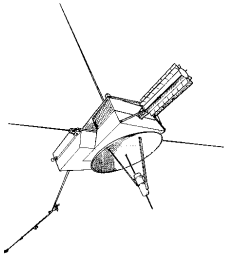
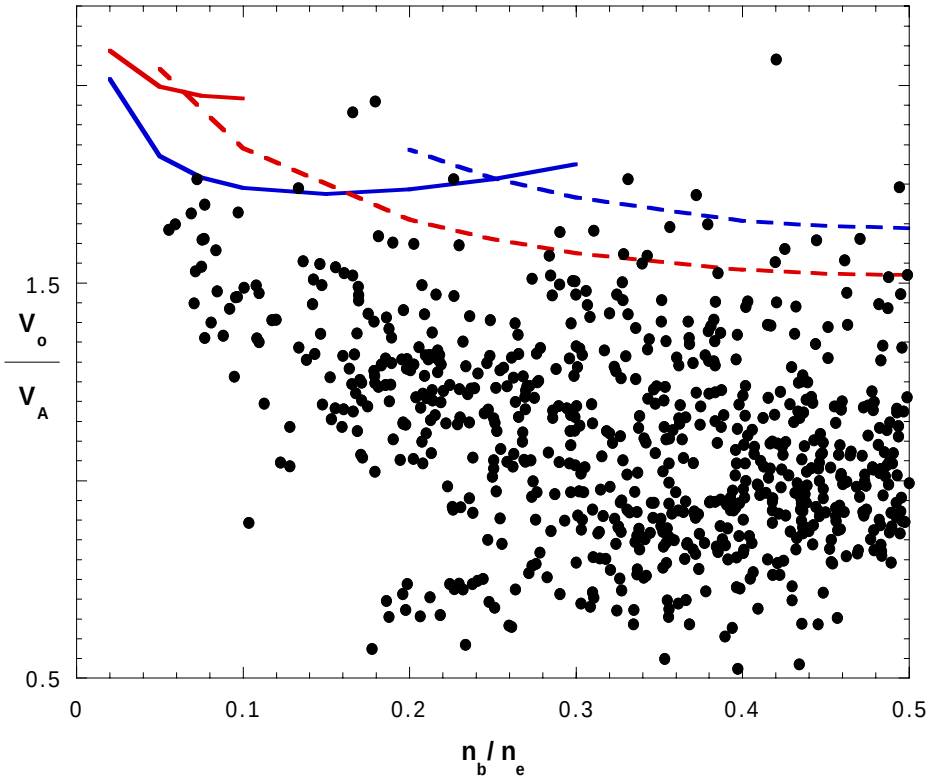
Speed Limit for Proton Beams in the Solar Wind





Dimensionless proton-proton relative drift speeds as measured by Ulysses/SWOOPS are represented as individual dots as a function of secondary beam density to total density. The four lines represent threshold conditions for two different proton-proton instabilities. The upper and lower solid lines represent the thresholds of the magnetosonic instability at parallel pressure to magnetic field pressure ratios of 0.2 and 1.0, respectively, whereas the upper and lower dashed lines display the thresholds of the Alfvén instability for values of this ratio at 1.0 and 0.2, respectively.

In the fast solar wind at high latitudes, two resolvable proton beams are typically present. Using Ulysses SWOOPS plasma data, statistical studies (Goldstein et al., GRL, 27, 53, 2000) of the magnetic field-aligned velocity difference of the beams, v_o, found that observed values of v_o/V_A, where V_A is the local Alfvén speed, are less than the upper bound determined from the linear theory for electro-magnetic proton-proton instabilities. This result is good evidence that these micro-instabilities constrain the relative streaming of the two components in the solar wind. This supports the idea that instability thresholds derived from linear theory offer a means by which collisionless transport coefficients may be derived.

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