Effects of baryon removal on the structure of dwarf spheroidals

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dwarf galaxies

- Clusters: $M_{tot} \sim 10^{14} M_\odot$
- Galaxies: $M_{tot} \sim 10^{12} M_\odot$
- Dwarf galaxies: $M_{tot} \lesssim 10^{10} M_\odot$
  - dwarf irregular (dIrr)
    - LMC, SMC
  - dwarf spheroidal (dSph)
    - Draco, Fornax
  - dwarf elliptical (dE)
    - M32

small dSphs

- Simulations Predict:
  - Many dwarf galaxies as satellites/sub-halos
- Observations:
  - Only 8 classical dSphs

- Fix with:
  - Reionization, stellar feedback, some are dark (no stars), observational incompleteness (ultra faints)

large dSphs

- Expectations:
  - All should be observed
  - Reionization/Feedback unimportant

- New simulation predictions:
  - ~8 dSphs with $V_{max} > 30$ km/s
- MW has none

reconciling simulations

- Cosmological *N*-body simulations
  - Baryons are included in particles
  - Milky Way has no disk

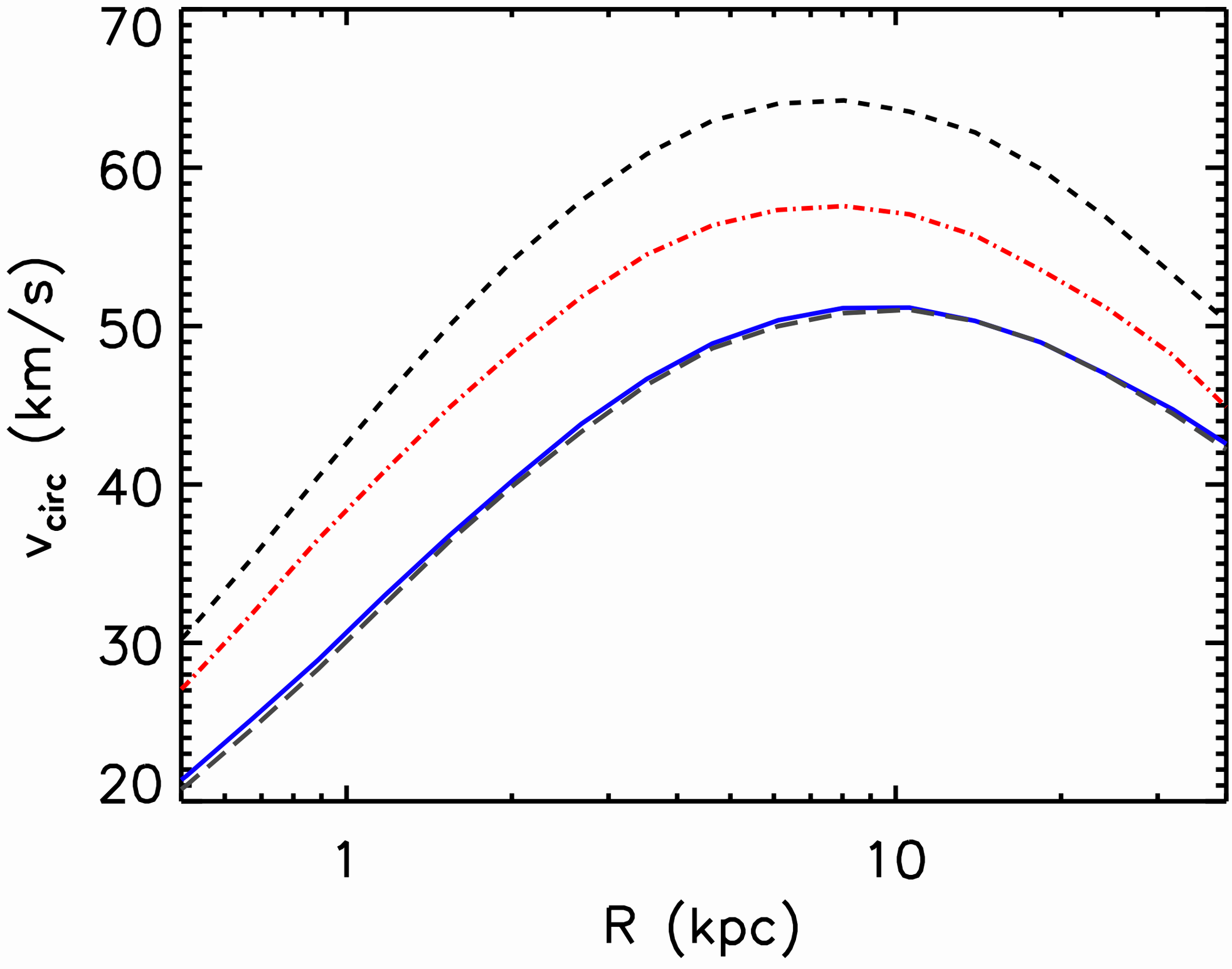
- Our *N*-body simulations
  - Baryon fraction removed
  - Add disk mass to MW
  - ***Cumulative effect!***

