Ion-cyclotron Resonant Heating in the Solar Wind

Roberto E. Navarro[1], Víctor Muñoz[2], Juan A. Valdivia[2], and Pablo S. Moya[2]

[1]*Departamento de Física, Facultad de Ciencias Físicas y Matemáticas, Universidad de Concepción, Chile*
[2]*Departamento de Física, Facultad de Ciencias, Universidad de Chile, Chile*

Abstract: Wave-particle interactions are believed to be one of the most important kinetic processes regulating the heating and acceleration of the Solar Wind plasma. A second order Fermi acceleration mechanism [1] has been proposed how heavy ions (as alpha particles He^{+2}) preferentially heated by multiple resonances with counter-propagating ion-cyclotron waves. In this work [2], we test this idea by calculating the number of plasma particles resonating with ion-cyclotron waves propagating parallel and anti-parallel to an ambient magnetic field in a proton/alpha plasma with cold electrons. Resonances are calculated through the proper kinetic multi-species dispersion relation of Alfvén waves. We show that 100% of the alpha population can resonate with counter-propagating waves below a given threshold $|\Delta U_{\alpha p}/v_A|<U_0+c(\beta_p+\beta_0)^b$ in the differential streaming between protons and He^{+2} ions, where the fitting parameters U_0, c, β_0, and b depend on the macroscopic parameters of the plasma. This threshold may explain the observed constraints for $\Delta U_{\alpha p}$ in the Solar Wind for low plasma beta (β_p) [3,4]. Finally, it is also shown that this process is limited by the growth of plasma kinetic instabilities, a constraint that could explain alpha-to-proton temperature ratio observations in the Solar Wind at 1 AU.

Acknowledgment: We thank the support of ANID, Chile, through FONDECyT grants No. 11180947 (R.E.N.), No. 1201967 (V. M.), No. 1190703 (J.A.V.), and No. 1191351 (P.S.M); CONICyT-PAI No. 79170095 (R.E.N.); and the BOF Network Fellowship NF/19/001 from KU Leuven (P.S.M.).

References: [1] P. A. Isenberg, Space Sci. Rev. **95**, 119 (2001); [2] R. E. Navarro *et al.*, Astrophys. J. Lett. **898**, L9 (2020); [3] S. Bourouaine *et al.,* Astrophys. J. Lett. **777**, L2 (2013); [4] J. C. Kasper *et al.,* Phys. Rev. Lett. **110**, 091102 (2013)

Session: Space Plasma Physics and Nonlinear processes in Space Geophysics

Oral or Poster: Oral