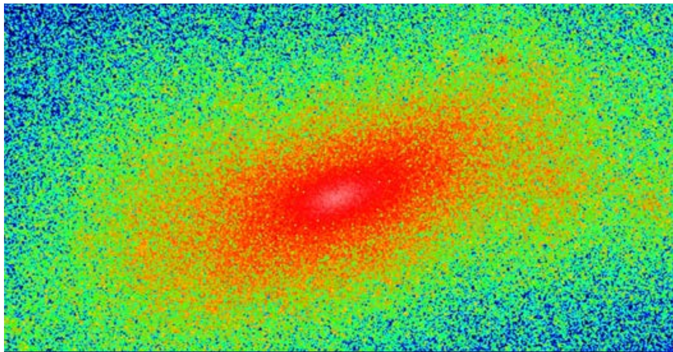
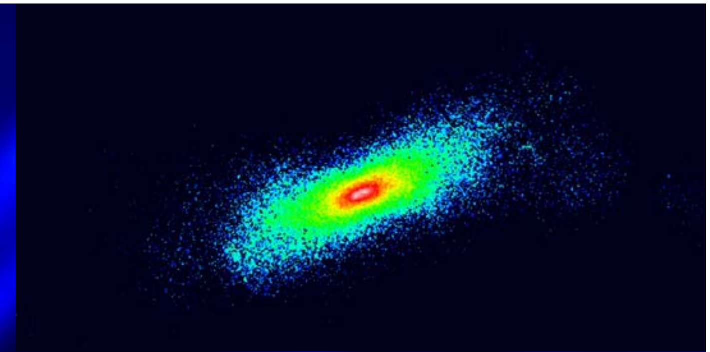
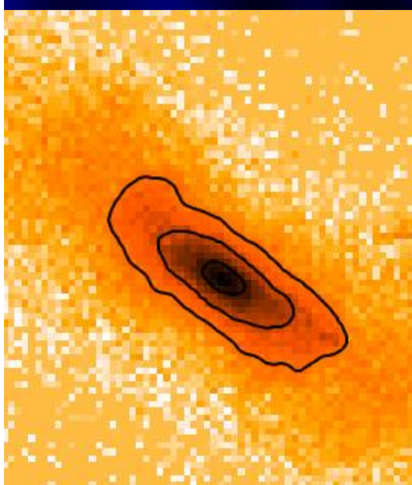
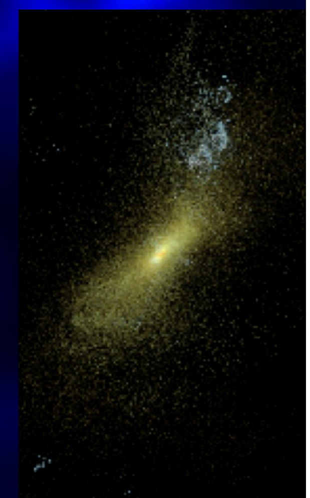




The Rise and Fall of Elongated Galaxies



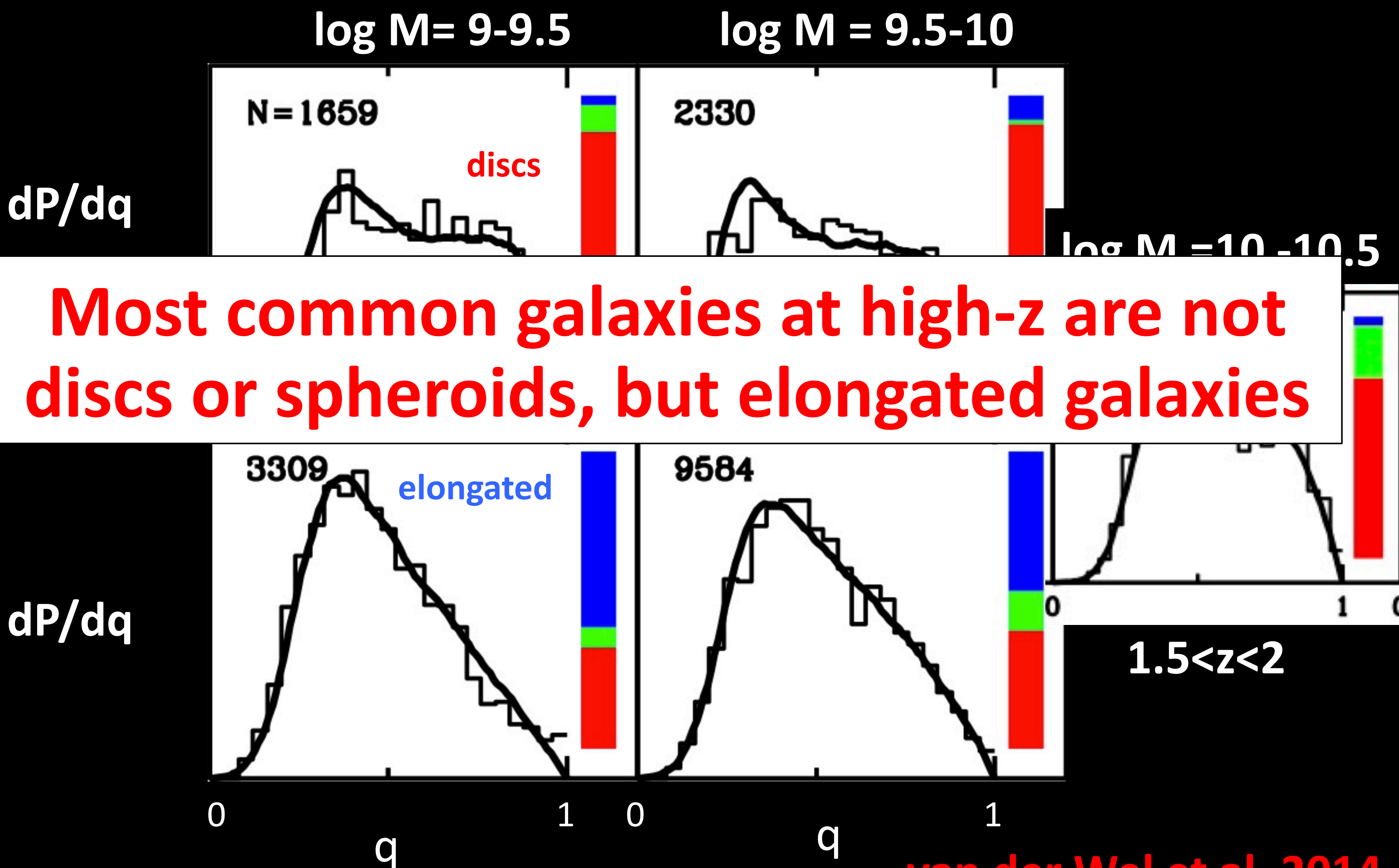


Daniel Ceverino (UAM, Madrid)

Joel Primack (UCSC); Miguel Rocha (UCSC)
Anatoly Klypin, (NMSU); Avishai Dekel (HUJI); Nir Mandelker (HUJI);
Dylan Tweed (SJTU); Greg Snyder (STScI)

