AST 1420

Galactic Structure and Dynamics

Q&A

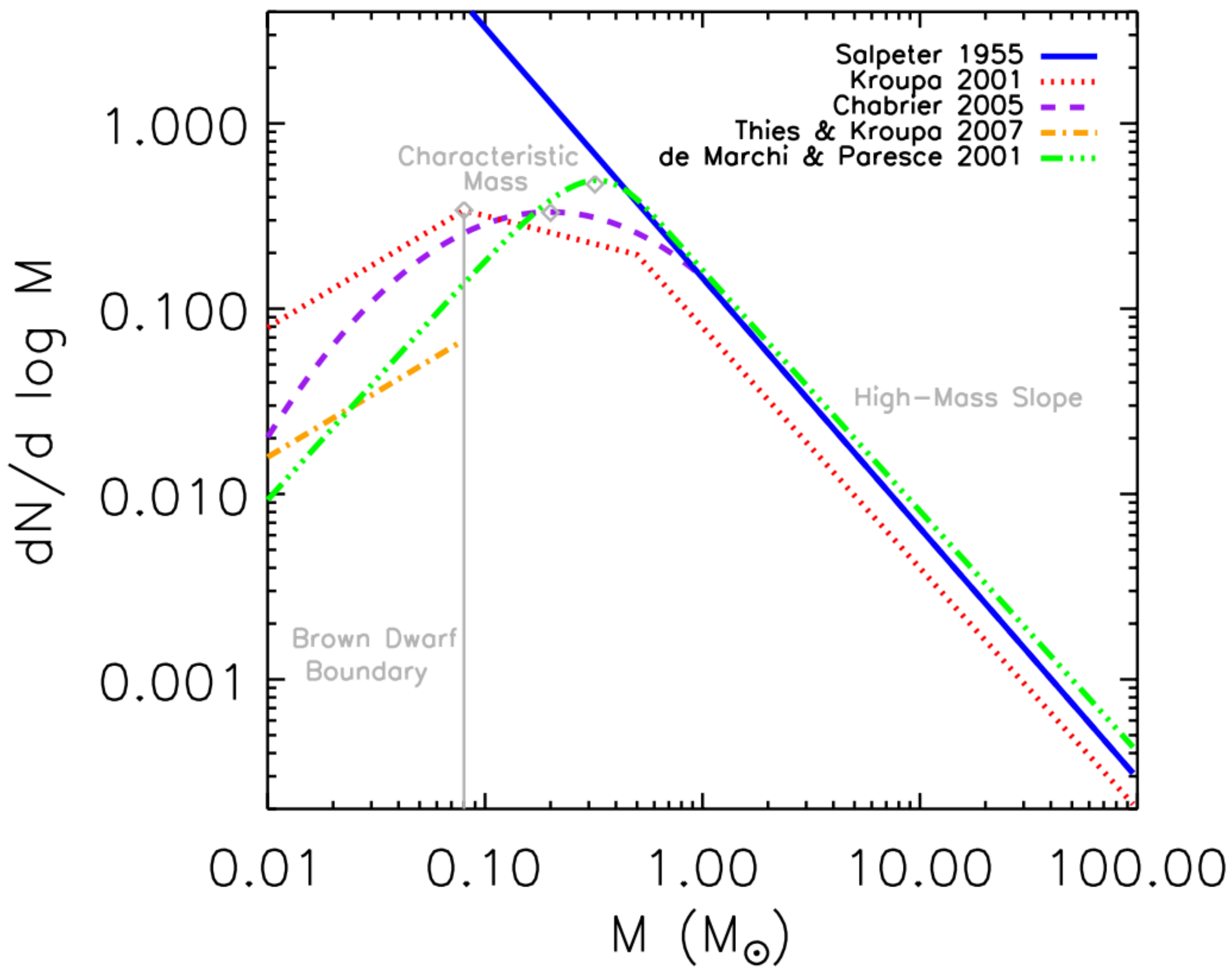
Questions submitted

- IMF and mass-to-light ratios:
  - How is the IMF determined observationally?
  - Do simulations predict the IMF?
  - How is the mass-to-light ratio computed?
- The definition of a galaxy:
  - What is the difference between a small galaxy like Fornax and a globular cluster?
- (next week):
  - AGN
  - How exactly is the scale length and scale height defined?

The IMF and mass-to-light ratios

How is the IMF determined observationally?

