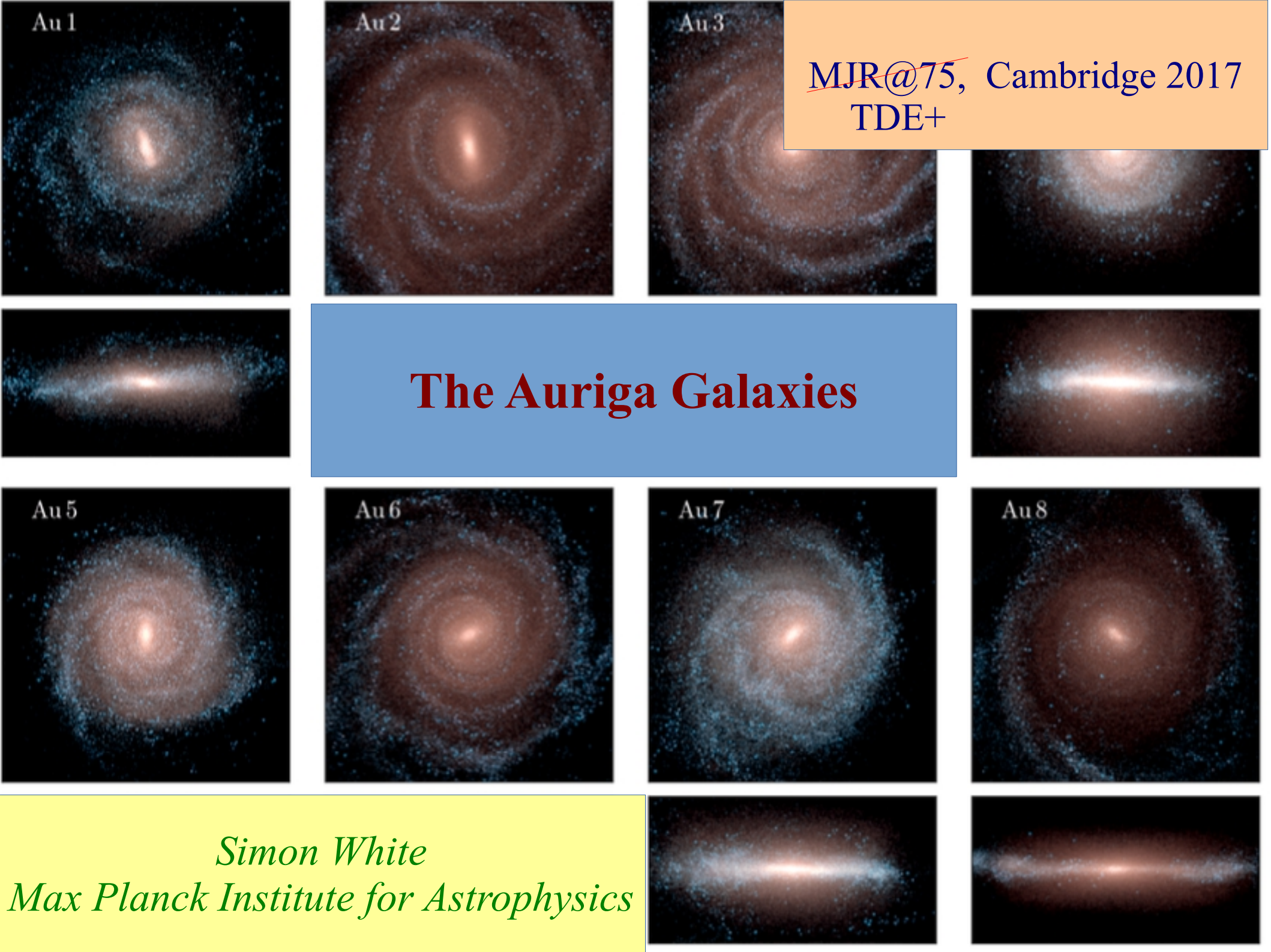

MJR@75, Cambridge 2017
TDE+

The Auriga Galaxies

Simon White
Max Planck Institute for Astrophysics

The Auriga Project: the properties and formation mechanisms of disc galaxies across cosmic time