Santa Cruz, 2014

Distribution of projected axis ratio

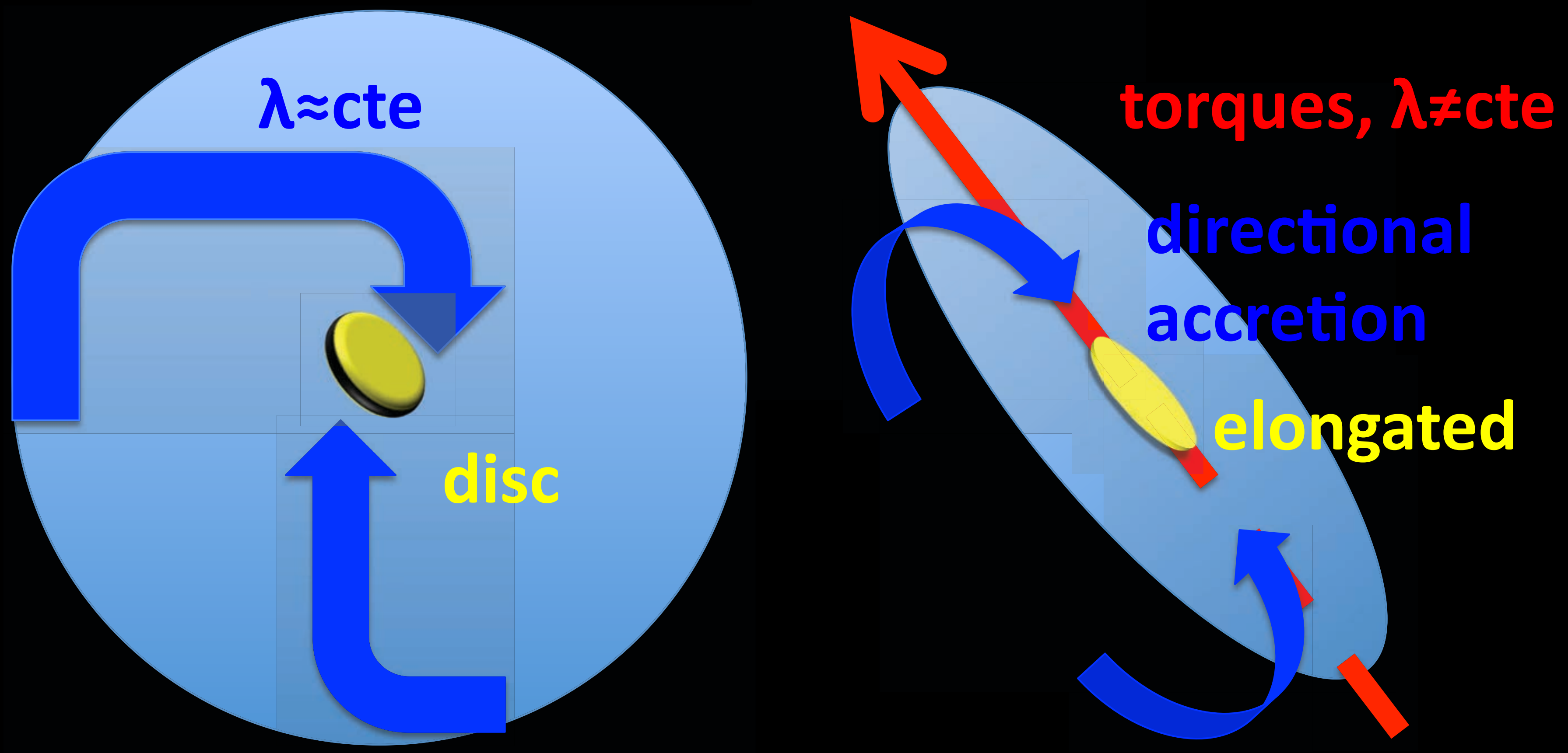


Most common galaxies at high-z are not discs or spheroids, but elongated galaxies

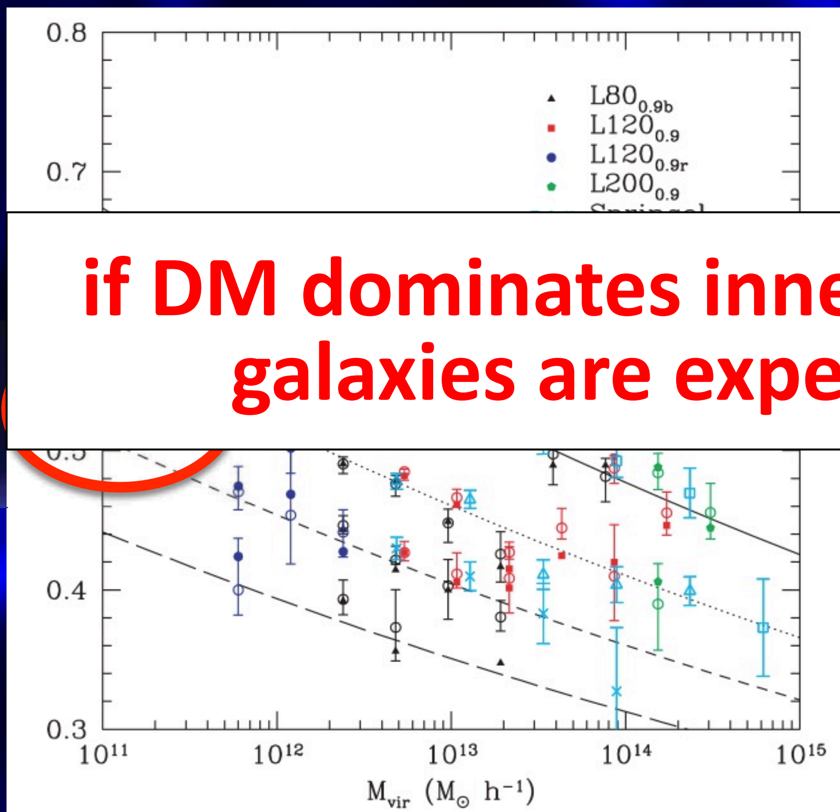
van der Wel et al. 2014

How do elongated galaxies form in ΛCDM?

