

DARK MATTER

ASTR 333/433

SPRING 2018

T R 4:00-5:15PM

SEARS 552

<http://astroweb.case.edu/ssm/ASTR333/>

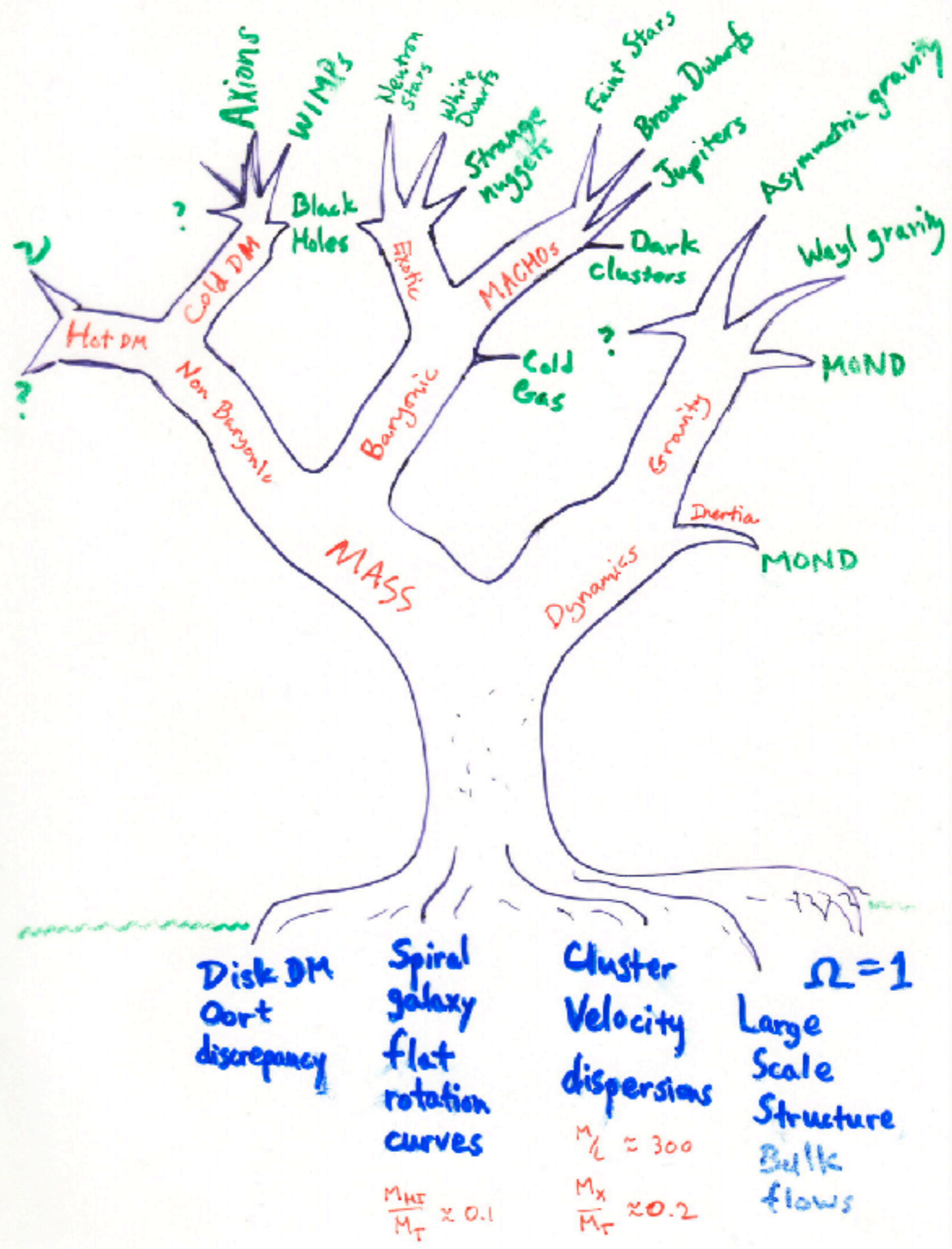
Shakespearean Insults

*He takes false shadows
for true substances.*

—Titus Andronicus



Thursday
January 14



Lots of particle candidates for CDM:

WIMPs

Axions

Light dark matter

wimpzillas

etc.