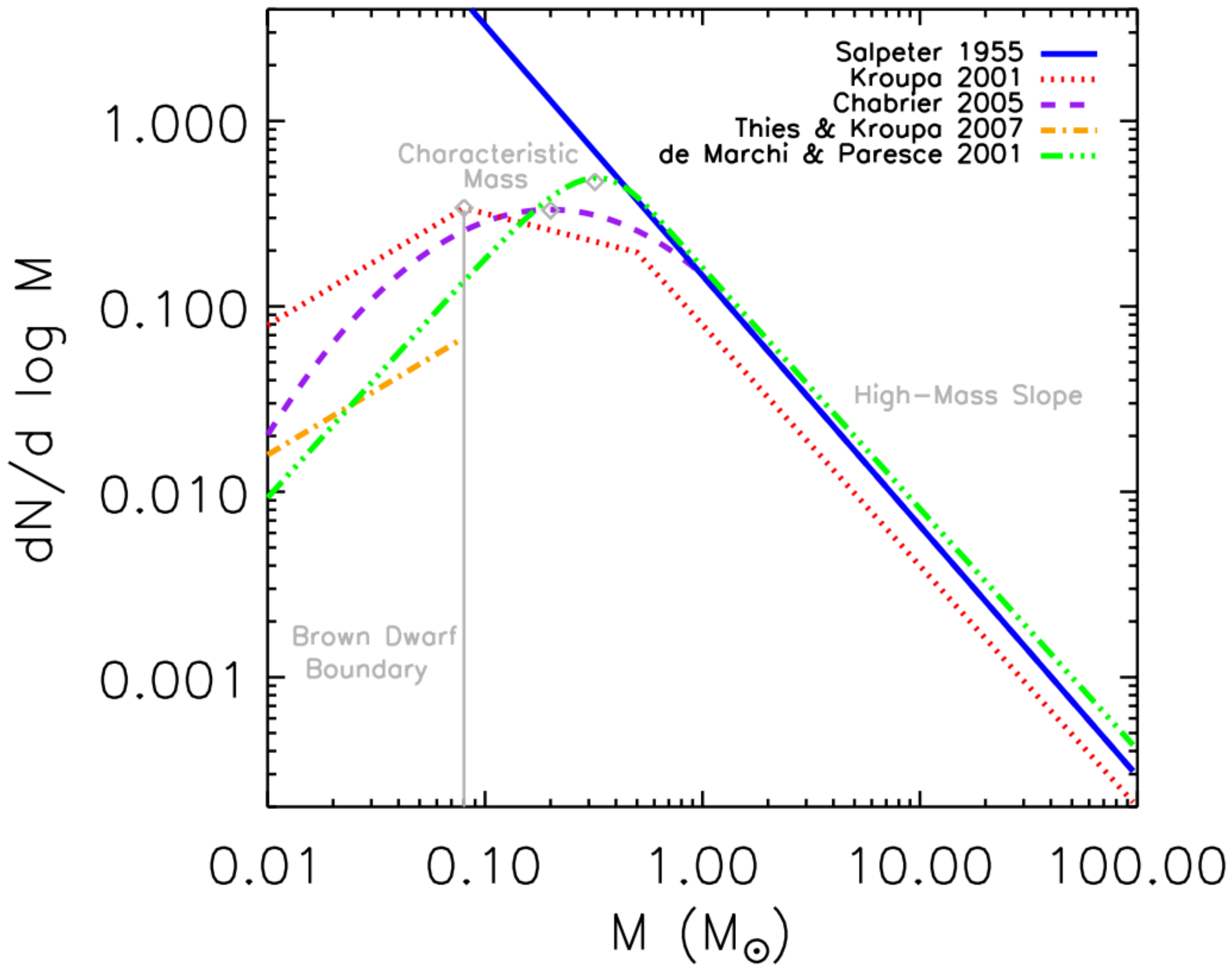
- Issue is that we can only see the "present-day mass function" (PDMF)
- Two regimes:
    - High mass: PDMF =/= IMF because stars explode or die otherwise
        - Issue down to about M ~ 0.8 Msun
    - Low-mass: PDMF == IMF
        - But stars so faint that hard to see them at great distances



Offner et al. (2014)

How is the IMF determined observationally?