The effect of a prolate halo on baryons



Small halos at high-z are highly prolate

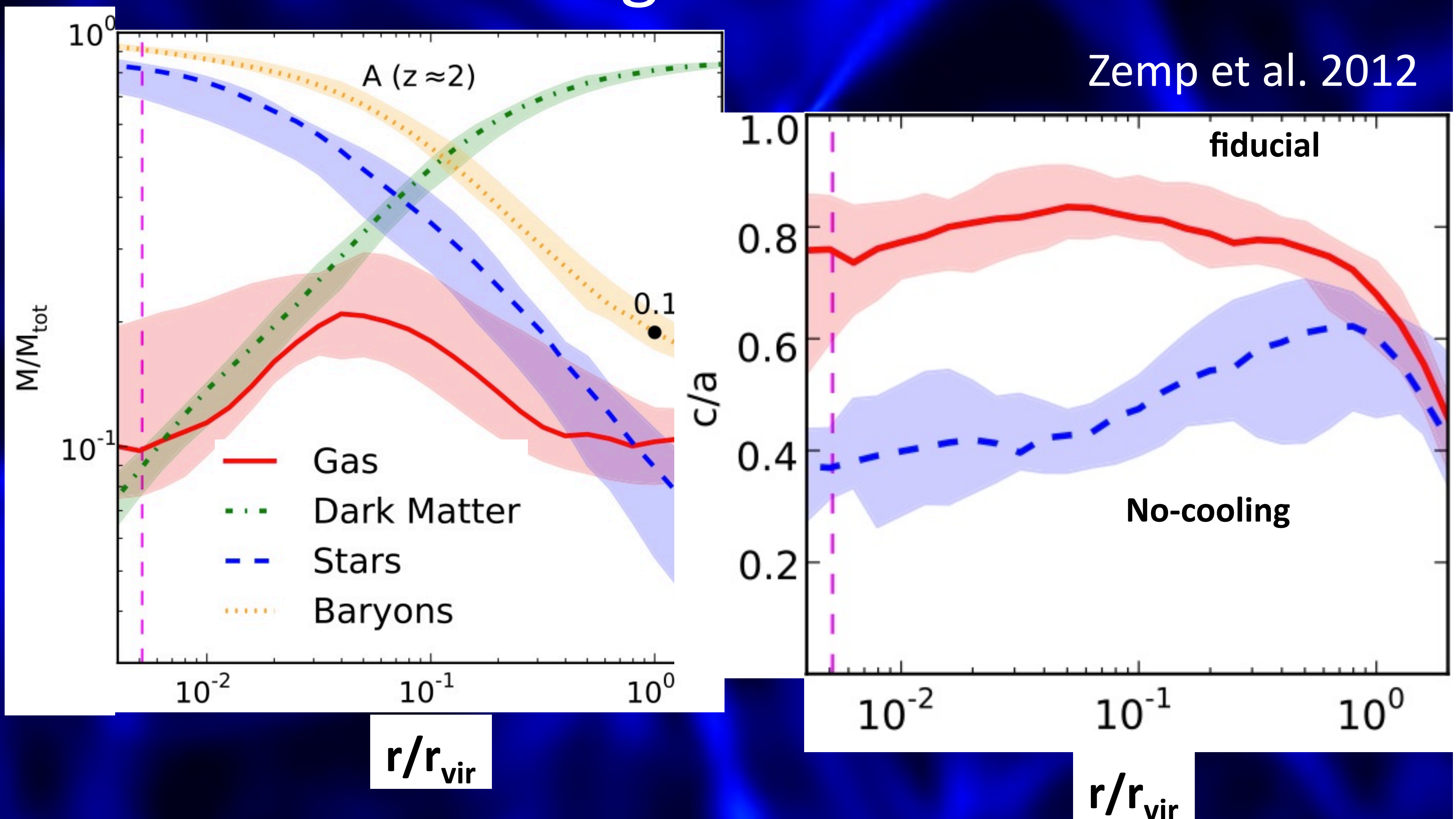


if DM dominates inner potential, elongated galaxies are expected within λCDM

Allgood et al. 2006:

- Halos of a given mass are more prolate at
- $M_\odot$ at z=2 are as prolate as today's clusters.
- Halos are increasingly elongated at lower radii

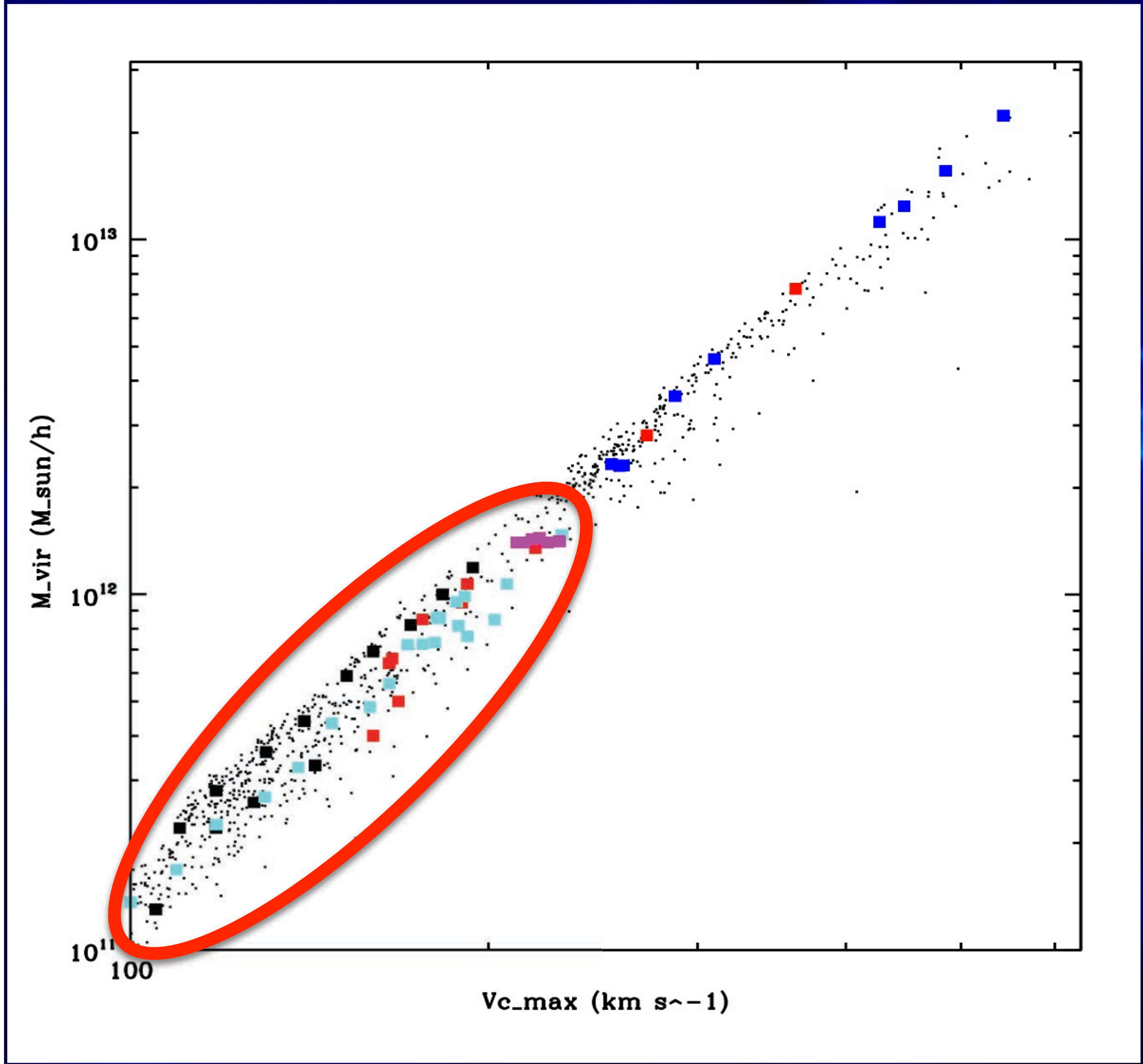
If baryons dominates inner potential, halos get rounder