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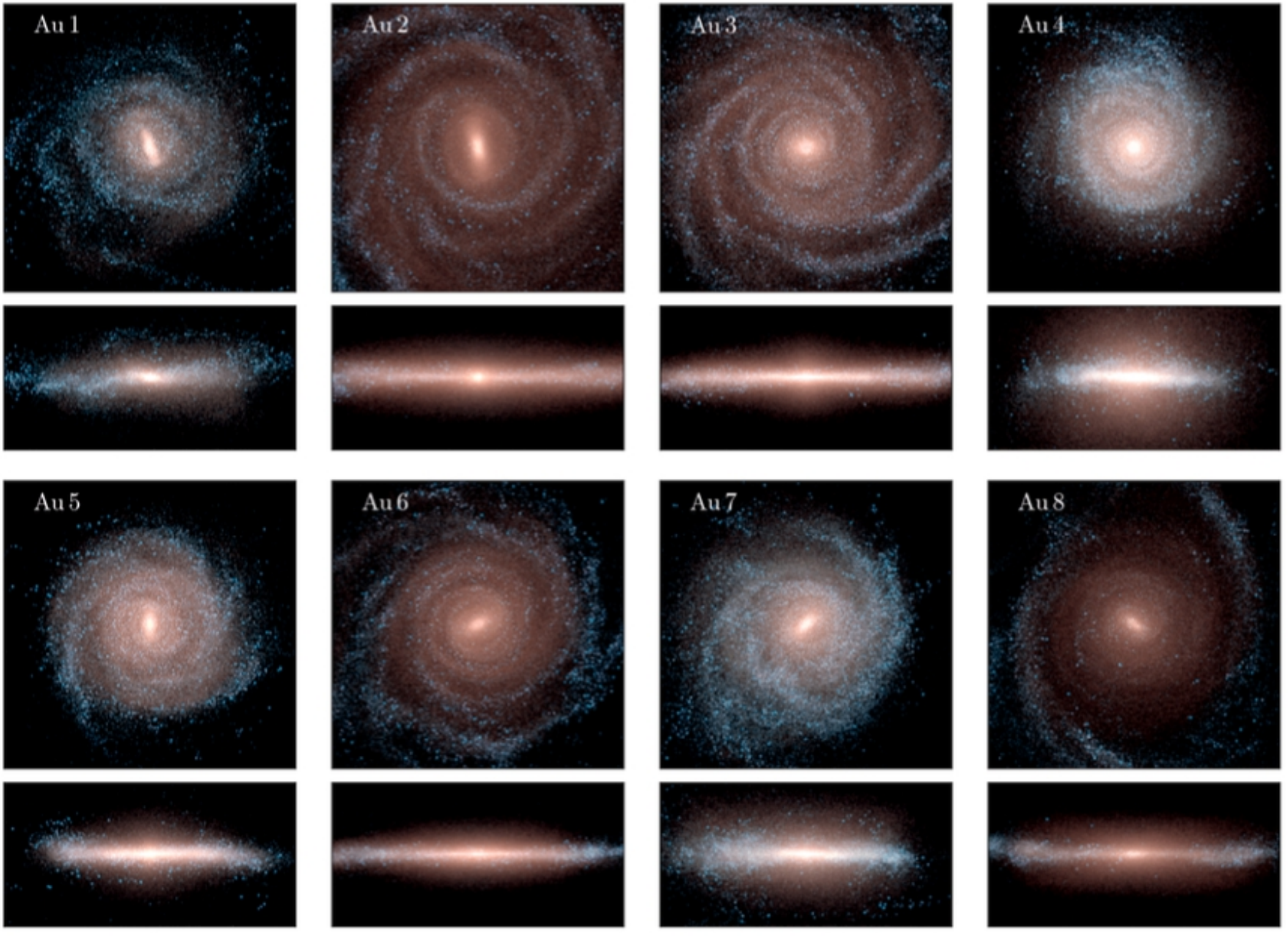
