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Transient growth and bypass transition in a Landau fluid plasma

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We study the linear and nonlinear stability of a collisionless bi-Maxwellian plasma in an homogeneous magnetic field, with a so-called Landau fluid (LF) model. LF includes linear Landau damping and finite Larmor radius corrections. We show that, even for a linearly stable plasma, small perturbations can undergo a transient growth, being amplified by large factors, before decaying. This is due to the non-normality of the linear operator, so that the its eigenvectors are not mutually orthogonal.
The non-normality of a collisionless plasma is intrinsically related to its kinetic nature, with the transient growth being more accentuated for smaller scales and higher plasma beta. A transition from the stable to the unstable region might be possible for a system that contains some free energy, available for instance in an anisotropic plasma. In this scenario, the amplification of small disturbances in a stable plasma could trigger nonlinear effects, which might provide a positive feedback to the transient growth, leading the system to an unstable condition. Hence, a bypass transition effect could effectively lower the threshold of marginal linear stability, which is believed to constrain the development of a large temperature anisotropy, in the solar wind.
We study the possibility of a bypass transition with a nonlinear LF code.