12. GROUP OF SPACE PLASMA

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12.1. INTRODUCTION

The research work carried out by the Space Plasma Group in 2004 follows naturally from the previously reported activity. During this period, three main areas were under investigation:

- Interpretation of Totem Pole emissions;
- Effects of large-amplitude waves on linear instabilities;
- Assessment on the feasibility of the *magnetic bubble* as a means of space propulsion.

12.2. TOTEM POLE EMISSIONS[1]

12.2.1. Introduction

Totem Pole emissions were first observed near the dayside magnetopause by the Geotail spacecraft in 1997[2]. They are electrostatic electron Bernstein waves whose characteristics are not fully explained by the standard model invoked for the generation of this type of wave activity. In particular, the occurrence of harmonic branches above the upper hybrid frequency and the fine spectral structure of the lower frequency emissions could not be interpreted in the context of the model adopted to study Bernstein waves in the magnetosphere.

12.2.2 . Approach and results

The classical paradigm associated with electron Bernstein emissions uses an admixture of cold and hot electron populations neutralized by a background of immobile ions, with the perpendicular velocity distribution of the hot species providing the free energy, and the emphasis placed on modes propagating slightly away from the perpendicular (with respect to the background magnetic field).

In a previous work[3], we adopted an alternative source of free energy to stimulate electron Bernstein waves: the almost monoenergetic ion (AMI) beams recently observed by the Interball 1 spacecraft. The success of this model led to its utilization in the context of the Totem Pole emissions, where it was demonstrated that AMI beams could generate electron Bernstein emissions both below and above the upper hybrid frequency (as observed by the Geotail spacecraft) and provided a simple means of accounting for the fine spectral structure found in the lower harmonic bands.

12.3. LARGE AMPLITUDE WAVES AND INSTABILITIES[4]

12.3.1. Introduction

The richness and variety of free energy sources in space plasma environments warrants the study of the influence of large amplitude waves (stimulated by a given free energy source) on the characteristics of instabilities (eventually fed by another free energy source).

12.3.2. Previous and present work

The study of the effect of large-amplitude circularly polarized waves on linear beam-plasma electromagnetic instabilities was followed by the investigation of electrostatic instabilities induced by large-amplitude left-hand polarized waves and the triggering of ion acoustic instabilities in the solar wind by finite amplitude waves.

12.4. MAGNETIC BUBBLE AND SPACE PROPULSION[5]

12.4.1. Introduction

In the year 2000, Winglee and collaborators proposed a new means of spacecraft propulsion[6]: tapping the energy of the solar wind with an (artificially created) 'magnetic bubble'.The basic objective of the so called Mini-Magnetospheric Plasma Propulsion system is to deflect the solar wind particles by a large magnetic bubble whose field lines are attached to the spacecraft; as the charged particles of the solar wind are reflected by the magnetic field, the force that they exert is transmitted along the field lines to the spacecraft to produce its acceleration.

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[1]This research line has been carried out in collaboration with Prof. Luis Gomberoff, Physics Department, University of Chile at Santiago and partially funded by FONDECYT (Chilean Institute).

[2] Matsumoto, H. and H.Usui, Intense bursts of electron cyclotron harmonic waves near the dayside magnetopause observed by Geotail, *Geophys. Res. Lett.*, *24*, 49, 1997.

[3] Brinca, A.L., F.J. Romeiras and L. Gomberoff, Stimulation of electron Bernstein modes by perpendicular ion beams, *Geophys. Res. Lett.*, *30*, 2175, doi: 10.1029/2003GL017501, 2003.

[4] This research line has been carried out in collaboration with the Physics Department of the University of Chile at Santiago and partially funded by FONDECYT (Chilean Institute).

[5] This research line was carried out by all the groups in the Centro de Física de Plasmas and was partially funded by ESA.

[6] Winglee, R.M., J. Slough, T. Ziemba and A. Goodson, Mini-magnetospheric plasma propulsion: Tapping the energy of the solar wind for spacecraft propulsion, *J. Geophys. Res.*, *105*, 21067, 2000.

The spacecraft to be propelled carries a current loop to generate a dipolar magnetic field and a plasma source. The success of the propulsion mechanism hinges on the magnitude of the force that, via the interaction of the solar wind with the created magnetic bubble, acts upon the spacecraft. Many complex phenomena influence the outcome of the interaction (for example, the characteristics of the plasma created by the spacecraft source); the investigation made a preliminary assessment of several of them.