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Universally Unstable Nature of Velocity Ring Distributions[1]

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Although it is typically believed that an ion ring velocity distribution has a stability threshold, we find that they are universally unstable. This can substantially impact the understanding of dynamics in both laboratory and space plasmas. A high ring density neutralizes the stabilizing effect of ion Landau damping in a warm plasma and the ring is unstable to the generation of waves below the lower hybrid frequency- even for a very high temperature plasma. For ring densities lower than the background plasma density there is a slow instability with growth rate less than the background ion cyclotron frequency and consequently the background ion response is magnetized. This is in addition to the widely discussed fast instability where the wave growth rate exceeds the background ion cyclotron frequency and hence the background ions are effectively unmagnetized. Thus, even a low density ring is unstable to waves around the lower hybrid frequency range for any ring speed. This implies that effectively there is no velocity threshold for a sufficiently cold ring. The importance of these conclusions on the nonlinear evolution of space plasmas, in particular to solar wind-comet interaction, post-magnetospheric storm conditions, and chemical release experiments in the ionosphere will be discussed.

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