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Electron Acceleration and Heating by Kinetic Alfvén Waves in the Saturn's Magnetosphere

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Through various satellite observations (such as Voyager-1, Voyager-2, and Cassini), it has been observed that the Saturn's magnetosphere consists of various types of ionic species such as H^+, O^+, N^+, OH^+ etc., along with electrons [1]. The Saturn's magnetosphere is embedded inside its internally generated magnetic field which extends up to several Saturn radii. The interaction of this magnetic field with the ion and electrons gives rise to different types of wave phenomena. The observed population of electrons can be divided into two species, i.e., hot and cold. The hot species may have temperature ~1000 eV, while the cold electrons may have temperature ~2 eV [2]. In order to explain this energization of electrons to such a high energy (~1000 eV), we propose a plasma model in which electrons are accelerated by the parallel electric field of kinetic Alfvén waves. Using the fluid plasma model equations, we derive the Sagdeev pseudopotential from the energy balance equation. On imposing appropriate boundary conditions on Sagdeev pseudopotential, solitary kinetic Alfvén waves are obtained. Parallel electric field of the solitary kinetic Alfvén waves interact with electrons [3], and heat them to high energies. By using the values of plasma parameters observed at various distances from the Saturn, we analyzed the existence of solitary kinetic Alfvén waves. Finally, we study the effect of magnetic field strength, plasma beta, speed of propagation of the wave via Mach number, and angle of propagation of the wave w.r.t. the magnetic field on the characteristics of solitary kinetic Alfvén waves. It is observed that the amplitude and width of these are very sensitive to the variation in these parameters, which in turn changes the extent of heating of electrons. Thus, this study may be very helpful for the comprehensive understanding of electron acceleration and heating in Saturn's magnetosphere.

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