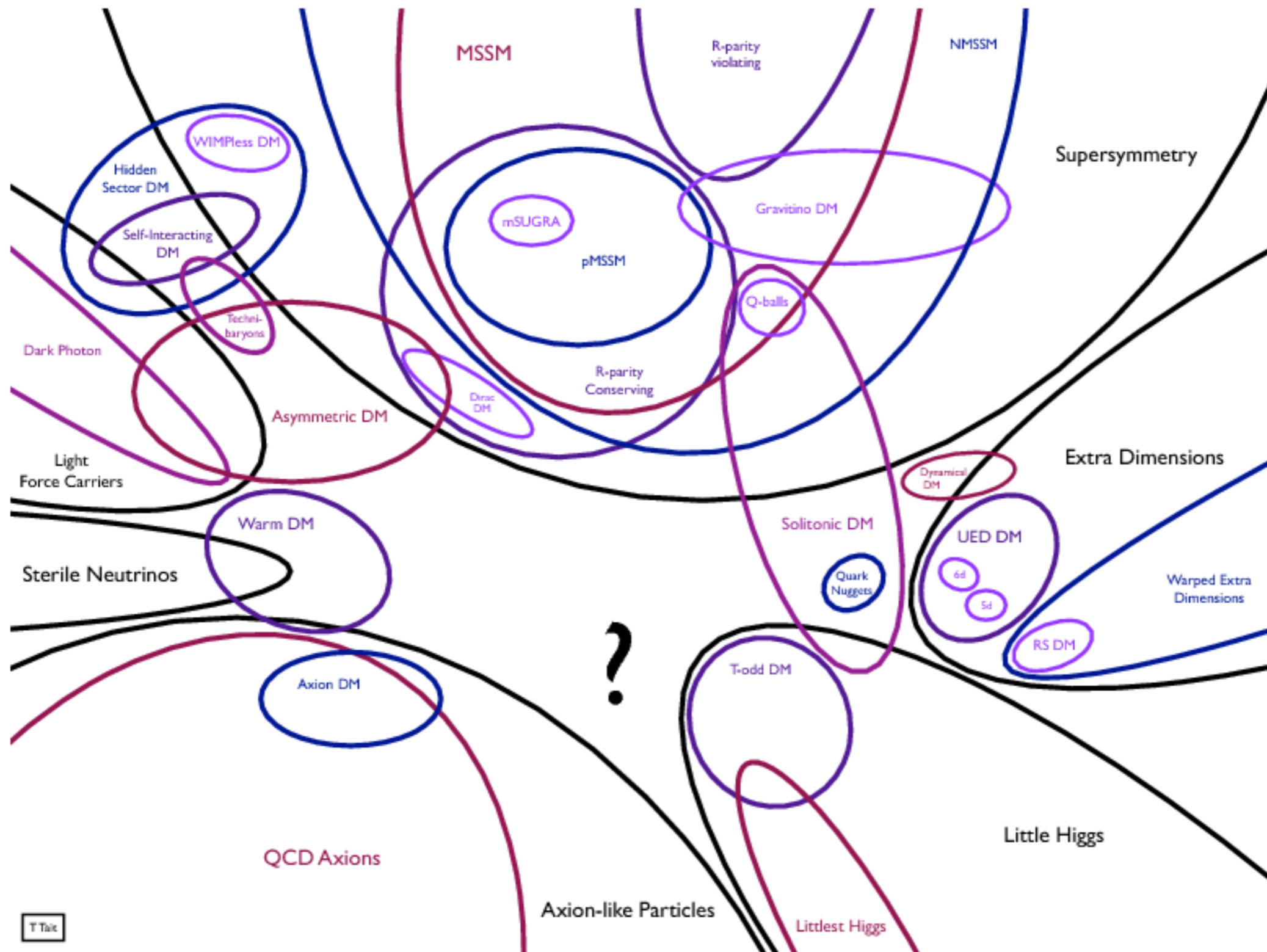
Can imagine other candidates as well:

Warm DM

Self-interacting DM

etc.

All of these ideas require a new “dark sector” beyond the known physics of the Standard Model. Some require complex dark sectors, with new forces as well as new particles (i.e., new forces of nature that only interact in the dark sector, e.g., dark E&M mediated by dark photons.)