our simulations

- 4 different dSph galaxies
  - Same total mass ($M \sim 3x10^{10}\,M_{\odot}$)
  - Different circular velocity/density profiles

- Test baryons removal methods

baryon removal

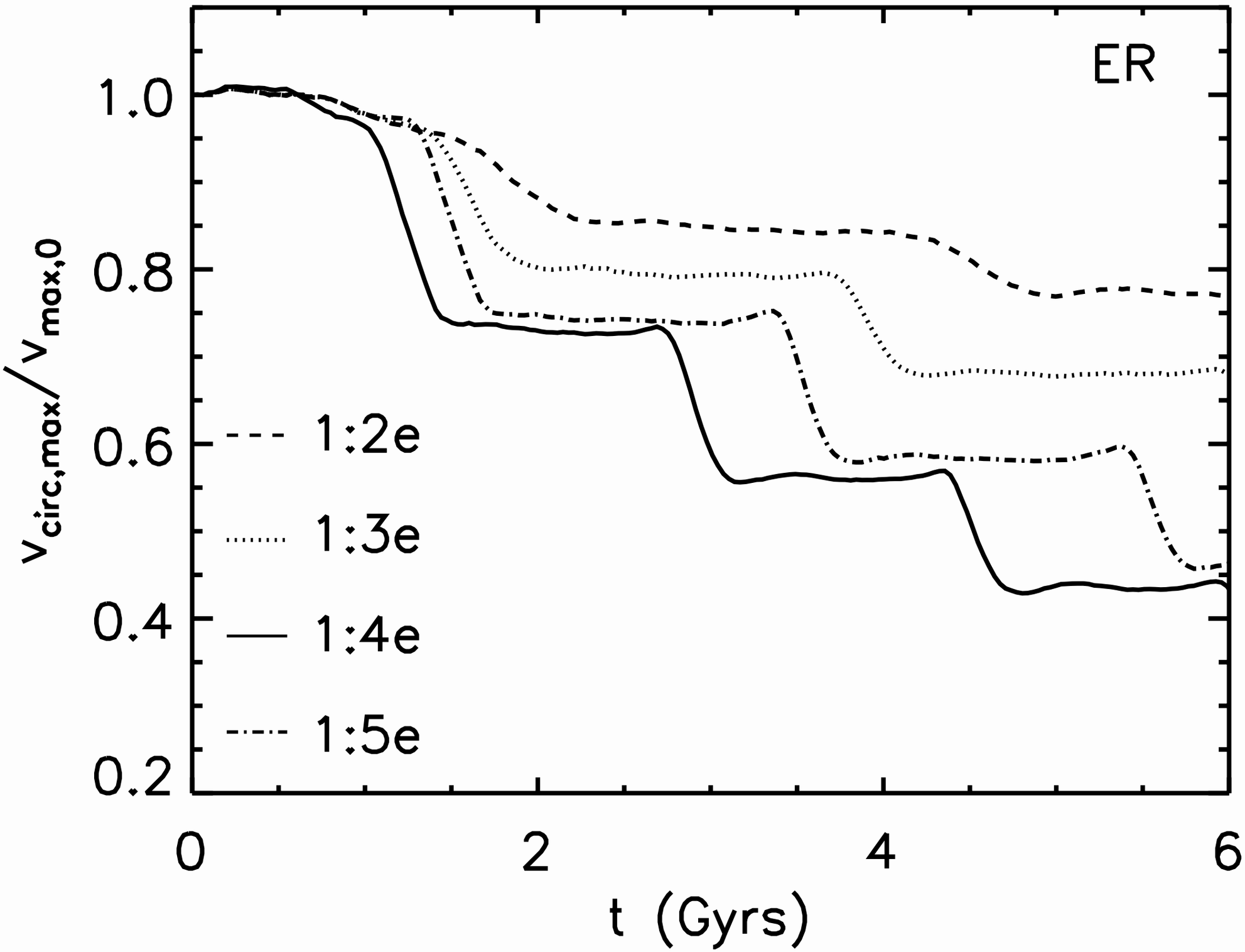


our simulations

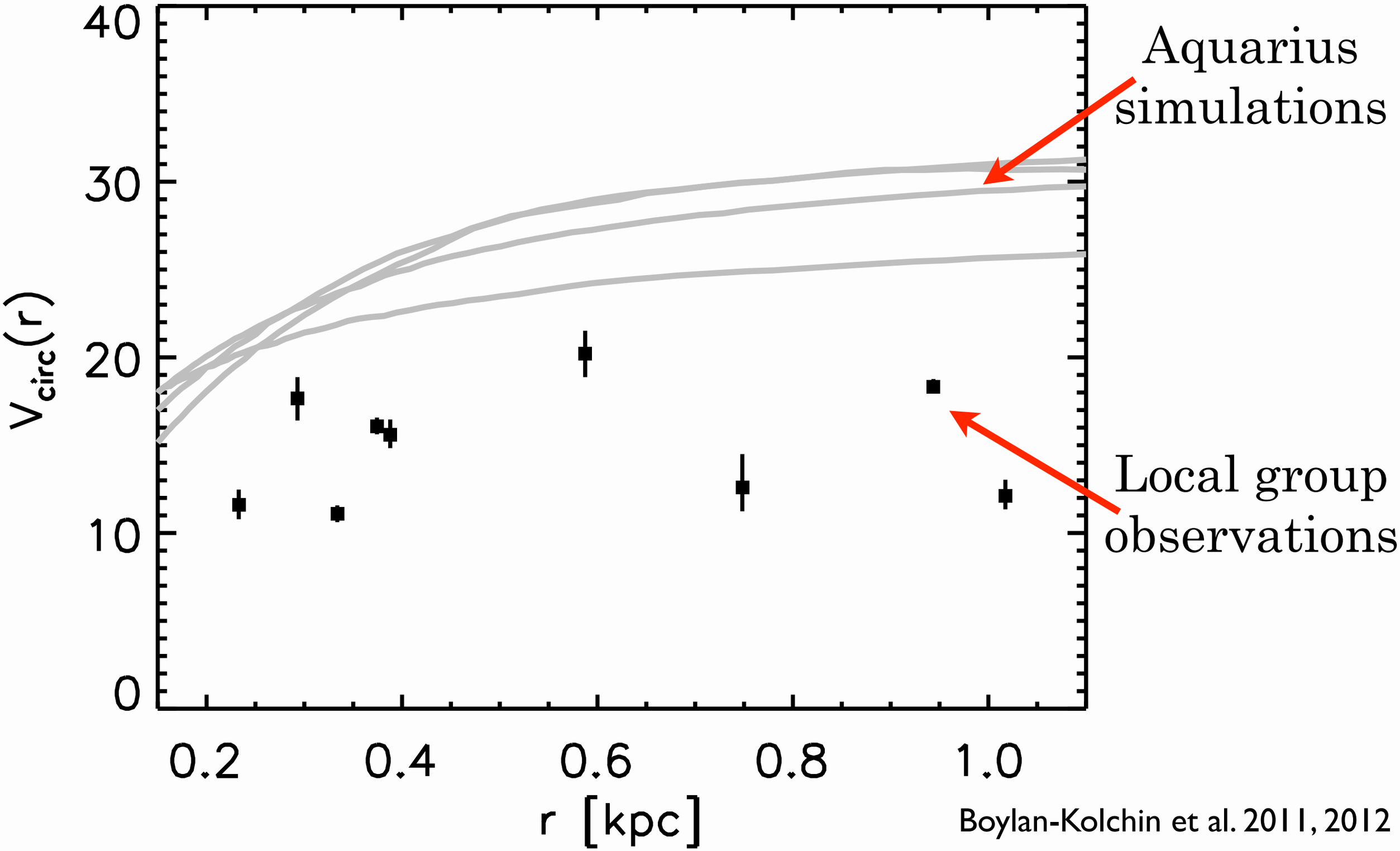
- Run on 8 orbits
  - 4 circular: 150kpc, 100kpc, 70kpc, 50kpc
  - 4 elliptical: 150→70kpc, 150→50kpc, 150→30kpc, 120→30kpc