Galaxy formation simulations done with ART

- AMR code: HYDRO-ART (Kravtsov et al 1997, Kravtsov 2003)
- Gas Cooling, Star Formation, Stellar Feedback (Ceverino & Klypin 2009; Ceverino, Dekel and Bournaud 2010)
  - Cooling below 10^4 K (minimum temperature of 300 K).
  - Thermal feedback + runaway stars.
- Radiative Feedback from ionizing photons (Ceverino et al. 2014)
- Zoom-in simulations: 15-30 **pc** resolution

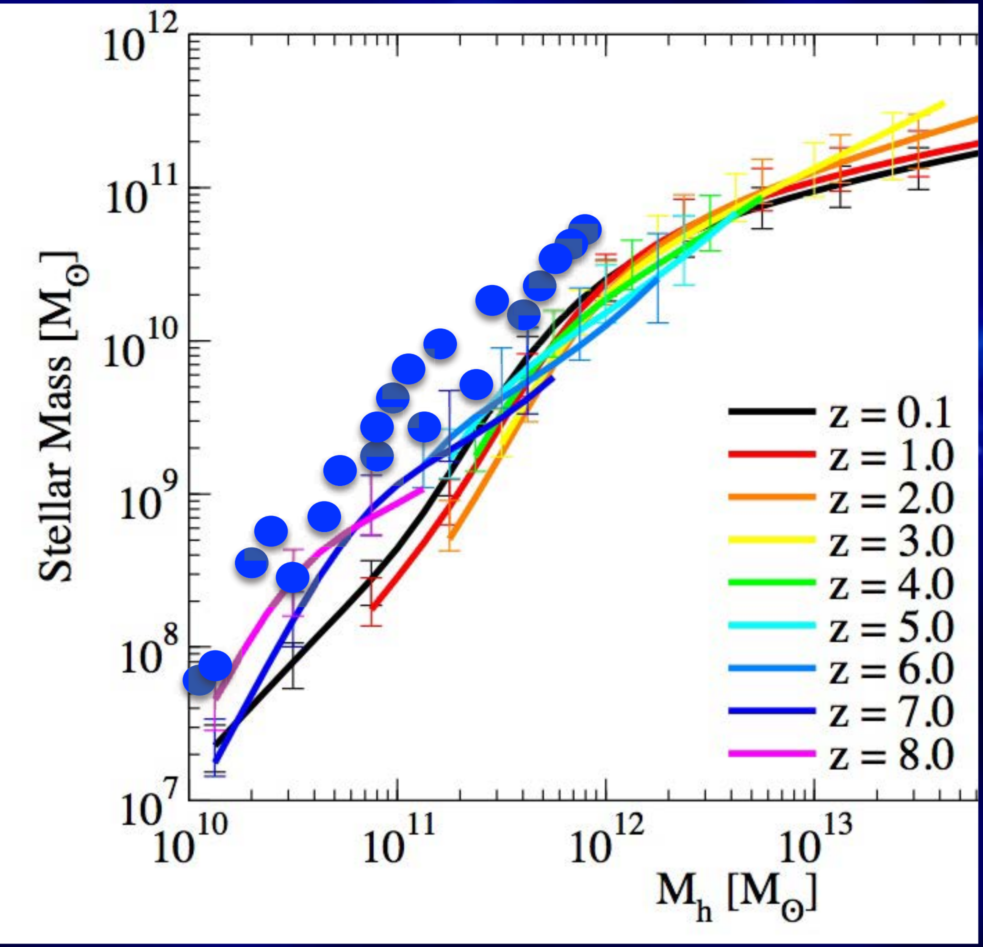
VELAs



- ~35 zoom-in simulations
- 15-30 pc reso
- M_{DM}=8 10^4 $M_\odot$
- M_*=10^3 $M_\odot$
- z=1-3

