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Sheared velocity flows as a source of pressure anisotropy in low collisionality plasmas

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Non-Maxwellian metaequilibrium states may exist in low-collisionality plasmas as evidenced by direct (particle distributions) and indirect (e.g., instabilities driven by pressure anisotropy) satellite and laboratory measurements. These are directly observed in the solar wind (e.g. [1]), in magnetospheric reconnection events [2], in magnetically confined plasmas [3] or in simulations of Vlasov turbulence [4]. By including the full pressure tensor dynamics in a fluid plasma model, we show that a sheared velocity field can provide an effective mechanism that makes an initial isotropic state anisotropic. We discuss how the propagation of "magneto-elastic" waves can affect the pressure tensor anisotropization and the small scale formation that arise from the interplay between the gyrotropic terms due to the magnetic field and flow vorticity, and the non-gyropropic effect of the flow strain tensor. We support this analysis by a numerical integration of the nonlinear equations describing the pressure tensor evolution. This anisotropization mechanism might provide a good candidate for the understanding of the observed correlation between the presence of a sheared velocity flow and the signature of pressure anisotropies which are not yet explained within the standard models based e.g. on the CGL paradigm (see also [5]). Examples of these signatures are provided by the threshold lowering of ion-Weibel instabilities in the geomagnetic tail, observed in concomitance to the presence of a velocity shear in the near-earth plasma profile [6], or by the relatively stronger anisotropization measured for core protons in the fast solar wind [4,7] or in “space simulation” laboratory plasma experiments [3].

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