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Whistling waves in ion-electron and pair plasmas

Rony Keppens[1], Jordi De Jonghe[1],
[1] Centre for mathematical Plasma Astrophysics, KU Leuven, Belgium
e-mail (speaker): rony.keppens@kuleuven.be

As an application of our recent work [1] on a completely general two-fluid analysis of all waves in a warm ion-electron (or pair) plasma, we connect to the vast body of literature on whistler waves and the high-frequency approximation known as the Appleton-Hartree equation [2]. For whistler waves of both descending and ascending frequency behaviour, the usual approximate group speed expressions are extended to include ion contributions and deviations from propagation parallel to the background magnetic field. At oblique angles as well as at perpendicular propagation, their presence is investigated using exact numerical evaluations of the two-fluid dispersion relation under magnetosphere conditions. For pair plasmas in pulsar magnetospheres it is shown that various wavetypes feature whistling behaviour at oblique angles.

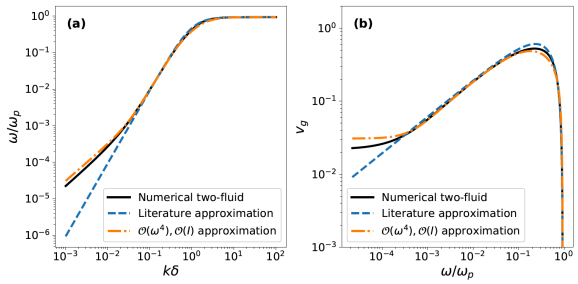

Figure 1: Comparison of the literature whistler approximation and our improved approximations to numerical evaluations of the full two-fluid dispersion relation for Earth's magnetosphere parameters at parallel propagation. (a) Whistler mode dispersion diagram showing frequency variation with wavenumber. (b) Whistler mode group speed showing group speed magnitude versus frequency.

References

[1] `A two-fluid analysis of waves in a warm ion-electron plasma', J. De Jonghe & R. Keppens, 2020, Physics of Plasmas **27**, 122107 (18pp) Full paper, doi:10.1063/5.0029534

[2] `Two-fluid treatment of whistling behaviour and the warm Appleton-Hartree extension', J. De Jonghe & R. Keppens, 2021, JGR: Space physics **126**, e2020JA028953 (24pp), Full paper, doi:10.1029/2020JA028953