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Fire hose instability driven by alpha particles in the solar wind

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We discuss the dynamics of fire hose parallel instability driven by anisotropic alpha particles in a plasma with typical solar wind composition ($n_\alpha = 5\% n_e$). We show, for the first time, the liner and nonlinear dynamics of the instability by means of hybrid numeric simulations, highlighting its dependence on the main plasma parameters, including the relative drift between the alphas and the main proton population. Our results confirm that the parallel fire hose instability can be efficiently excited by anisotropic distribution of the less abundant alpha particles, even when the rest of the plasma (electrons and protons) is Maxwellian. Moreover, our finding suggest that the dynamics driven by the alphas can also influence the properties of the protons. In particular the instability is found to significantly affect the evolution of the alpha-proton drift, constraining its final intensity to values smaller than the local Alfvén speed, as observed in the solar wind far from the Sun. When simulations with both species initially anisotropic are performed, we find a coexistence of the fire hose wave activity excited by both ions, leading to final stable configurations which reflect the marginal stability state of each species. As a consequence, when observed in the commonly used ($\beta_\parallel, T_\perp/T_\parallel$) plane, alpha particles and protons are seen to saturate in different regions of the parameter space. This property is in very good agreement with recent solar wind in situ observations and strongly suggests that those instabilities play a role in regulating the anisotropy solar wind ions.