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DM GHOSts: Anomalous low-mass structures induced by the supersonic relative velocity between dark matter and baryons

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A supersonic relative velocity between dark matter (DM) and baryons–the stream velocity–at the time of recombination induces the formation of low-mass objects with anomalous properties in the early universe. We investigate objects we term Dark Matter + Gas Halos Offset by Streaming (DM GHOSts)–diffuse, DM-enriched structures formed because of a physical offset between the centers of mass of DM and baryonic overdensities. We present an updated numerical investigation of DM GHOSts and Supersonically Induced Gas Objects (SIGOs), including the effects of molecular cooling, using high-resolution hydrodynamic simulations run with the AREPO code. We find that the stream velocity causes deviations from sphericity in both the gas and dark matter components and lends greater rotational support to the gas. Further, low-mass objects demonstrate core-like rotation and mass profiles. Anomalies in the rotation and morphology of DM GHOSts could represent an early universe analog to observed ultra-faint dwarf galaxies with variations in DM content and unusual rotation curves.

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