10^{11} $M_\odot$/h < M_H < 10^{12} $M_\odot$/h
V_{max} =100-200 km/s

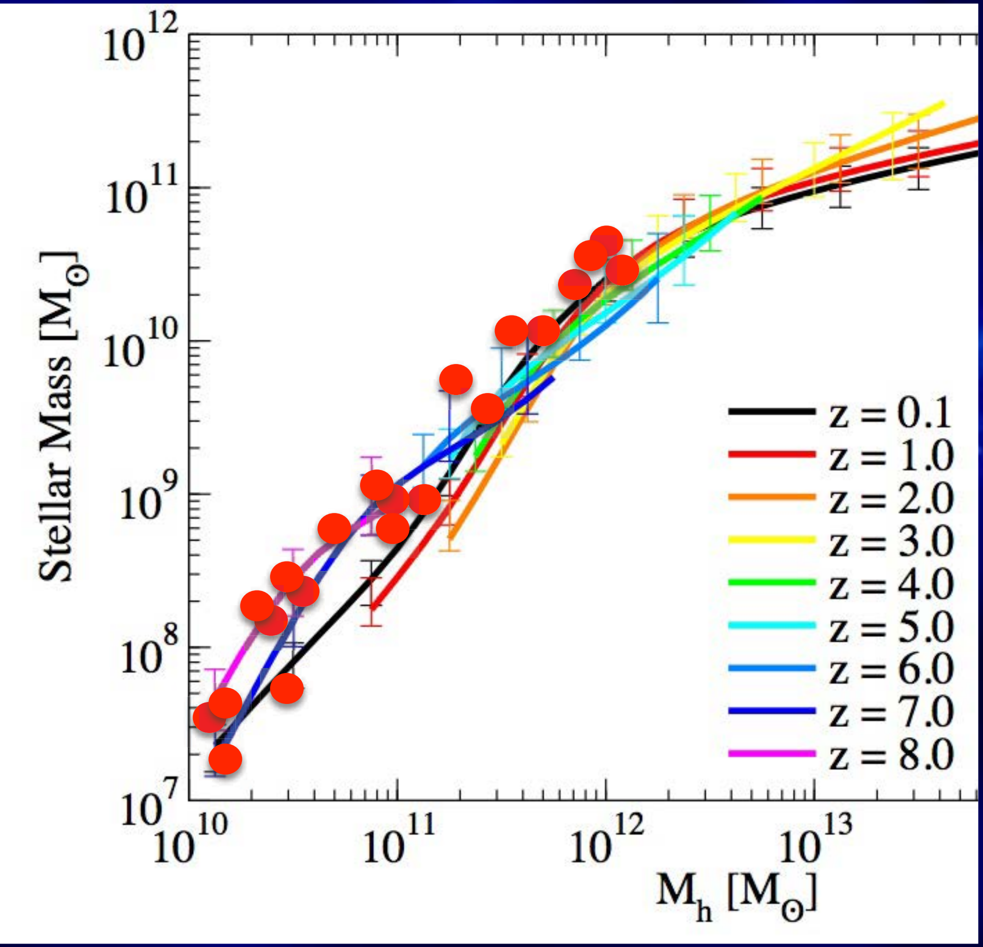
Low Star Formation Efficiency



Behroozi+13

- Without radiative feedback, only thermal feedback
- Overproduction of stars

