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Understanding the Variability of Europa's Interaction with the Jovian Magnetosphere

Krishan Khurana (1), Xianzhe Jia (2), Chris Paranicas (3), Timothy Cassidy (4), and Kenneth Hansen (2)

(1) Dept. Earth, Planetary and Space Sciences, University of California at Los Angeles, CA, 90095. United States, (2) Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, Michigan, USA, (3) Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, (4) University of Colorado, Laboratory for Atmospheric and Space Physics, 1234 Discovery Drive Boulder, CO 80303, USA

Field and plasma observations from the vicinity of Europa by the Galileo spacecraft show that Europa's response to the corotating field and plasma impinging on it is binary in nature. Galileo successfully encountered Europa 10 times during its mission. During nine of these flybys, the interaction between Europa and Jupiter was observed to be fairly modest. The modeling of magnetic data from these flybys shows that the interaction currents were in the range of 0.5 MA and the plasma addition to the corotating flow was between 2 – 8 kg/s. However, during one of the flybys, namely E12, the field and plasma perturbations were observed to be extremely large. During this flyby, the magnetic field was observed to almost double in strength from its nominal value of 450 nT. The plasma density in the environment was also extremely high during this flyby (exceeding 800 particles/cm-3 compared to the nominal values of 50-100 $particles/cm^3$ expected near Europa's orbit). The energetic ion fluxes on the other hand were seen to drop significantly in count presumably from ion losses and cooling in Europa's environment.

In order to understand the two interaction states of Europa observed so far, we have now developed quantitative 3-D MHD models of plasma interactions of Europa with Jupiter's magnetosphere. In these models we include the effects of plasma pick-up and plasma interaction with a realistic exosphere as well as the contribution of the electromagnetic induction. We will present results of these quantitative models and show that the plasma interaction is strongest when Europa is located at the center of Jupiter's current sheet. We find that plasma mass loading rates are extremely variable over time. We will investigate various mechanisms by which such variability in mass-loading could be produced including episodically enhanced sputtering from trapped gaseous molecules in ice and enhanced plasma interaction with a vent(s) generated dense exosphere. The new model will aid researchers in planning observations from future missions such as JUICE and Europa flagship mission.