LCDM, Modified Gravity or new Dark Matter models?

Q&A Session

Tuesday 30th May 2017

Regarding the Baryonic Tully-Fisher:

1. is the slope exactly 4 as the MOND proponents say
2. are there any observed systems which violate the relation?

Galaxy simulations of collision-less CDM with baryonic feedback have pointed out that the formation of cores inside haloes requires substantial late-time star formation, and that a galaxy may form and then destroy a core and recontract to a cuspy profile [e.g. FIRE (1502.02036), NIHAO (1507.03590)].

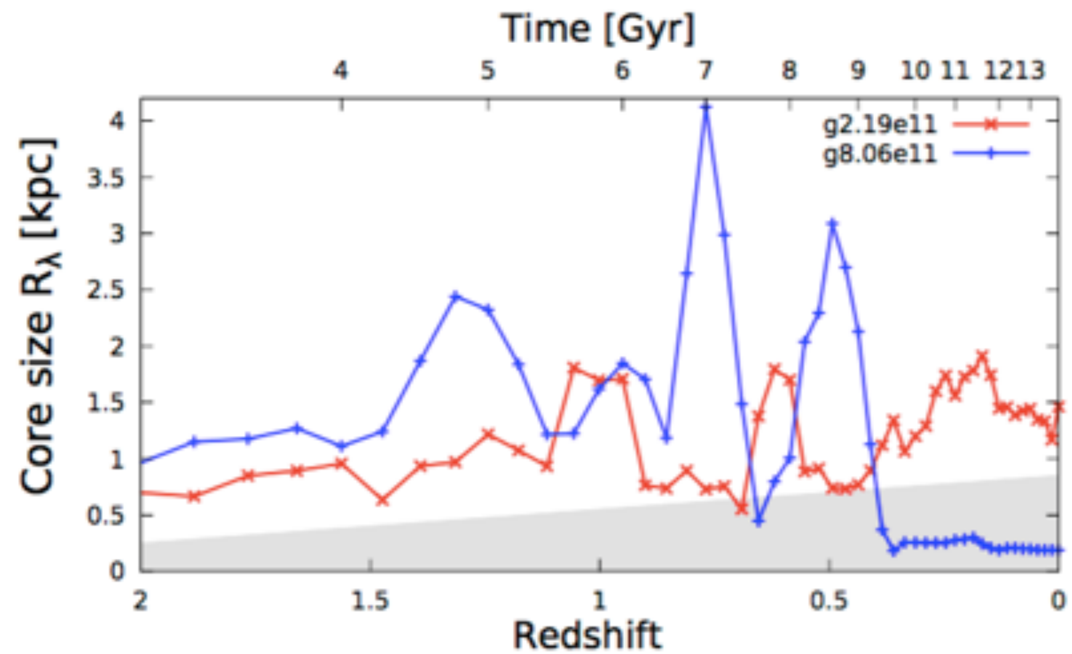

Figure 9. Core size R_λ as a function of time $1/(1+z)$ for g2.19e11 (red) and g8.06e11 (blue). The grey shaded region corresponds to the resolution limit of the simulations.

NIHAO (1507.03590)

1. Does this imply a statistical prediction of what portion of galaxies should exhibit cores and what portion should exhibit cusps (and would this depend on the redshift)? Can such a prediction be used to check or rule out the hypothesis that baryonic feedback alone is sufficient to explain away the cores-vs-cusps and too-big-to-fail issues?
2. Is the situation different for self-interacting dark matter? That is, if dark matter is sufficiently self-interacting, do galaxies form and retain their cores independently of their star-formation history?

The recent paper Calmet & Kuntz (1702.03832) states that a very large class of theories of modified gravity is equivalent to General Relativity with one or more extra particles, and that therefore "it is impossible to differentiate experimentally between these theories".

> gravitational degrees of freedom or matter fields. This leads to an equivalence between dark matter particles gravitationally coupled to the standard model fields and modified gravity theories designed to account for the dark matter phenomenon. Due to this ambiguity, it is impossible to differentiate experimentally between these theories and any attempt of doing so should be classified as a mere interpretation of the same phenomenon.

1. Is the claim solid?
2. What are, if any, the modified gravity theories that evade this equivalence?
3. I'm confused by the statement about Dark Matter, cause it does not seem to me that the correct abundance of the particle is a consequence of the equivalence. Or am I missing something?
4. Independently of 3., could one use the equivalence of the paper as a tool to derive a cosmology of modified gravity theories, and e.g. to obtain CMB predictions in such theories?

Is it possible to devise a theoretical dark matter component (perhaps fluid dark matter) which does not provide dynamical frictions? That is, any e.g. satellite galaxy moving through such a hypothetical fluid should experience little dynamical friction.

But if possible, would such a model be consistent with structure formation? In the current main-stream model, structure formation is largely if not nearly exclusively driven by dynamical friction and dissipation of energy through the expansive particle dark matter halos.

Can the concepts of dark matter and dark energy be experimentally falsified?