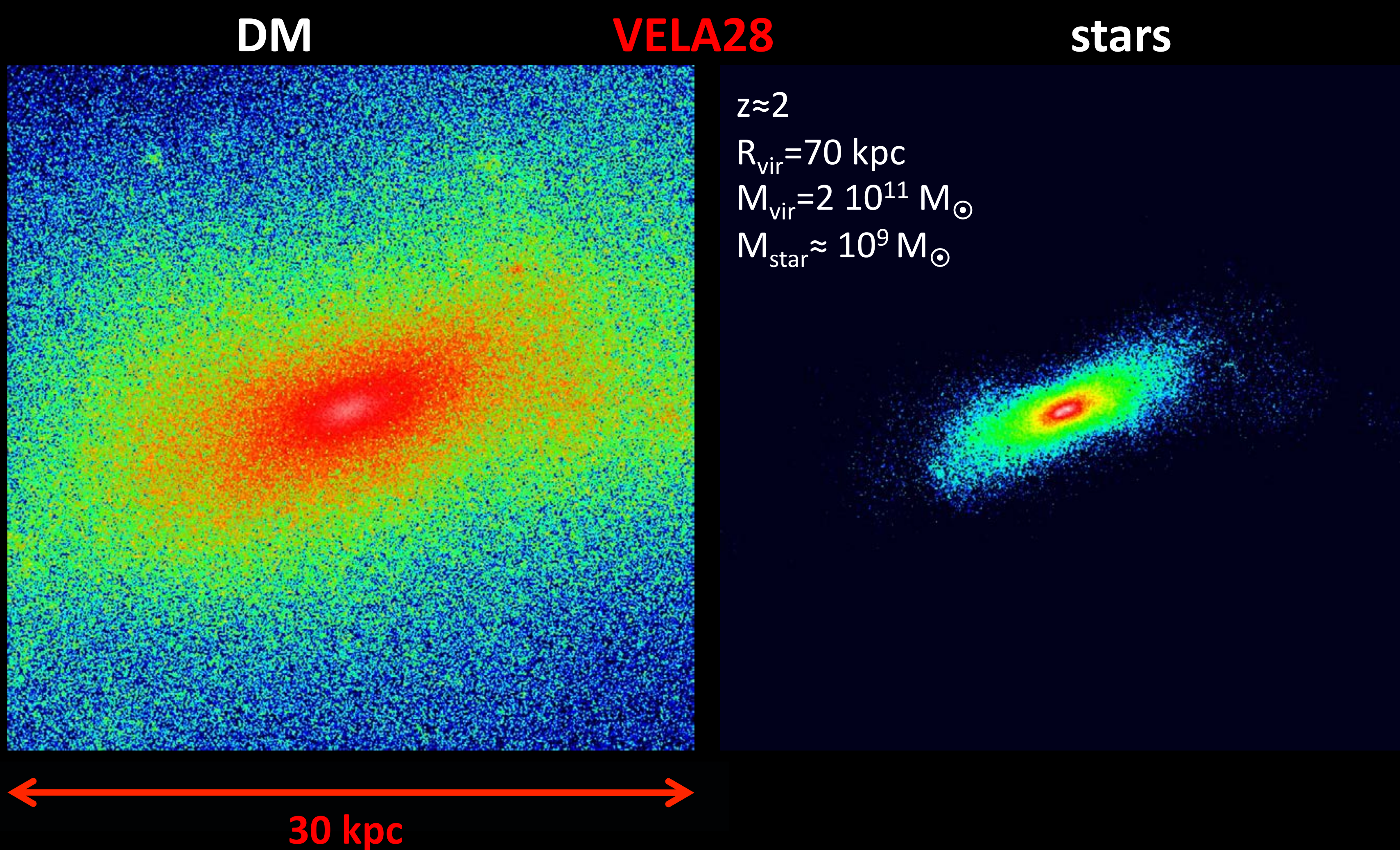
Low Star Formation Efficiency

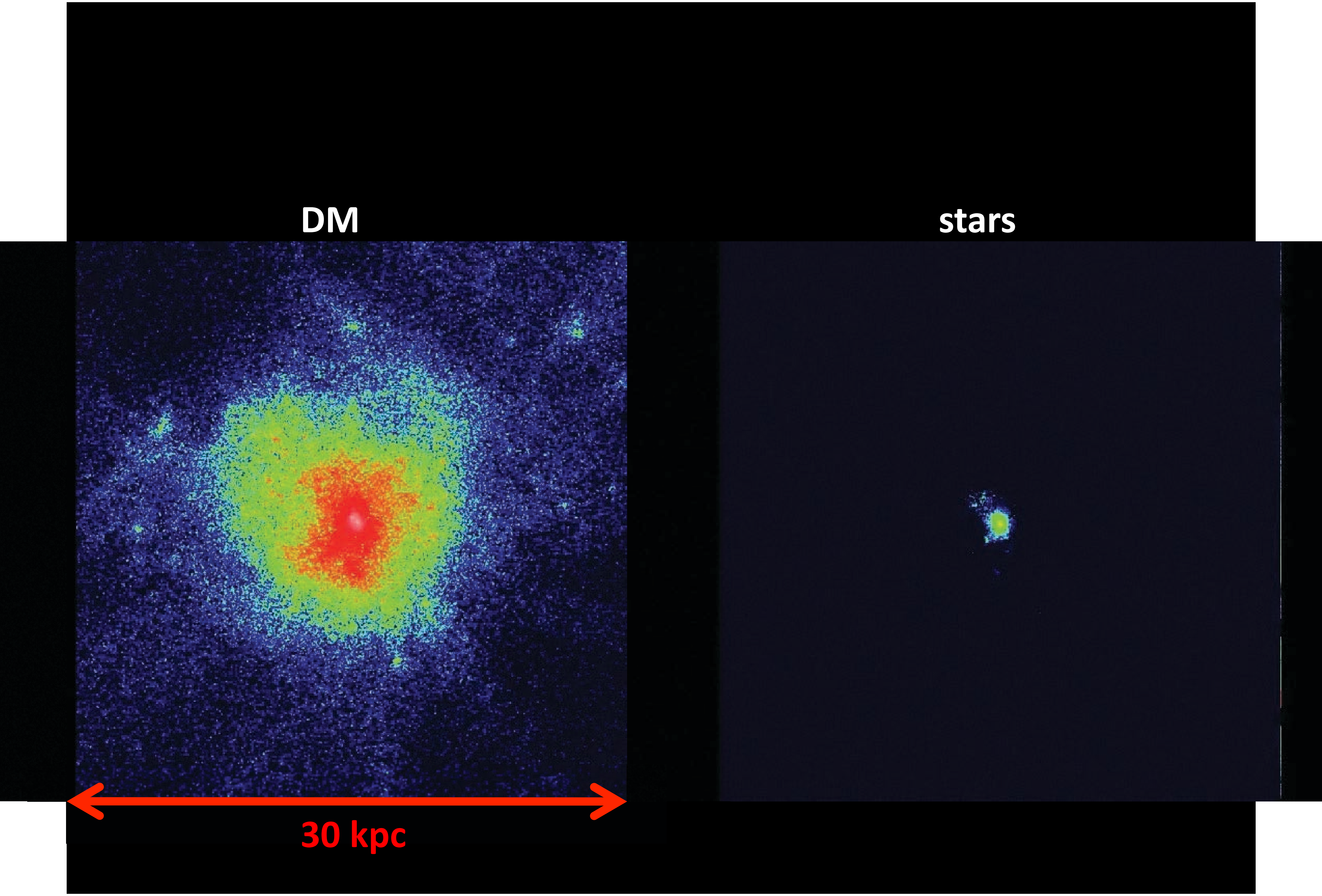


Behroozi+13

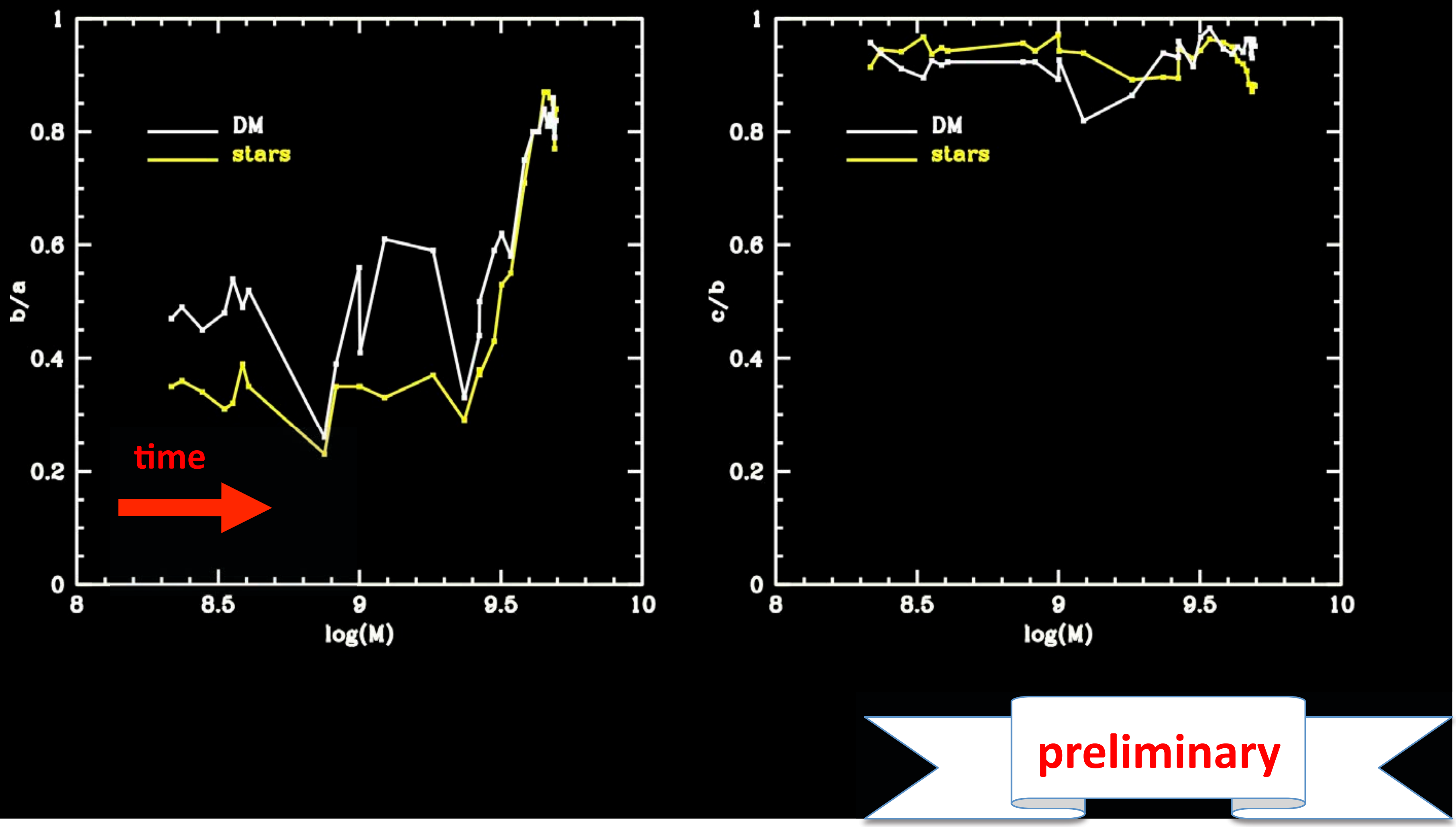
- Radiation pressure reduces SFR and stellar mass by a factor ~3
- Without tuning parameters