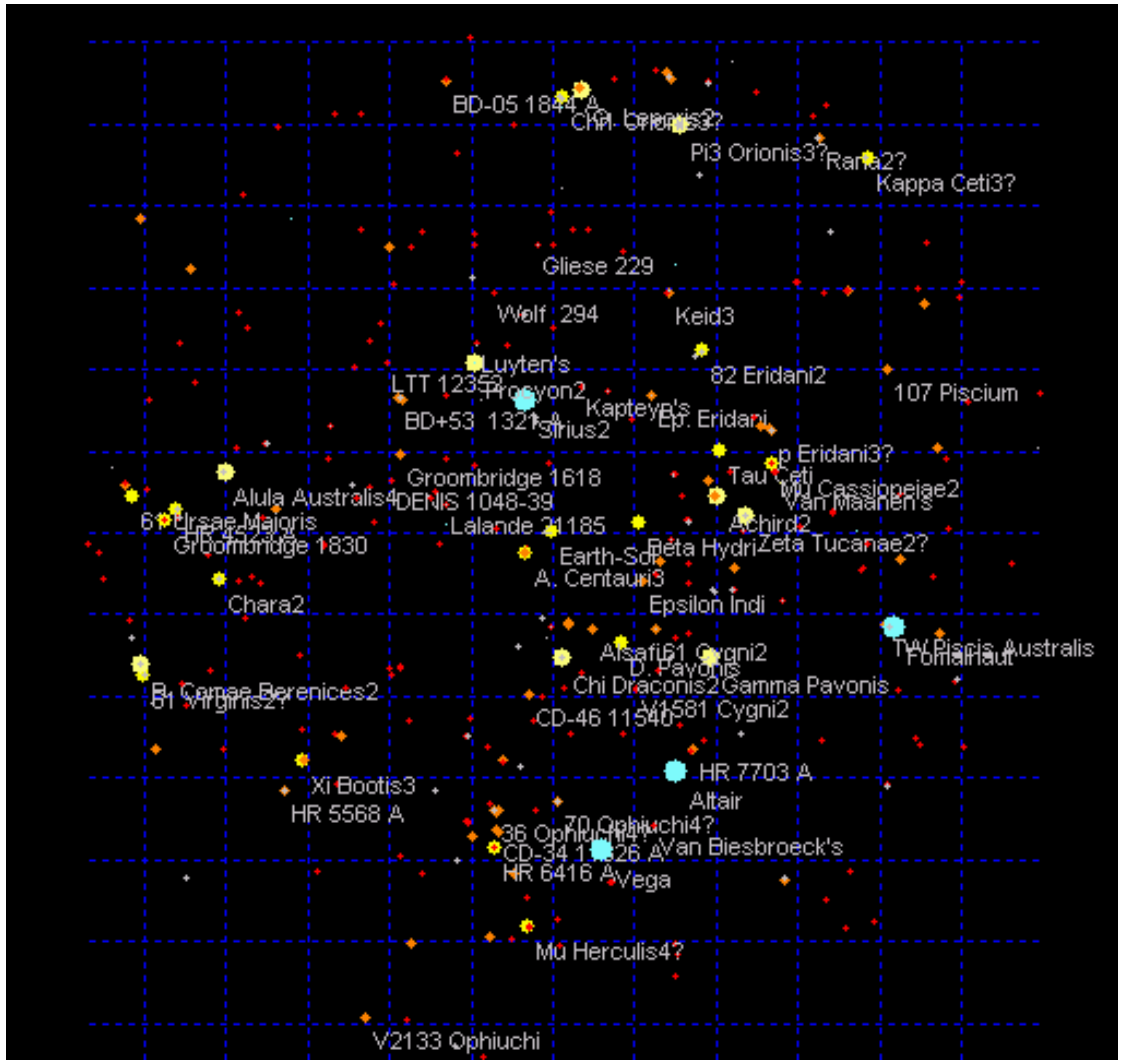
- High mass:
  - Essentially no robust way to correct the PDMF to the IMF when they differ significantly
  - Therefore, need to look at stars for which PDMF ~ IMF
  - Young clusters (how young? how long do the most massive stars live?)
  - Massive stars are bright, so can be done at great distance (e.g., M31)



Offner et al. (2014)

How is the IMF determined observationally?

