TEMPERATURE-ANISOTROPY INSTABILITY THRESHOLDS IN THE SOLAR WIND

Michal Michno and Reinhard Schlickeiser
Institut für Theoretische Physik, Lehrstuhl IV: Weltraum- und Astrophysik
Ruhr-Universität Bochum, D-44780 Bochum, Germany

The explanation of the relaxation of cosmic collision-poor plasmas with velocity-anisotropic distribution functions (VADs) and their near energy density equipartition with electromagnetic plasma turbulence are two challenging fundamental problems of plasma astrophysics.

The occurrence of VADs is a well-established feature of the solar wind: Ten years of Wind spacecraft experiment data near 1 A.U. have demonstrated that the proton and electron temperature anisotropies \( \mathbf{A} = \mathbf{T}_p / \mathbf{T}_e \) are bounded by the mirror and firehose instabilities at large values of the parallel plasma beta \( \beta_p = \frac{8\pi n k_B}{B^2} > 1 \).

With marginal linear instability conditions (linear growth rate \( \gamma > 0 \)), it has been demonstrated that the confinement limits at small values of the parallel plasma beta \( \beta_p < 1 \) in principle can be provided by polarized parallel propagating Alfvén waves generated by bi-Maxwellian proton and electron distributions, although the confinement limits did not match the Wind spacecraft solar wind experiment observations particularly well.

Here, we improve the agreement of the Alfvénic confinement limits by properly accounting for the influence of damping processes connected with the collisional effects in the solar wind plasma. Although the plasma parameter of the fully ionized solar wind is small, collisional damping associated with Joule dissipation as well as electron and ion viscosity cannot be neglected. In contrast to earlier works, where the marginal instability condition \( \gamma > 0 \) has been used, we consider here the more appropriate condition that the growth rate has to be greater than all collisional damping rates \( \gamma > \gamma_{\text{damp}} \). This modification provides tighter threshold constrains in the low plasma beta regime.