DARK MATTER

Waves from the early Universe

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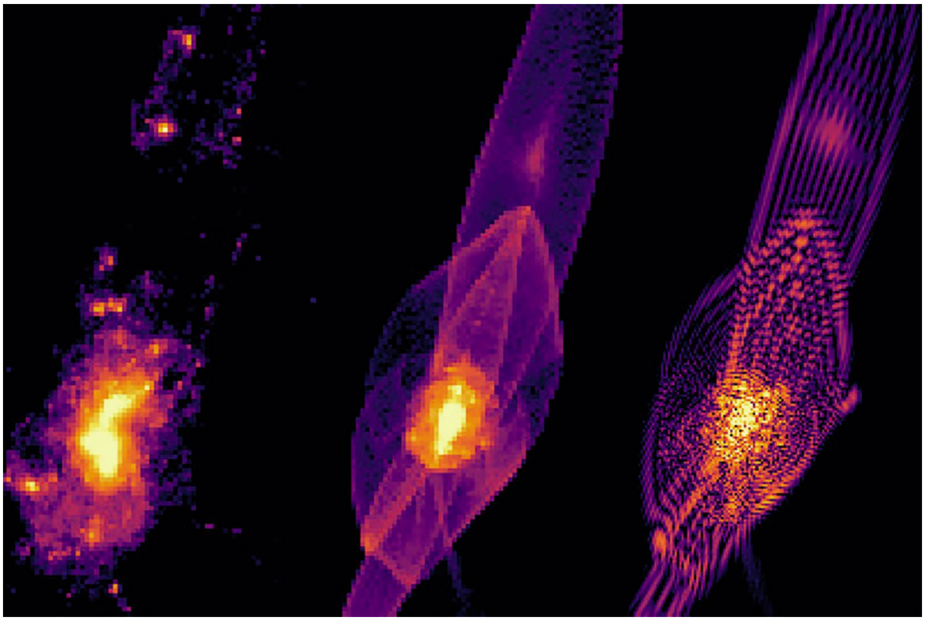

Credit: image courtesy of Philip Mocz

The standard model of cosmology is based on cold dark matter (CDM) — a gas of non-baryonic particles that attract ordinary matter through gravity to shape the Universe. It successfully describes the clumpy distribution of galaxies as well as the smoothness of the cosmic microwave background on large scales. But the model continues to be challenged, partly because no dark matter has been detected. What if dark matter isn't cold but warm and fermionic (WDM), or an ultralight superfluid of bosons with wave-like properties, such as 'fuzzy dark matter' (FDM)? Philip Mocz and co-workers look back to the early Universe to discriminate between cold, warm and fuzzy dark matter models.

The authors use the AREPO magnetohydrodynamic code to simulate the formation of galaxies with CDM, WDM and FDM. The large-scale structure with CDM shows the dark matter fragmenting into spherical subhaloes, whereas WDM and FDM both show filamentary structure. Slicing through these features reveals the uniqueness of the different dark matter structures (pictured from left to right: CDM, WDM and FDM). WDM has caustic shapes. FDM shows strong interference patterns due to wave superposition. And upon zooming in below the de Broglie wavelength, FDM filaments uniquely exhibit a soliton core. The collected gas has the same profile as the soliton cores, so that the dark matter profile is imprinted in the distributions of gas and stars. The James Webb Space Telescope should be able to detect such star-forming filaments in order to validate, or rule out, these more exotic forms of dark matter.

May Chiao

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