- Test different orbits
  - around a Milky Way sized galaxy with a disk

evolution



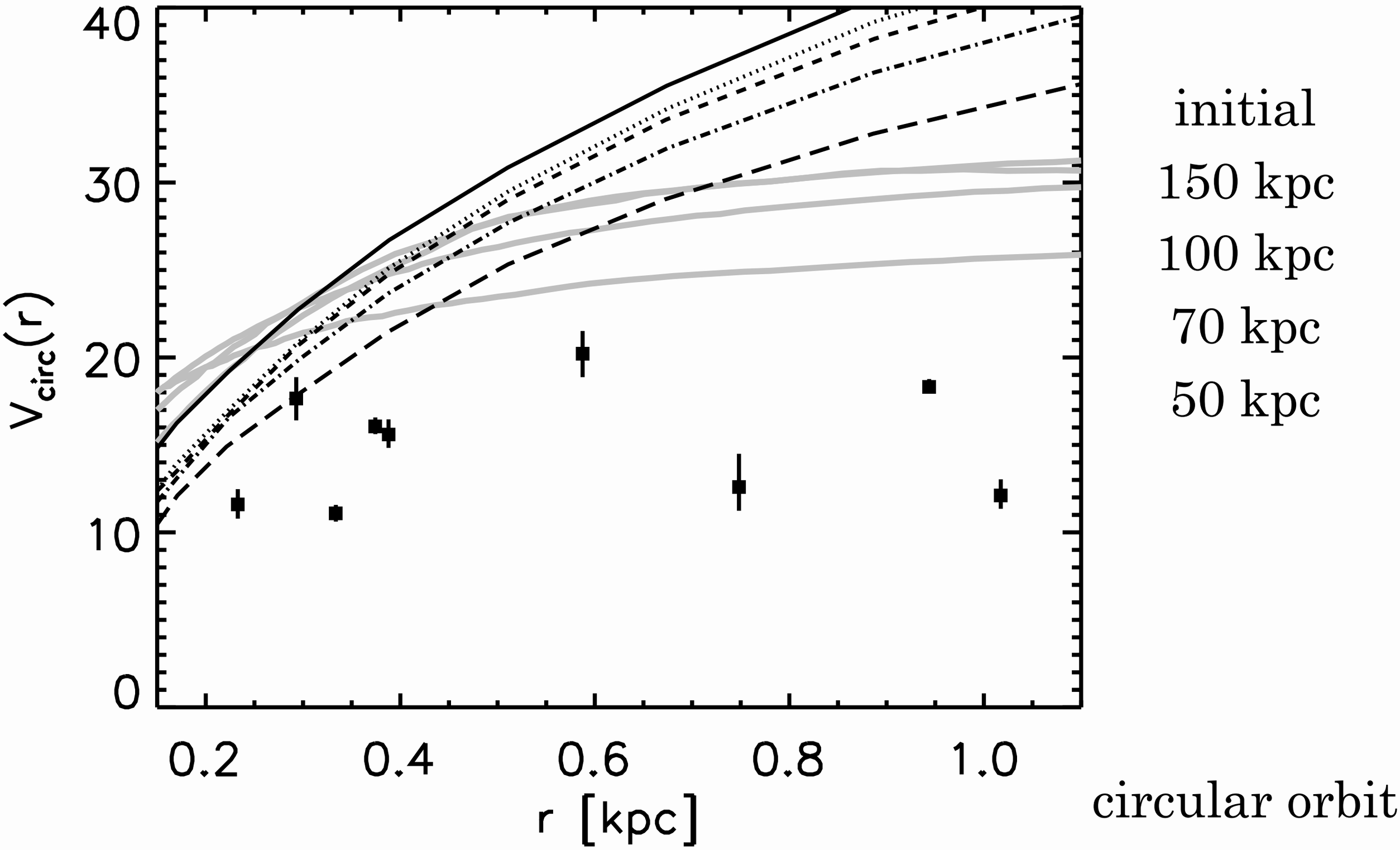
results



Boylan-Kolchin et al. 2011, 2012

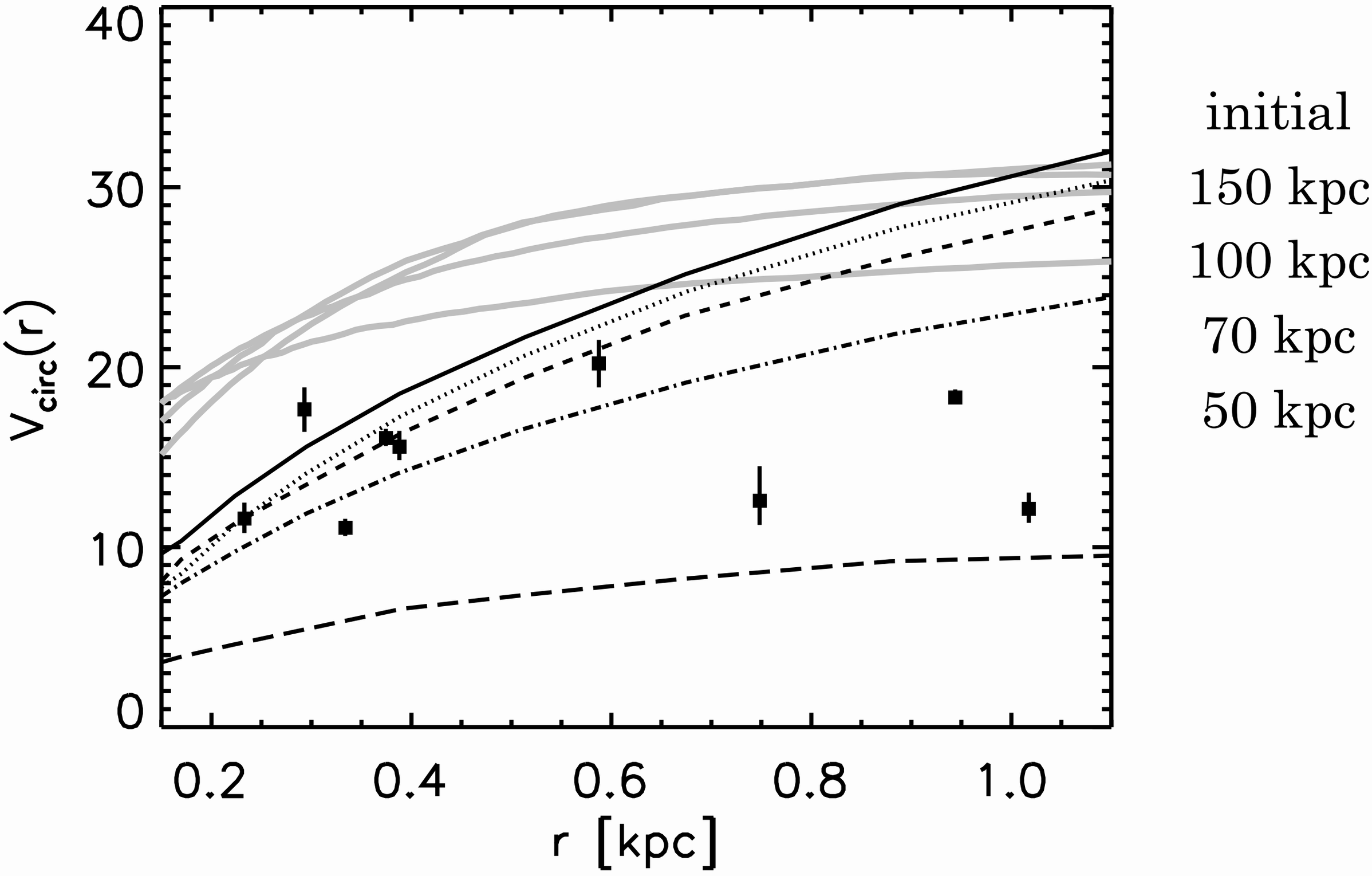
results

No baryon removal
No disk