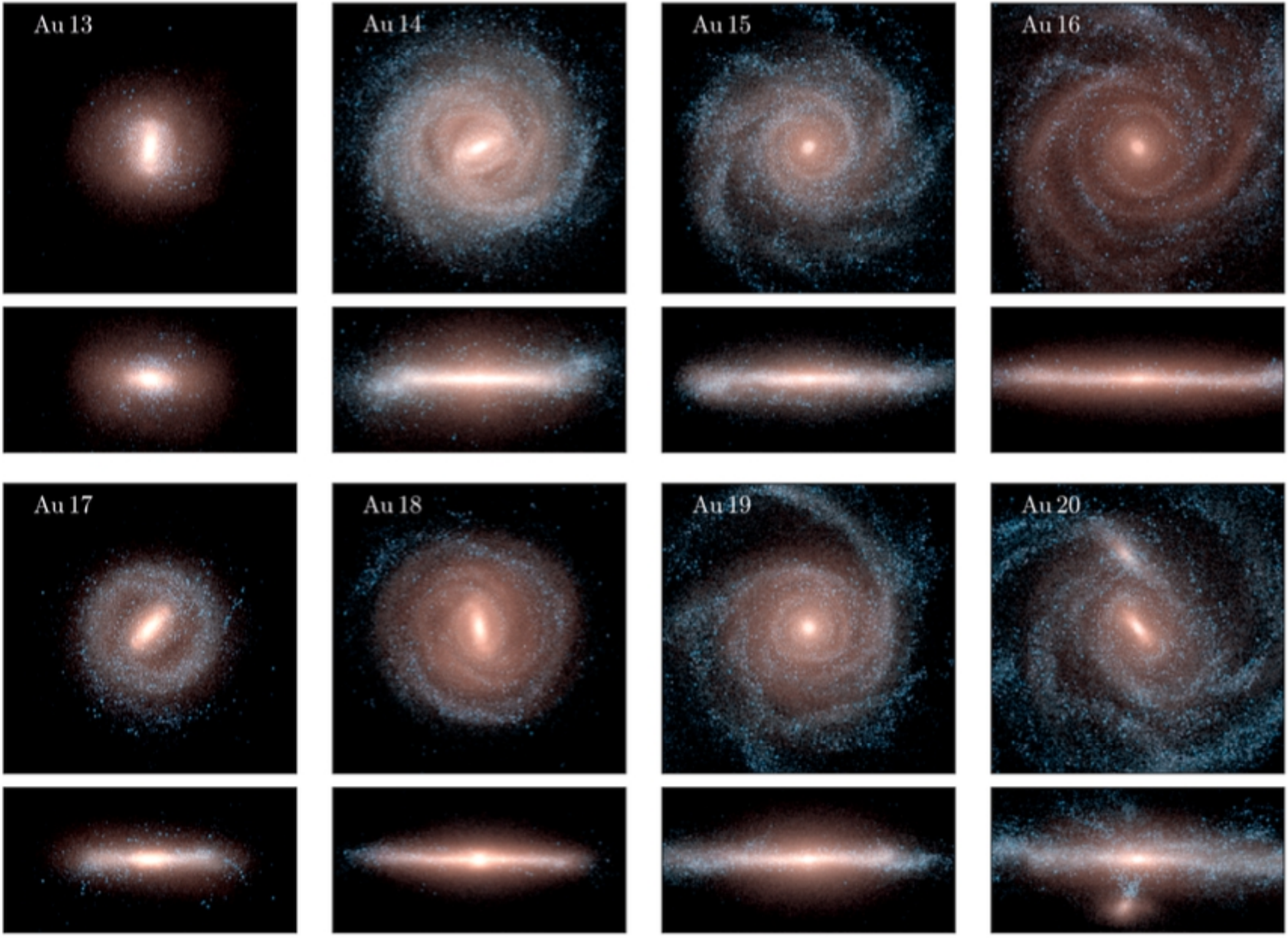
The Auriga Project