- Low mass:
  - Use volume-complete samples near the Sun, typically have been 10s of pc
  - Radius out to which the volume is complete sets the minimum luminosity of stars that we can see
  - Low-mass stars brighter in the IR, so best done in NIR



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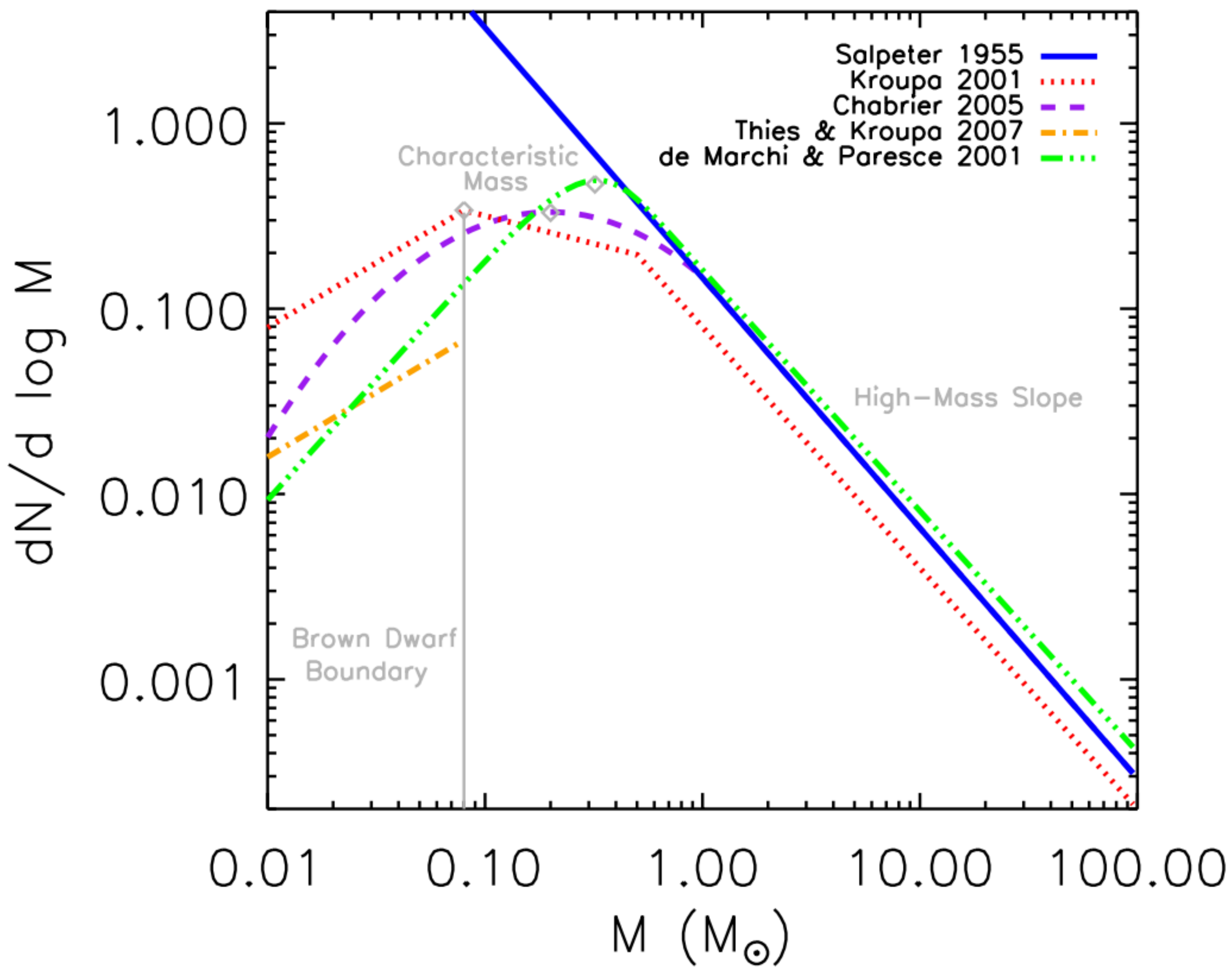
How is the IMF determined observationally?

