Revealing turbulent Dark Matter via merging of self-Gravitating condensates

Contributed Talk

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Self-gravitating condensates, modelled using the Gross-Pitaevskii-Poisson equation, have been proposed as potential dark matter candidates. We numerically investigate the dynamics of dark matter by studying the merging of self-gravitating condensates to identify distinct turbulent regimes based on the merging speed of the condensates. As a result of the collision, we observe the appearance of various dark-soliton-mediated instabilities, which ultimately lead to a turbulent state characterized by Kolmogorov-like turbulence scaling $\varepsilon^{i}_{kin} \sim k^{-5/3}$ in the infrared region and $\varepsilon^{i}_{kin} \sim k^{-3}$ in the ultraviolet region. The turbulent fluctuations in the condensate diminish as the vortices formed via soliton decay are expelled to the the periphery of the condensate. This process manifests as the transfer of kinetic energy from incompressible and compressible flows to the quantum pressure energy. We also highlight the significant role played by the self-gravitating trap in determining the distribution of compressible kinetic energy and the resulting density waves, which differ significantly from those observed in atomic condensates under harmonic confinement. Our study may provide valuable insights into the merging of binary stars and open new avenues for understanding the structure and dynamics of dark matter through self-gravitating condensate.

References

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