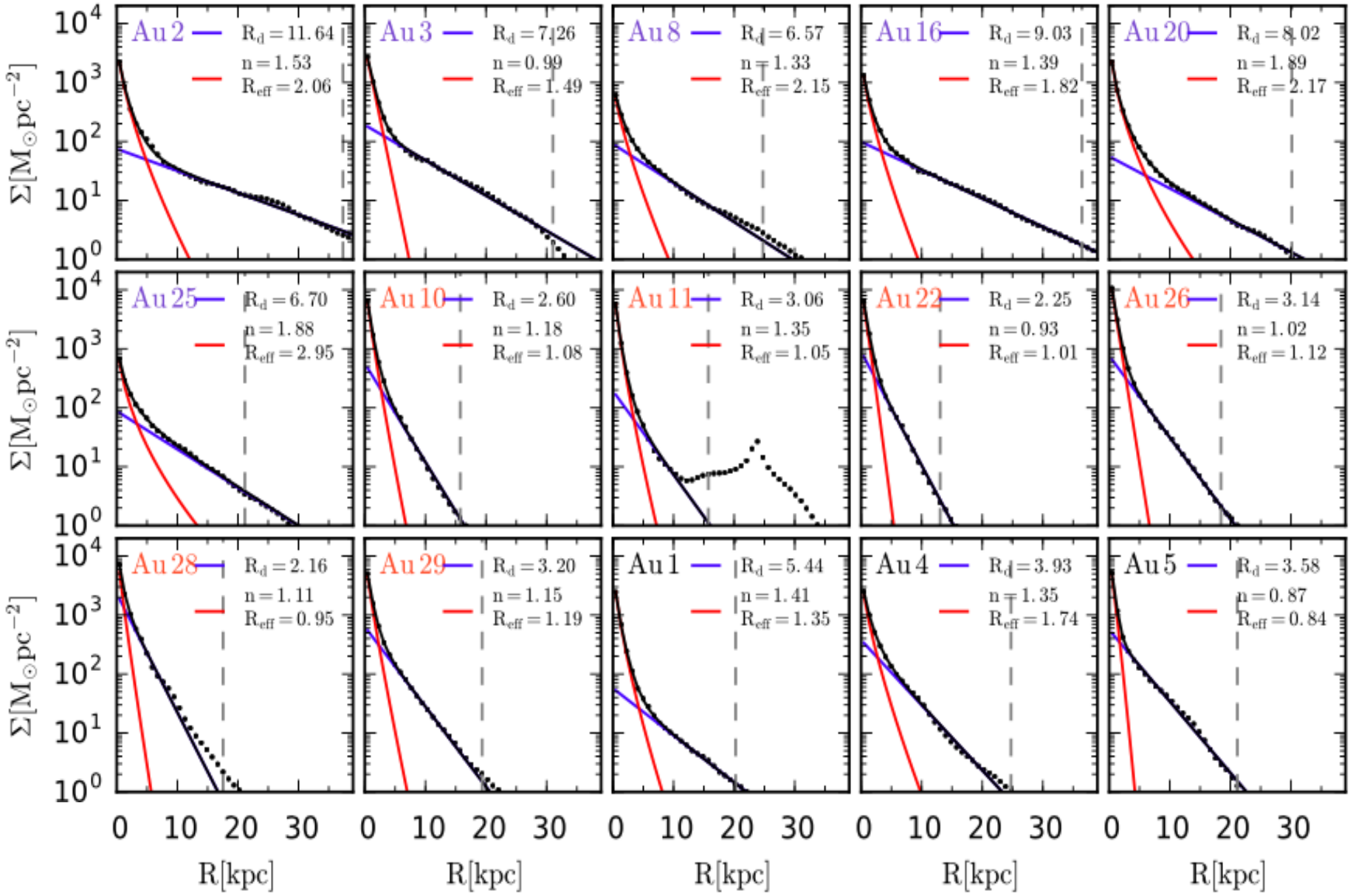
- Cosmological resimulations of thirty moderately isolated Milky-Way-mass halos
- All have mass resolution ~ 30 (dark matter) and 5 (baryons) x $10^4 M_\odot$
- Six halos are also resimulated with seven times higher resolution
- The simulations use the moving mesh MHD+N-body code AREPO with
  - active ideal magnetohydrodynamics
  - photoionisation heating from an imposed UV background
  - continuum/metal-line cooling with self-shielding corrections
  - an effective equation of state to mimic ISM behaviour
  - stochastic star formation in dense gas on timescale 2 Gyr
  - feedback and chemical enrichment from SNI, SNII and AGB stars
  - SMBH formation and growth by accretion and merging
  - a crude model for wind feedback from both SNe and SMBH