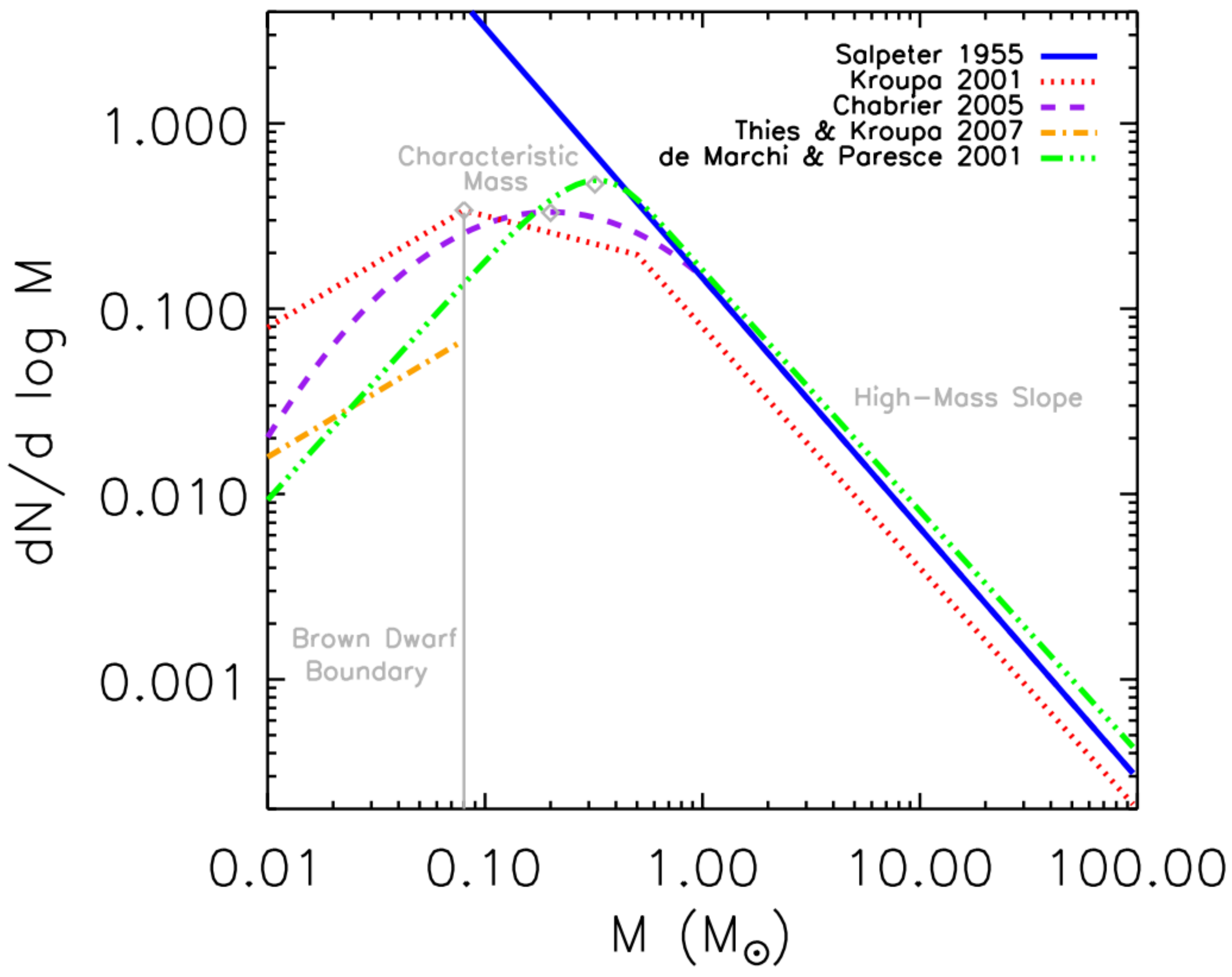
- Observationally, measure the luminosity function most directly
- Need a relation between luminosity and mass to convert this to a mass function
- Those are determined and calibrated using binaries



Offner et al. (2014)

Do simulations predict the IMF?

- Short answer is *no*
- Simulations of gas fragmentation can determine distribution of cores and regions that likely form stars (actual full collapse and emergence of a star cannot be simulated)
- This core distribution is similar to the IMF



Offner et al. (2014)

How is the mass-to-light ratio computed?

