the aims of the thesis. The following chapter describes spacecraft used in the study. The detailed results of the study are presented in chapter 5, while the last chapter summarizes the main results.

The task of studying the shock propagation into the Earth's magnetosphere is complicated by different properties of the regions the shocks propagate through (solar wind, magnetosheath, and magnetosphere), which may lead to the modification of the shock parameters. Further complication includes the shock interactions with the boundaries between these regions (bow shock and magnetopause), resulting in creation of new discontinuities. One of the main advantages of the present study is multi-point observations with a total of about 10 spacecraft which cover region of the solar wind, magnetosheath, and magnetosphere. The orientations and propagation speeds of the shocks in the solar wind were calculated using the Szabo [1994] "Rankine-Hugoniot" technique and the four-spacecraft technique, which are considered the most accurate techniques for the determination of shock local and global parameters, respectively. The multi-point observations in the magnetosphere allowed calculation of the disturbance propagation speeds from the times of observations at different locations there. Another advantage of the study is a statistical analysis of 42 events, which allowed comparison of the shock speeds in the solar wind with the speeds of the corresponding disturbances in the magnetosphere and estimation of the evolution of the speeds from the dayside to the nightside magnetosphere. The statistics also resulted in the discussion of the magnetosphere disturbance speed dependences on the solar wind parameters. The detailed investigations of two events revealed double-step profiles of the disturbance fronts in the magnetosphere as opposed to single-step profiles in the solar wind and similar to double-step profiles observed in the magnetosheath. The MHD simulations of these events demonstrated 3D structure of the magnetospheric response to the shocks and revealed deformation of the disturbance fronts there.

I have not found any significant disadvantages in the thesis. I have only a few questions that could be addressed during the presentation:

(1) Figure 5.6 shows double-step structures observed by the GOES spacecraft in the magnetosphere as a response to the solar wind fast shocks. Is it possible to identify type of the discontinuity that follows the signature of the solar wind fast shock in such events? This can be done, for example, using one of the events when the double-step structure is clearly visible in magnetic filed and plasma measurements of the Cluster spacecraft.

(2) Guo et al. [2005] simulations predict that the transition time of the disturbance in the magnetosphere depends significantly on the solar wind shock orientation, being longer for inclined shocks. Based on the analyzed 42 events with the cone angles ranging from 0 to 50 deg, what conclusions can be made about the observed dependence of the disturbance transition time on the shock inclination?

(3) Table 5.6 shows significant differences between the disturbance passage times observed in the magnetosphere and predicted by the GUMICS-4 model. What is a possible explanation for these differences?

In the end, I would like to summarize that by the presented thesis the author demonstrated a wide theoretical knowledge and ability to work independently, which resulted in new knowledge on the topic. Therefore, I recommend accepting the thesis for defense.

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Andriy Koval