Au 1
Au 2
Au 3
Au 4
Au 5
Au 6
Au 7
Au 8


Au 13
Au 14
Au 15
Au 16
Au 17
Au 18
Au 19
Au 20

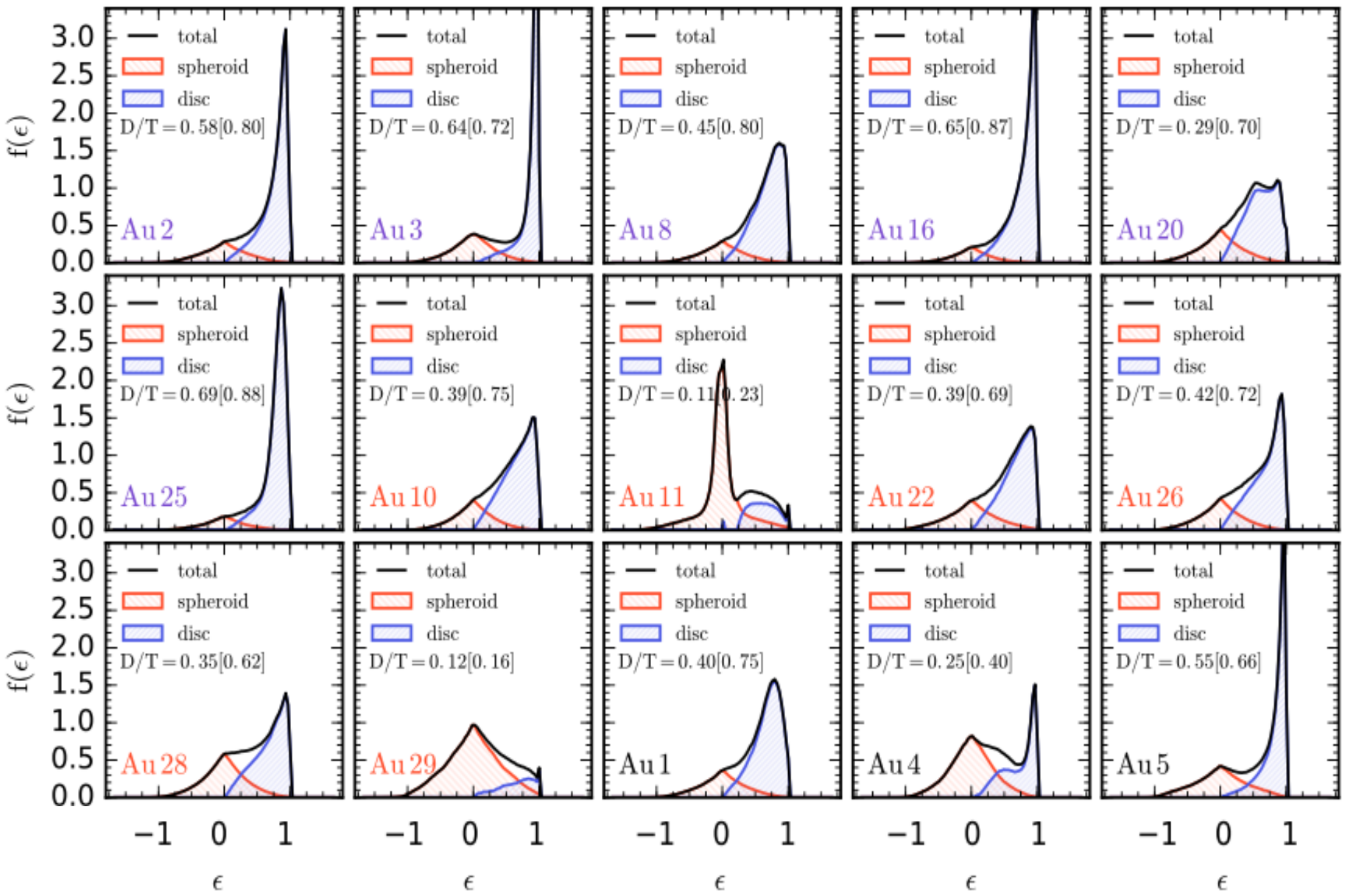
Disk/bulge decompositions of surface density