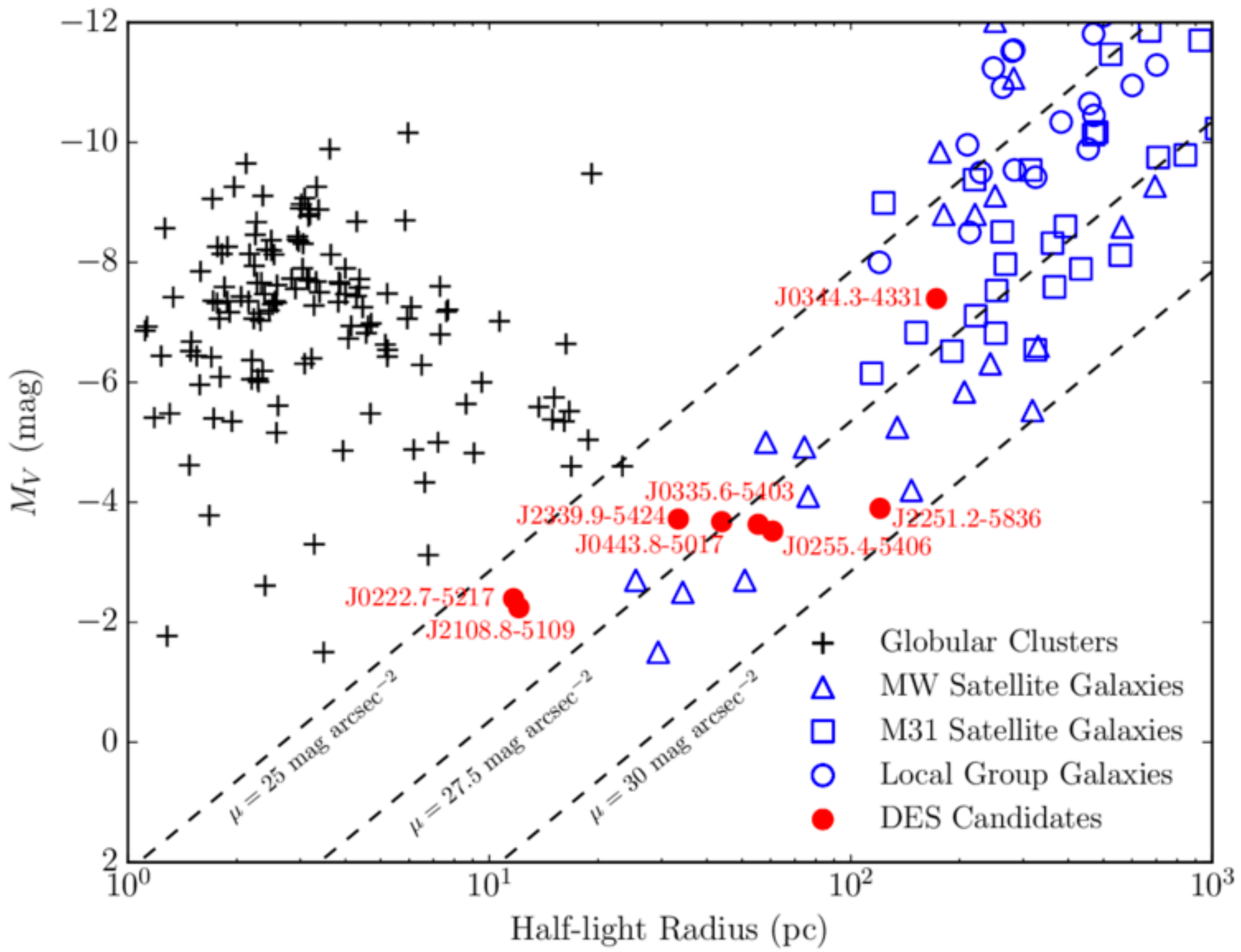
- Typical values are a few (3 is a good number to keep in mind), but it depends on the bad
- Basic calculation assumes a L(M) function and a mass function dN/dM, can then compute
    - total L = int dM L(M) dN/dM
    - total mass = int dM M dN/dM
    - M / L = the ratio between these
- Exercise: Assume L ~ $M^{3.5}$ and use the Kroupa IMF to compute these
- Typically we need the M/L for L measured in a given band, L(M) is then more complicated and best given by stelar models
    - Blue band: L more dominated by rare, high-mass stars —> M/L higher
    - Redder (or NIR) band: L more dominated by lower mass stars —> M/L lower
    - NIR bands best trace stellar mass

The definition of a galaxy

How is a galaxy defined?

A thorny problem!

