

## **Subjecting theories of dark matter to the cluster test**

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Galaxy clusters, such as the “cosmic train wreck” Abell 520 and the well relaxed, nearly spherical cluster Abell 1689, provide stringent tests for various theories of dark matter. Non-Newtonian gravities like MOND (MODified Newtonian Dynamics), EG (Emergent Gravity),  $f(R)$  theories and MOG (MODified Gravity) are seen to fail, unless additional massive neutrinos or axions are assumed. Primordial Black Holes and light axions appear to be under severe stress. New constraints appear for particle dark matter such as WIMPs, thermal axions and thermal neutrinos. The NFW profile does not perform well, but the isothermal profile can take its place. Thermal axions are possible. However, the best option remains thermal neutrinos with a mass of 1.85 eV and having a Dirac nature, that is, having also right handed “sterile” partners. The case will be tested later this year in the KATRIN experiment.