Grand et al 2017



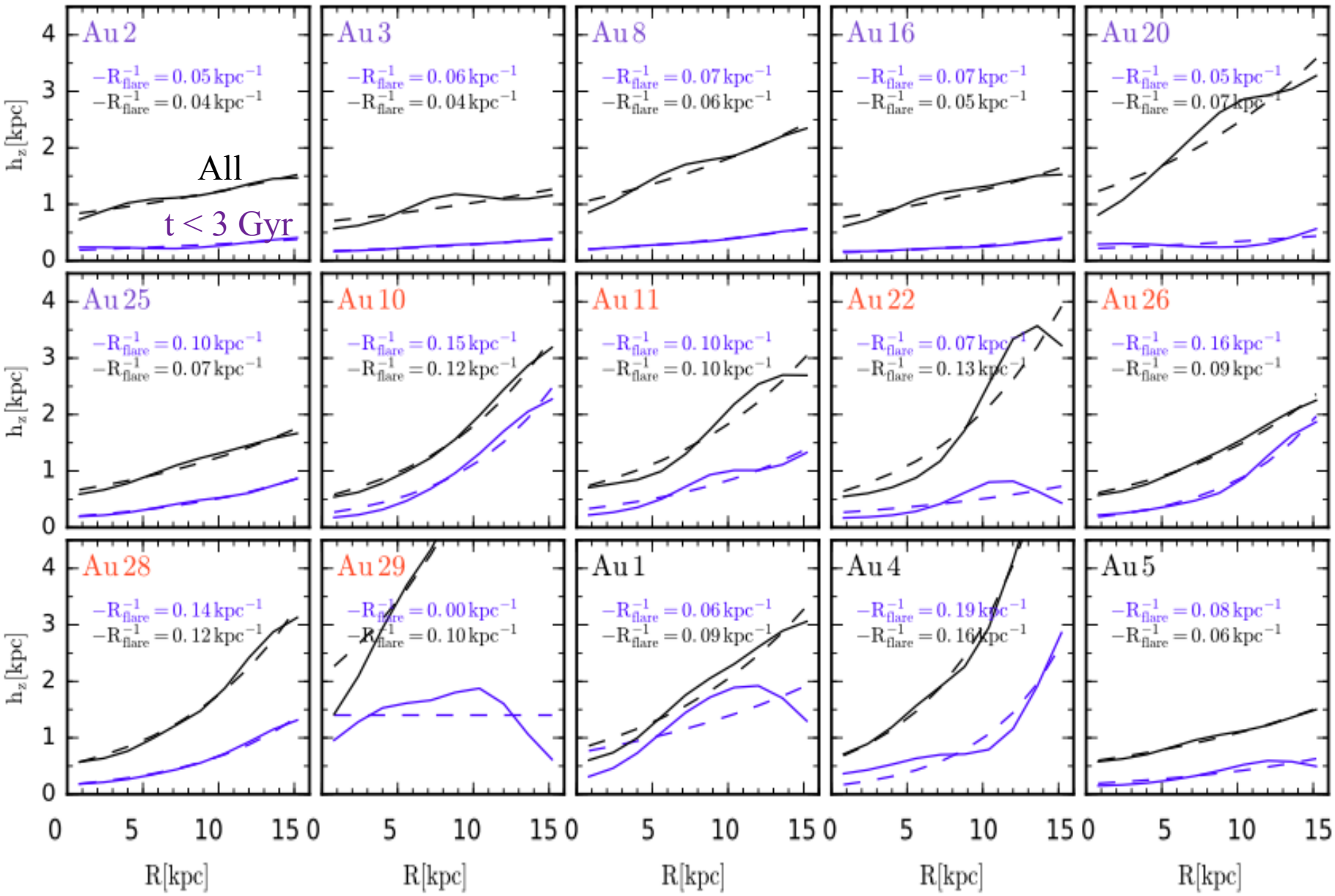
Kinematic disk/bulge decompositions

Grand et al 2017



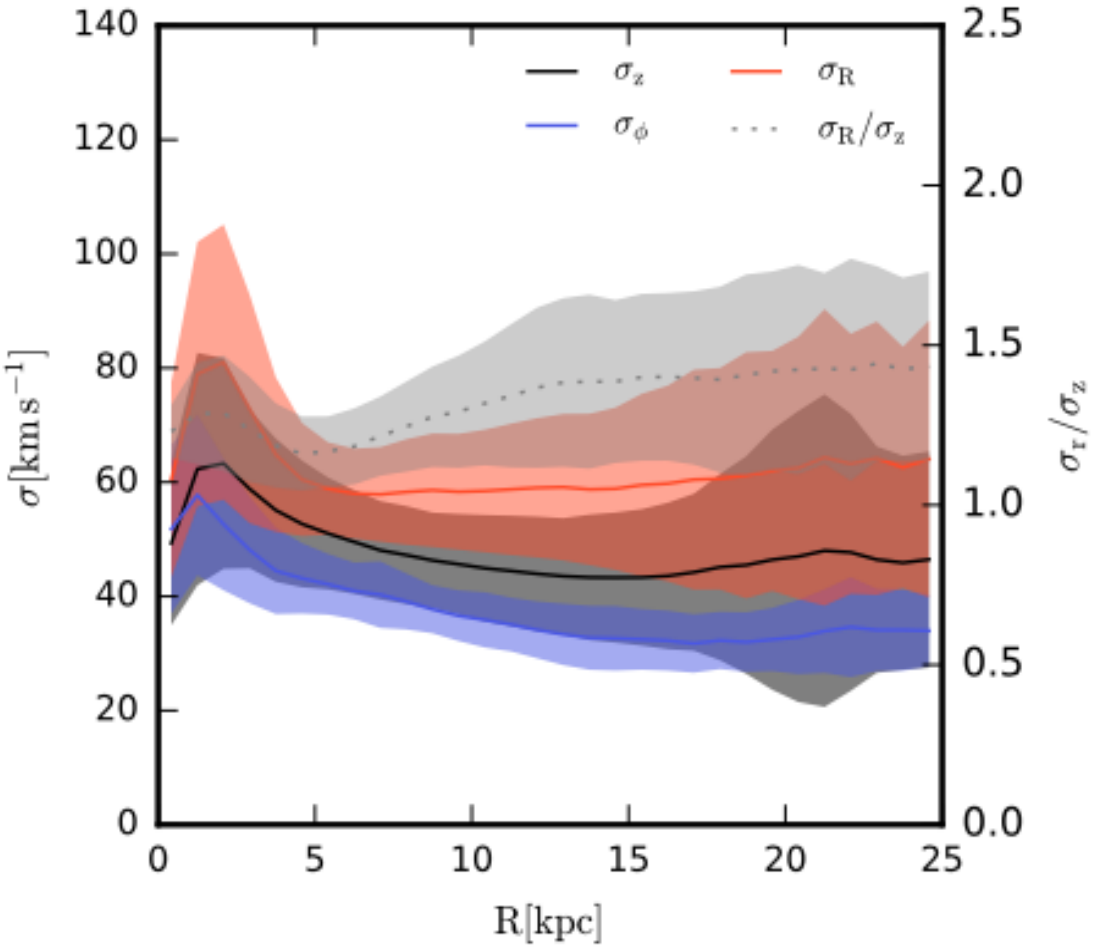
Disk scale-height as a function of radius

