9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Relaxed magnetic structures in the Saturn's ring

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A theoretical investigation is presented to explain the formation and characteristics of relaxed equilibrium structures in a three component dusty plasma within Saturn's atmosphere, composed of negatively charged dust particles, electrons, and ions. The Quadruple Beltrami equation is derived by utilizing the vortex dynamic equations along with the current density. Solutions for the higher Beltrami states are obtained in two different modes, a simple rectangular geometry and a coplanar rectangular geometry, to explore the characteristics of relaxed structures within the Saturn magnetosphere and its rings. The solutions are depicted through some plots by varying the Beltrami parameters and the densities of the plasma species. It is observed that only paramagnetic structures are formed in the coplanar geometry, while variations in the Beltrami parameters and plasma species densities significantly affect the magnetic characteristics of the relaxed structures in a simple rectangular geometry. This work will provide an important contribution to understand the atmospheric vortical structures developed in different astronomical bodies that have double or more than double configurations, such as Saturn's rings, Jupiter magnetosphere, Uranus, Neptune, etc.

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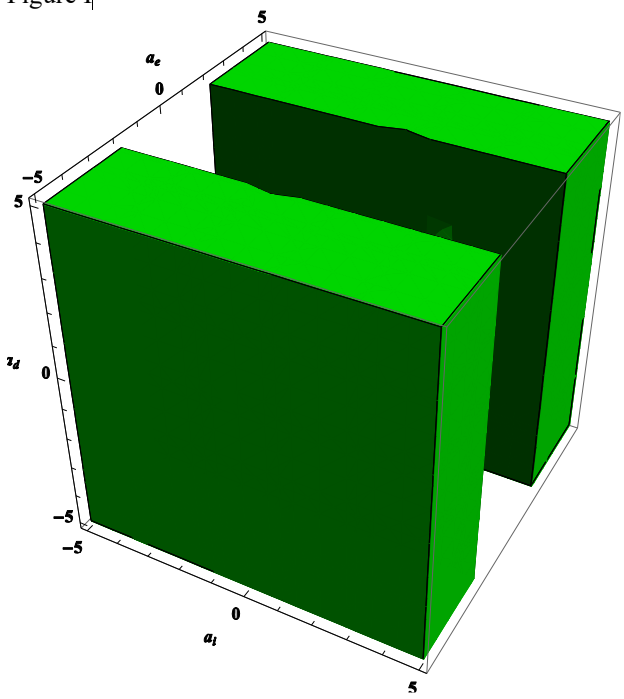
Figure I



3D plot to study the nature of the eigen values (k_1, k_2, k_3, and k_4) as a function of Beltrami parameters (a_d, a_e, and a_i).