Prolate DM halo → elongated galaxy

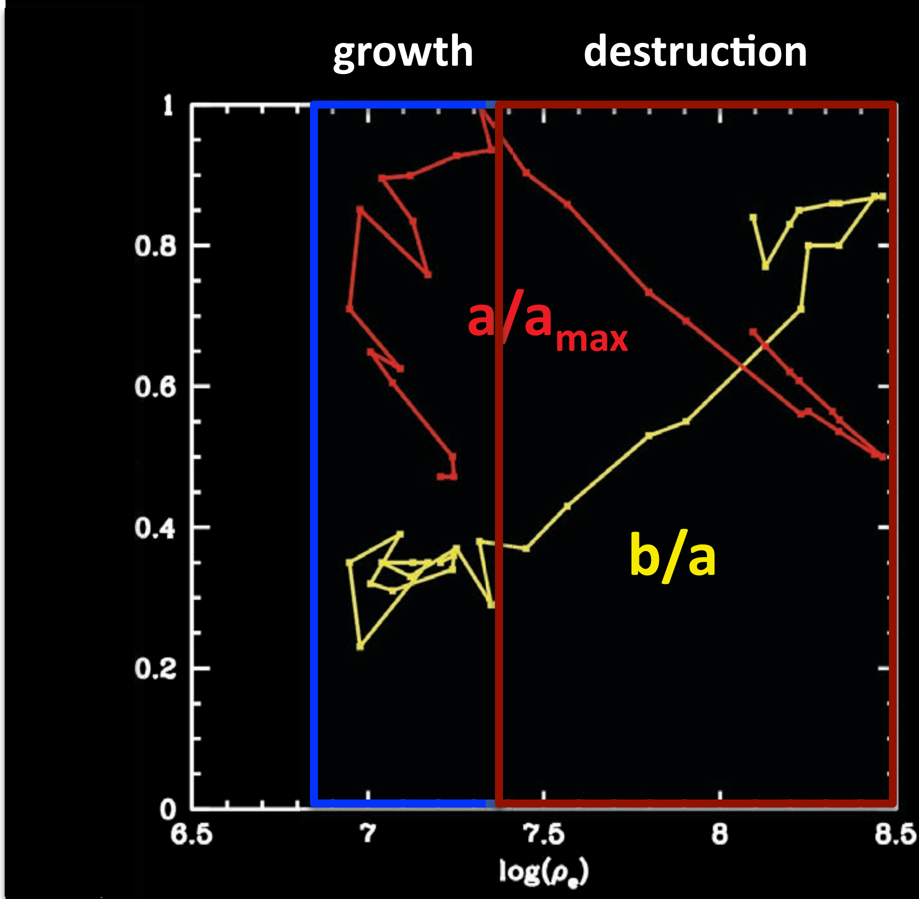



DM
stars
30 kpc

evolution of intrinsic 3D axis ratios

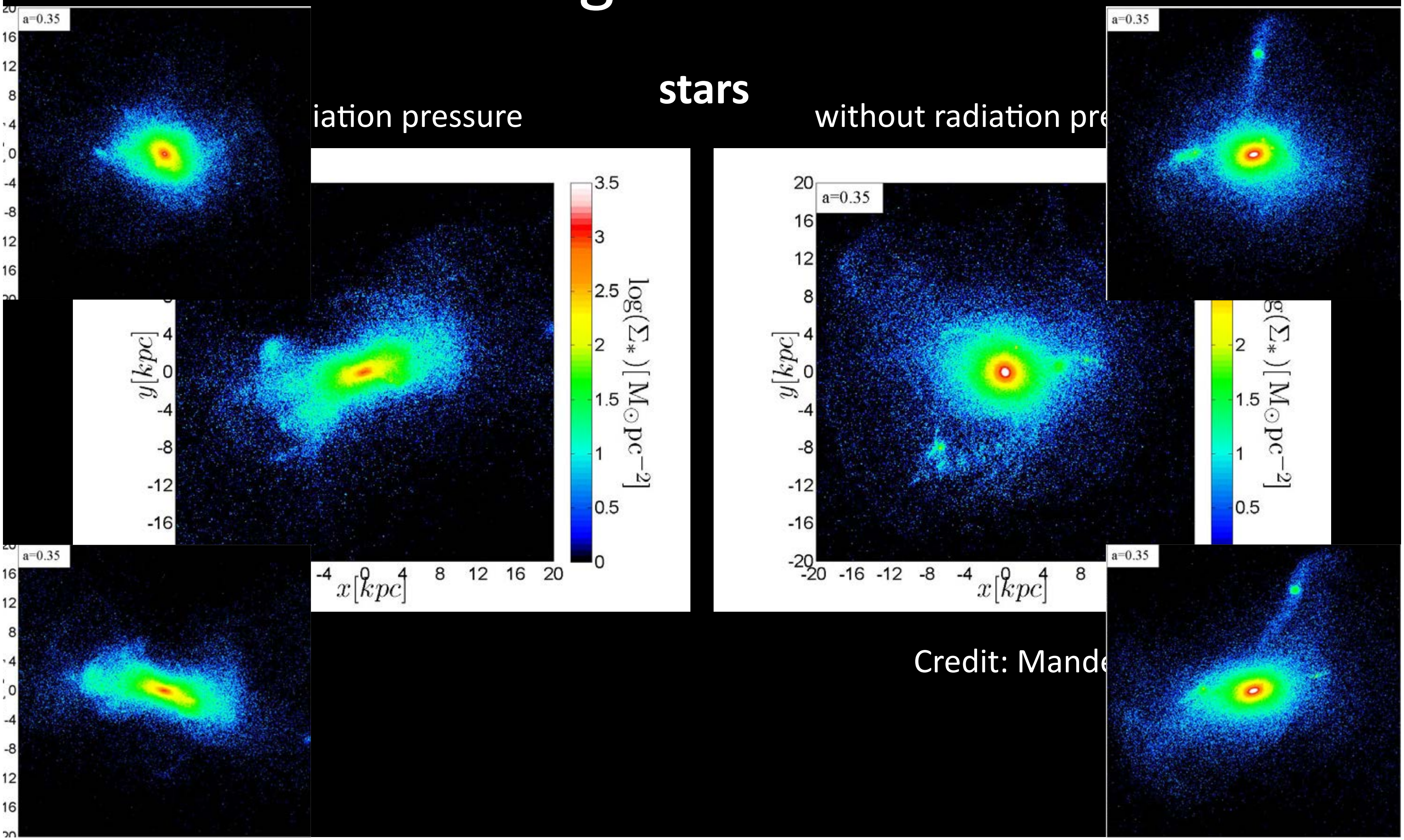


growth and disruption of elongated galaxies



- Growth of an elongated galaxy
- During the compaction phase (Zolotov's talk), stellar density increases
- Disruption of stellar orbits with high eccentricity.
- Rounder nugget