Grand et al 2017



Mostly too large!

Disk velocity dispersions as a function of radius



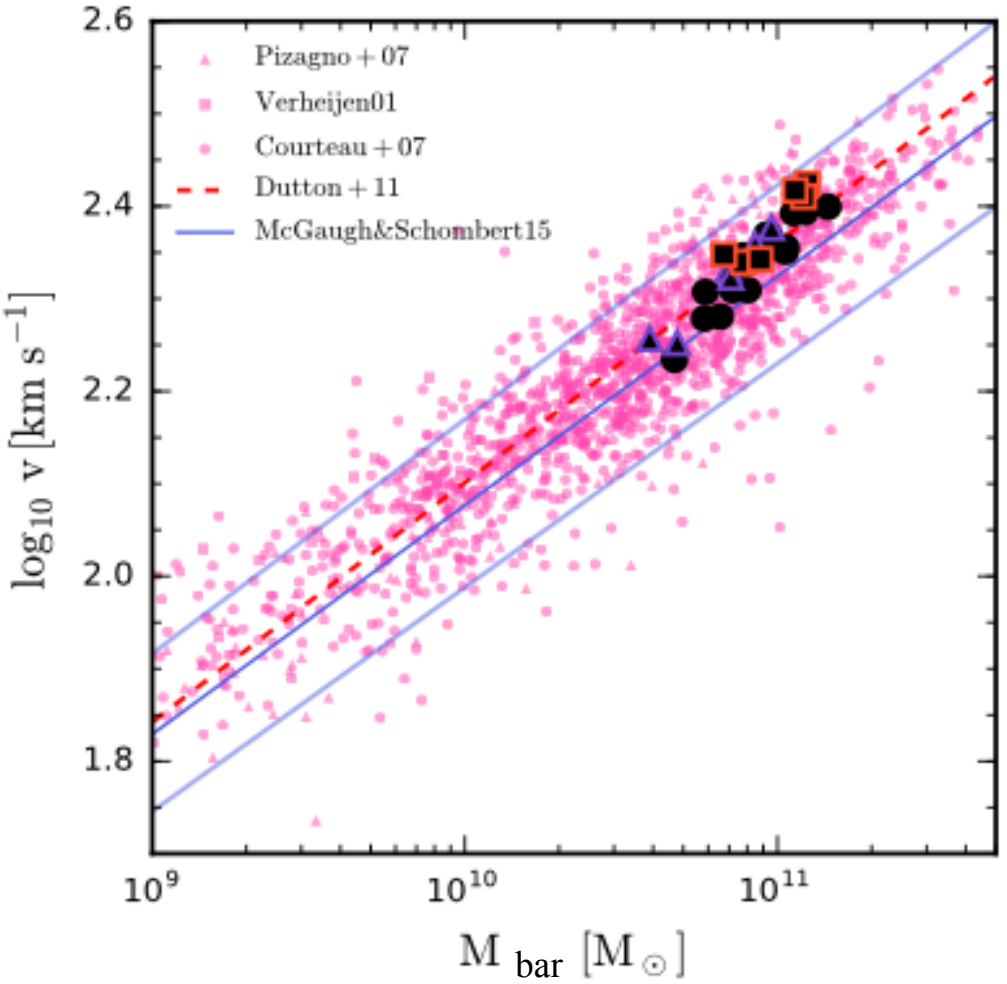
Grand et al 2017

The velocity dispersions are all too large compared to the Milky Way

