NONLINEAR STRUCTURES IN MAGNETIZED PLASMAS

An analysis by Crockett Grabbe of the University of Iowa has produced the first analytic solution of wave structures with electrons intrinsically trapped in them for magnetized plasmas. This significantly extends the solution obtained for these structures in an unmagnetized plasma in 1957. That solution for unmagnetized plasmas has intrigued plasma physicists for several decades, and has been proposed in the last few years to explain broadband waves that permeate regions in space plasmas all the way from less than 20,000 miles out to well over a million miles out from the Earth in what is called the magnetotail. However, the new analysis extending the solution to magnetized plasmas has been applied to cast serious doubt on that interpretation by showing that cannot account for the bulk of those observed waves.

In his analysis Dr. Grabbe derived a condition for the trapping of the electrons as a function of the angle of the magnetic field with respect to the waves, and other parameters of the local plasma. The allowable angle at which trapping can occur is quite small for the conditions in space where the waves are observed. Thus the observations rule out these structures as an explanation for most of the ubiquitous broadband of waves.

This new condition for the electron trapping in magnetized plasmas and the implications it has for the ubiquitous broadband waves will be published in the journal Geophysical Research Letters later this year. In the last couple of years Dr. Grabbe has published papers proposing a new model for generating these broadband waves by electron and ion beams streaming toward the Earth, in which the electron trapping does not occur as an essential part of the generated waves.

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