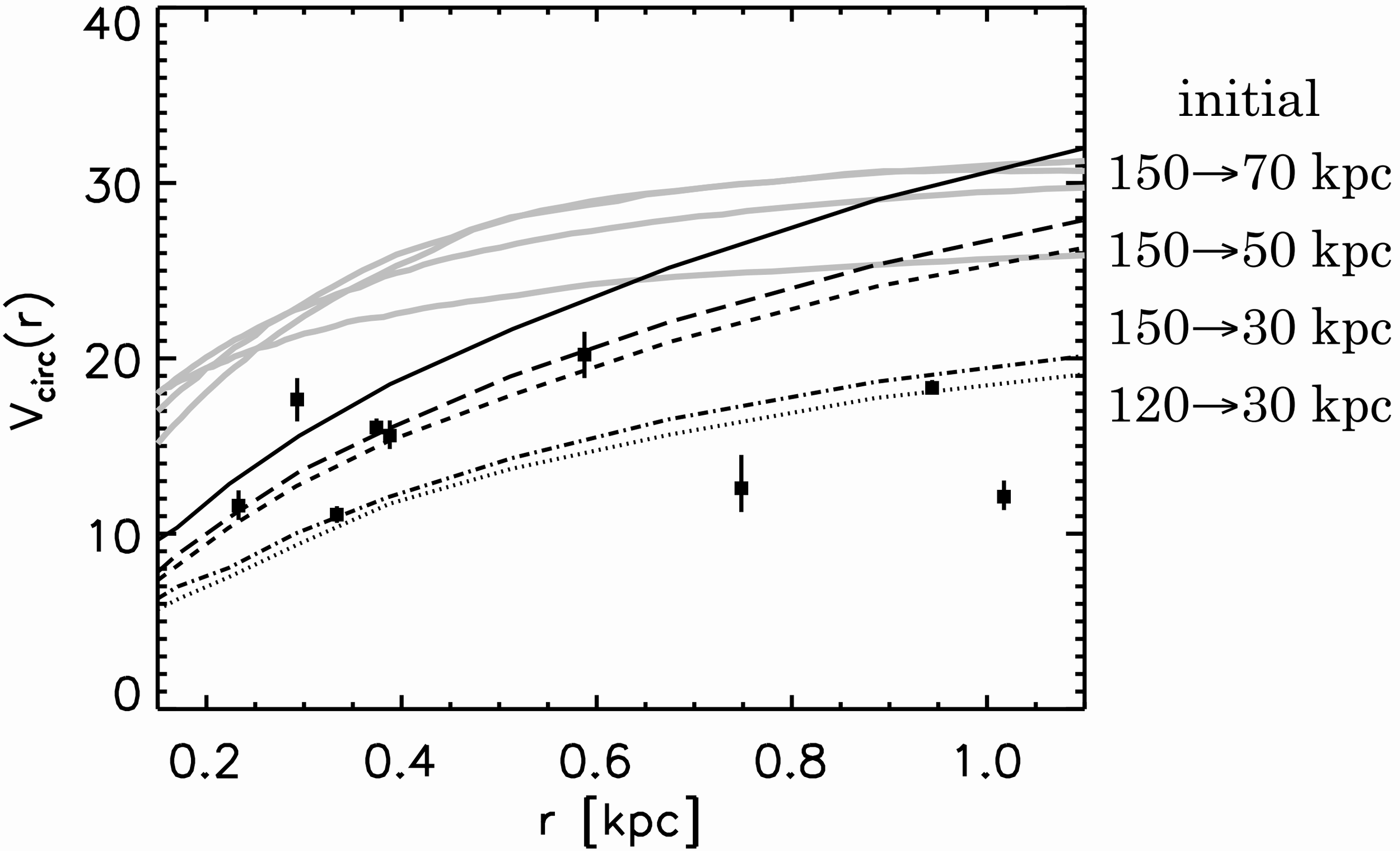
results

Baryon removal
Disk
circular orbit



results

Baryon removal
Disk
elliptical orbit



conclusions

- Recent simulations find ~8 dwarf galaxies too dense and massive to match *any* observed LG dwarfs
- Cosmological simulations do not account for baryonic physics (dissipation, collisions)

- Combining *baryon removal* and a *MW disk* brings a very massive satellite into agreement with LG dwarfs

- Sensitive to the way baryons are removed and the satellite's orbit