Factors controlling the magnetosphere response to interplanetary shocks

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Abstract: The impact of interplanetary shocks on the magnetosphere triggers geomagnetic activity that can be measured in the geospacer and on the ground, such as variations of energetic particle flux in the radiation belts, geospace magnetic field and wave perturbations, auroral substorms, and ground geomagnetic field variations, which can generate geomagnetically induced currents (GICs) in artificial ground conductors. Moreover, there has been significant evidence in past years that the shock impact angle, the angle between the shock normal vector and the Sun-Earth line, is a major factor controlling the subsequent geomagnetic activity. As shown by many simulation and experimental works, geomagnetic activity occurring under symmetric magnetospheric compressions are usually higher when the compression is asymmetric. This is explained by fast and effective compressions of the most important magnetosphere-ionosphere current systems in case of nearly head-on impacts. In this talk, we briefly present the framework for shock normal determinations and summarize general results. We then focus on two instances of shock geoeffectiveness: (i) a few minutes after shock impact, when the major perturbation sources come from the dayside magnetopause (Chapman-Ferraro) current; and (ii), 30-60 minutes after shock impact, when the major perturbation sources come from the magnetotail due to energetic particle injections occurring during substorm times. The geoeffective response is characterized

by multipoint dB/dt variations in North America and around the world. By comparing all cases, we will show that dB/dt variations are more intense, occur earlier, and cover larger geographic areas as a result of nearly frontal shock impacts. Therefore, we will show that the shock impact angle is a very important feature when predicting geomagnetic activity triggered by shocks that are bound to impact Earth with different orientation.

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