The effect of radiation pressure on galaxies

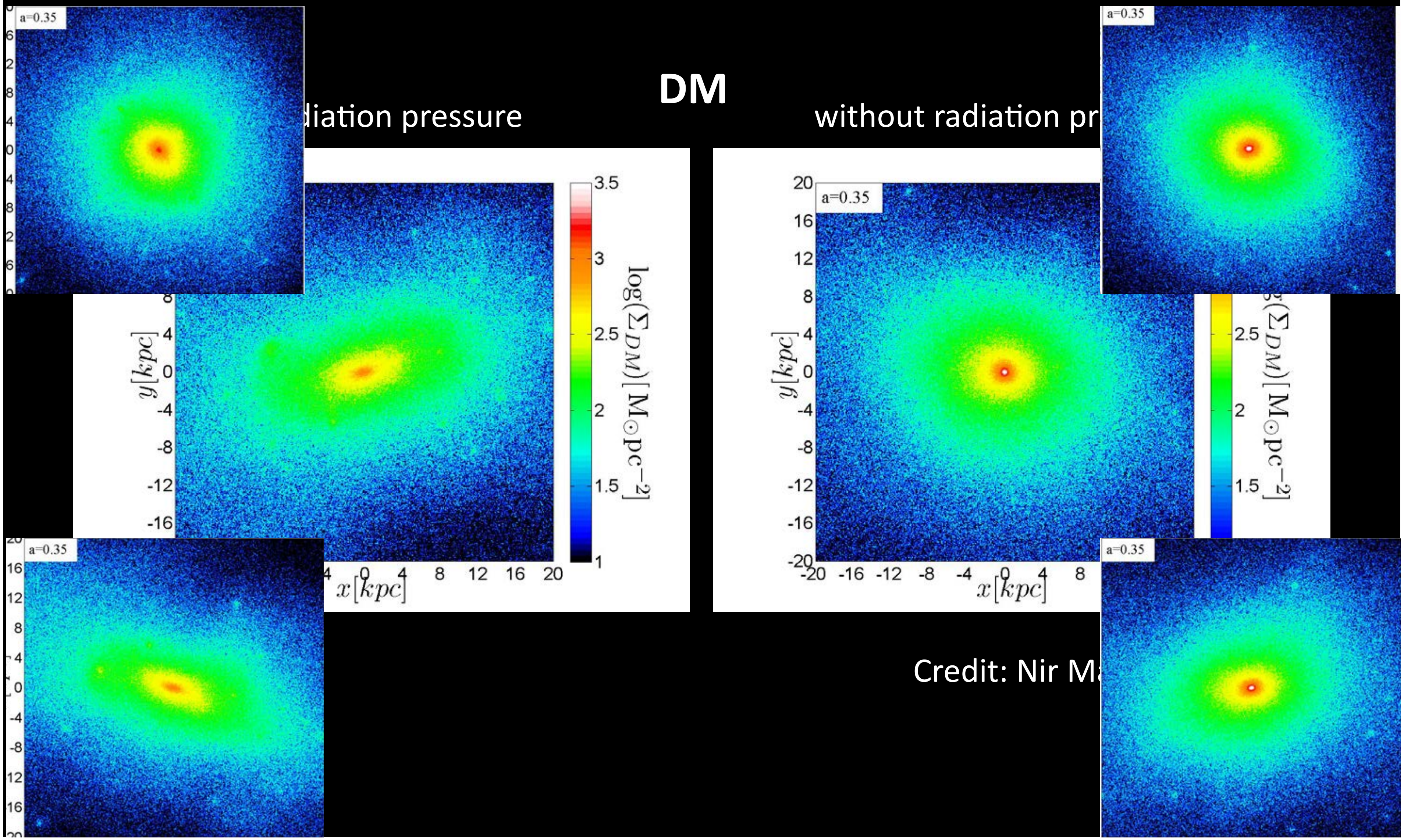


The effect of radiation pressure

DM

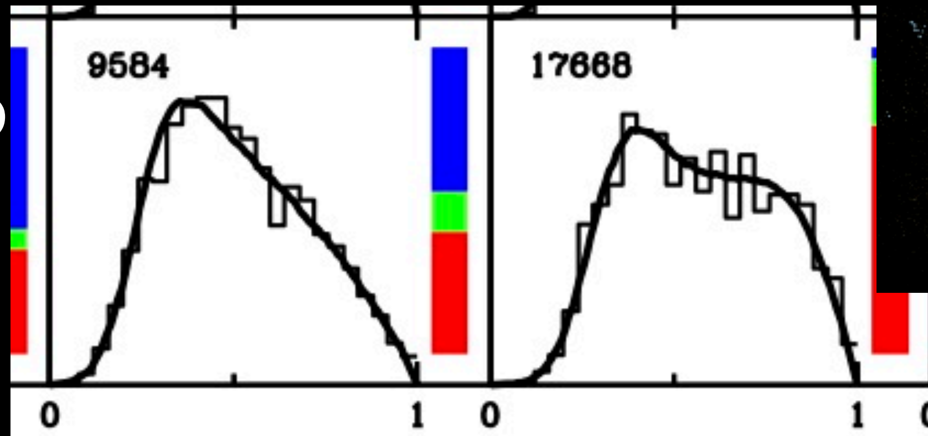
diation pressure

without radiation pr

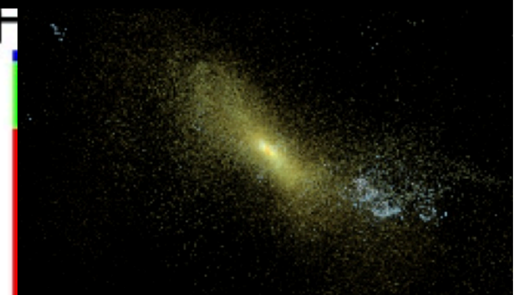


Credit: Nir M

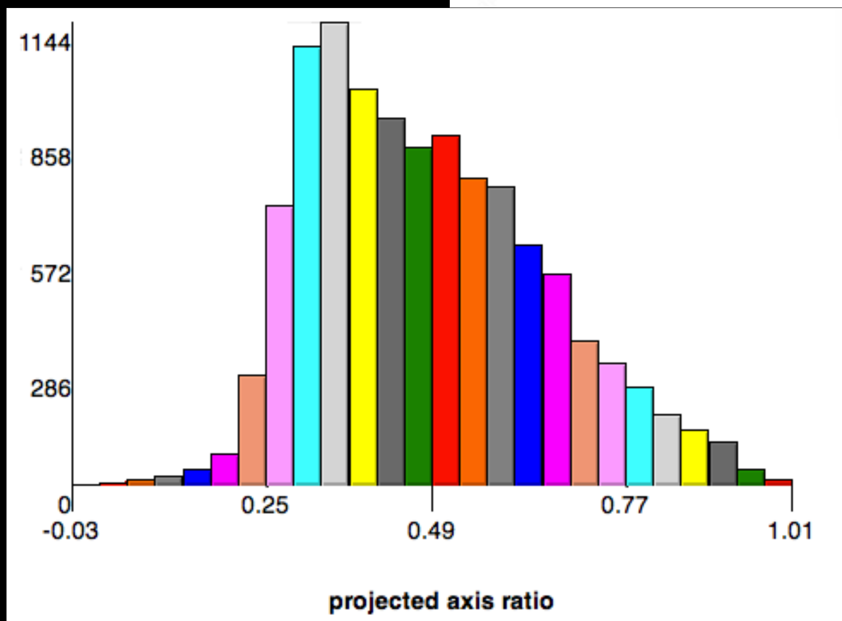
P

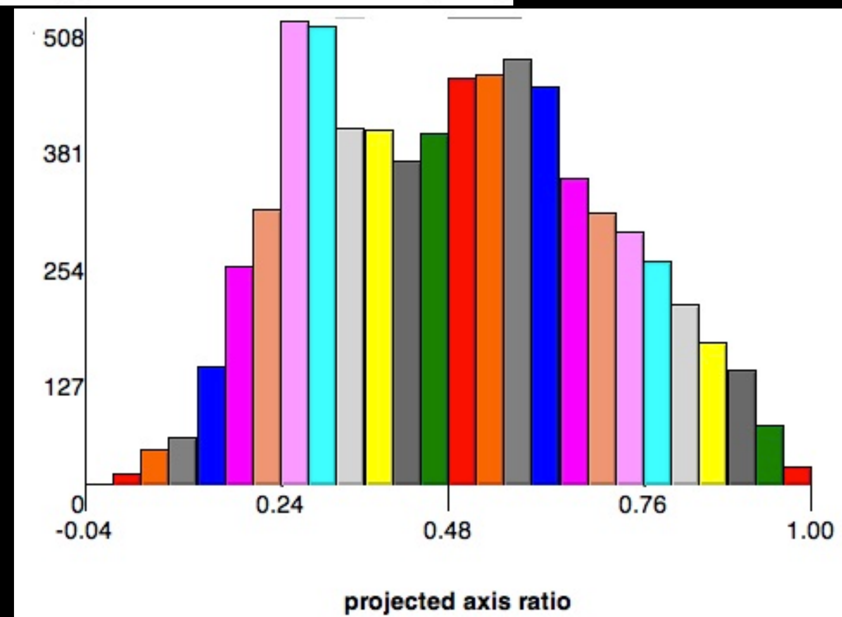


log M 10



Snyder et al





Summary

Formation of elongated Galaxies

- DM dominates inner potential
- prolate inner halo
- directional accretion along major axis

Destruction of elongated galaxies

- if baryonic density increases
- high-eccentric orbits are deflected


The End