Electron-Positron Plasma Turbulence Driven by Pressure Gradients

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The stability and turbulence properties of pair plasmas are of significant consequence in many, disparate physical systems. Fluctuations may appear in laser-induced or magnetically confined pair plasmas, and electron-positron plasma turbulence may affect the radiation signature of objects such as Gamma Ray Bursts (GRBs).

Here, the focus lies on electron-positron plasmas in a strong, homogeneous magnetic guide field, subject to a background density or temperature gradient. It is shown that this setup allows the $E\times B$ and $\nabla B_\parallel$ drifts to couple, causing instability. This process is referred to as the Gradient-driven Drift Coupling (GDC) mode [1], which is also able to drive turbulence in helium plasma experiments [2].

Unlike standard fluid models, which do not include a succinct description of the $\nabla B_\parallel$ drift, a new fluid model is presented that recovers gyrokinetic analytical and numerical mode properties. Furthermore, nonlinear gyrokinetic simulation results are shown, demonstrating that the GDC instability may indeed drive quasi-stationary turbulence in pair plasmas.

Consequences are discussed for specific physical systems: in addition to GRBs, the focus lies on high-density, laser-induced pair plasma experiments [3] – assuming the addition, presently under discussion, of a magnetic guide field – and low-density, zero-shear magnetic-confinement experiments [4].

References

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