- For large galaxies, it's pretty obvious what a galaxy is, but at the lower-mass end it becomes ambiguous
- Especially for ultra-faint galaxies, which can have luminosities of just a few 1000 solar luminosities, galaxies and star clusters start to become very similar
- Star clusters and faint galaxies start to overlap in their structural properties

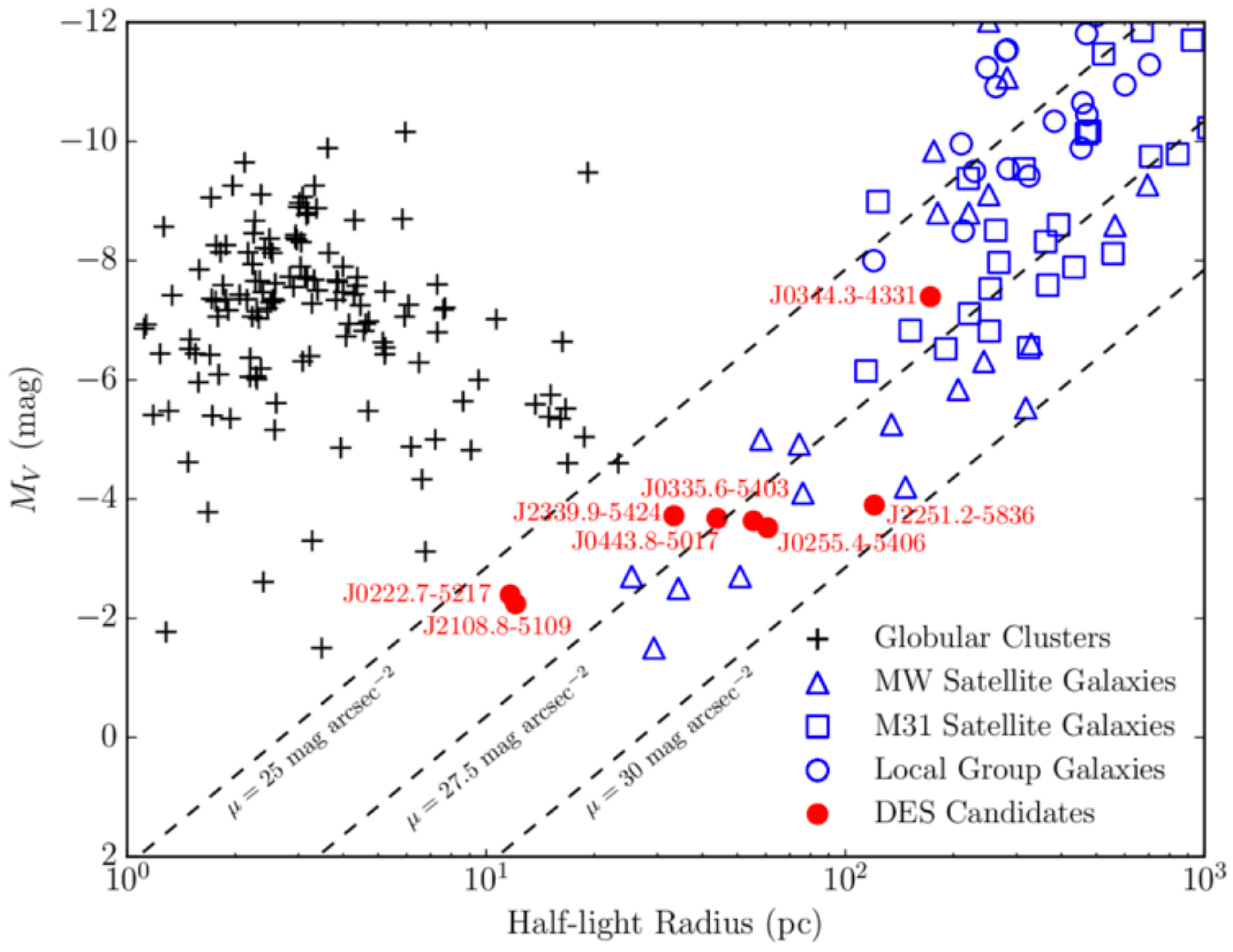


Bechtol et al. (2015)

How is a galaxy defined?

A thorny problem!

- Different definitions have been proposed:
    - Crucial thing about galaxies is that they form in dark-matter halos, while clusters do not have DM halos
      —> galaxy is something that has a DM halo
    - Galaxies have non-trivial chemical evolution, which results in a spread in abundances, while star clusters have been observed to be very close to chemically homogeneous
      —> galaxy is something with a spread in [Fe/H]
    - For clusters, “collisions” between individual stars are important, while these are unimportant for galaxies (see next weeks)
      —> galaxy is something whose dynamics satisfies the collisionless Boltzman equation (see later)
- No great one-size-fits-all answer when it comes down to it



Bechtol et al. (2015)