“Graphical representation of the (incomplete) landscape of candidates.” (arXiv:1310.8642)

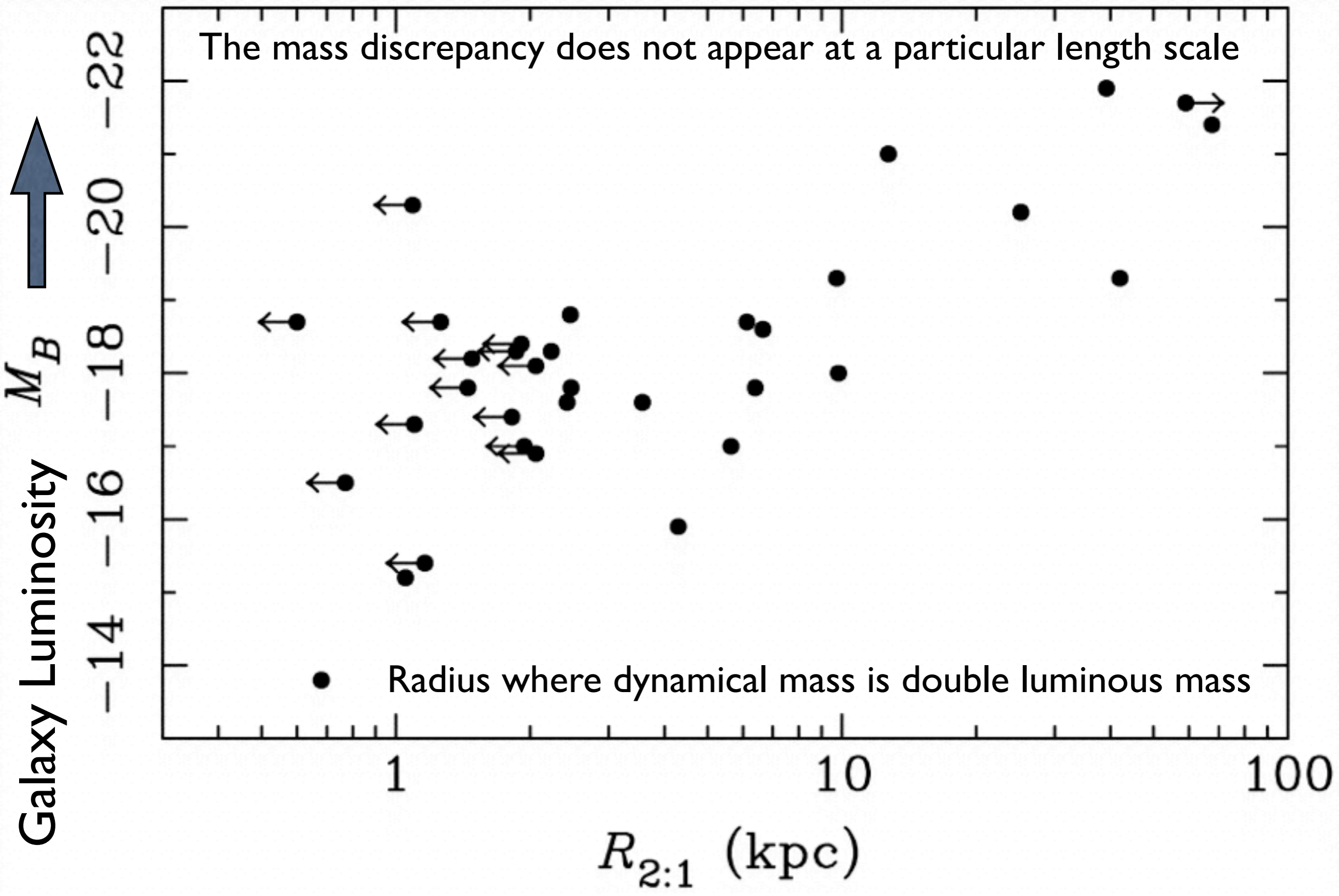
Motivations for non-baryonic Dark Matter:

- 1) total mass outweighs normal mass from BBN
- 2) needed to grow cosmic structure

(1) and (2) hold only when gravity is normal.

Leaves room to consider modifications of dynamical laws (e.g., gravity or inertia) as alternatives to dark matter.

Can exclude length-scale based modifications



Potentially viable modified dynamical theories

MOND (Modified Newtonian Dynamics) [Milgrom]

can be interpreted as either a modification of gravity or of inertia

modification at a critical acceleration scale

$$a_0 \sim 10^{-10} \text{ m/s/s}$$

Conformal Weyl Gravity [Mannheim]

4th order extension of General Relativity

Others? MOG? Emergent Gravity? Others?

Not easy to build a theory that is consistent

with all known facts