However, the shape of the velocity ellipsoid matches reasonably well

The baryonic Tully-Fisher relation

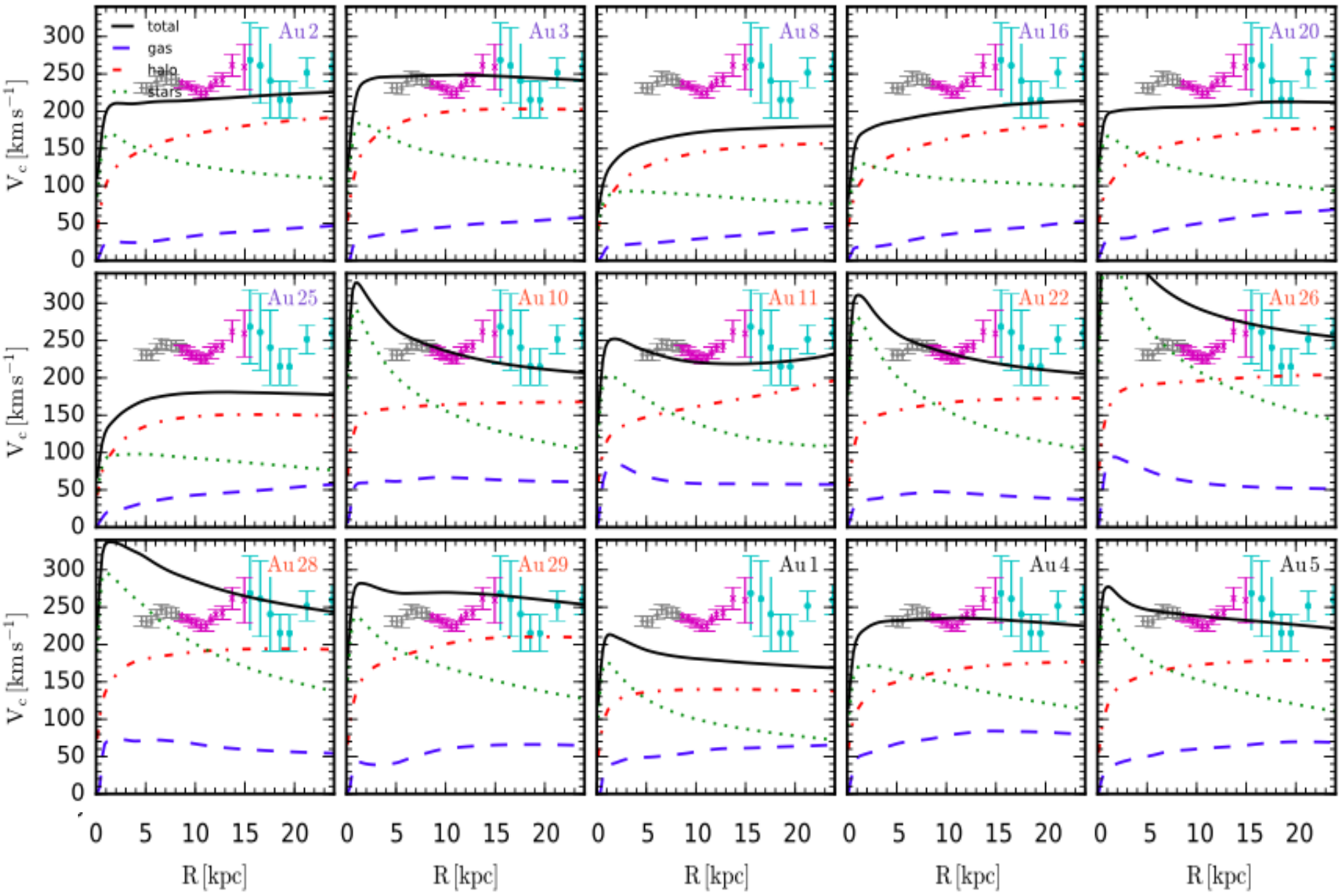
Grand et al 2017



There is no shift of the relation with galaxy size (as observed)

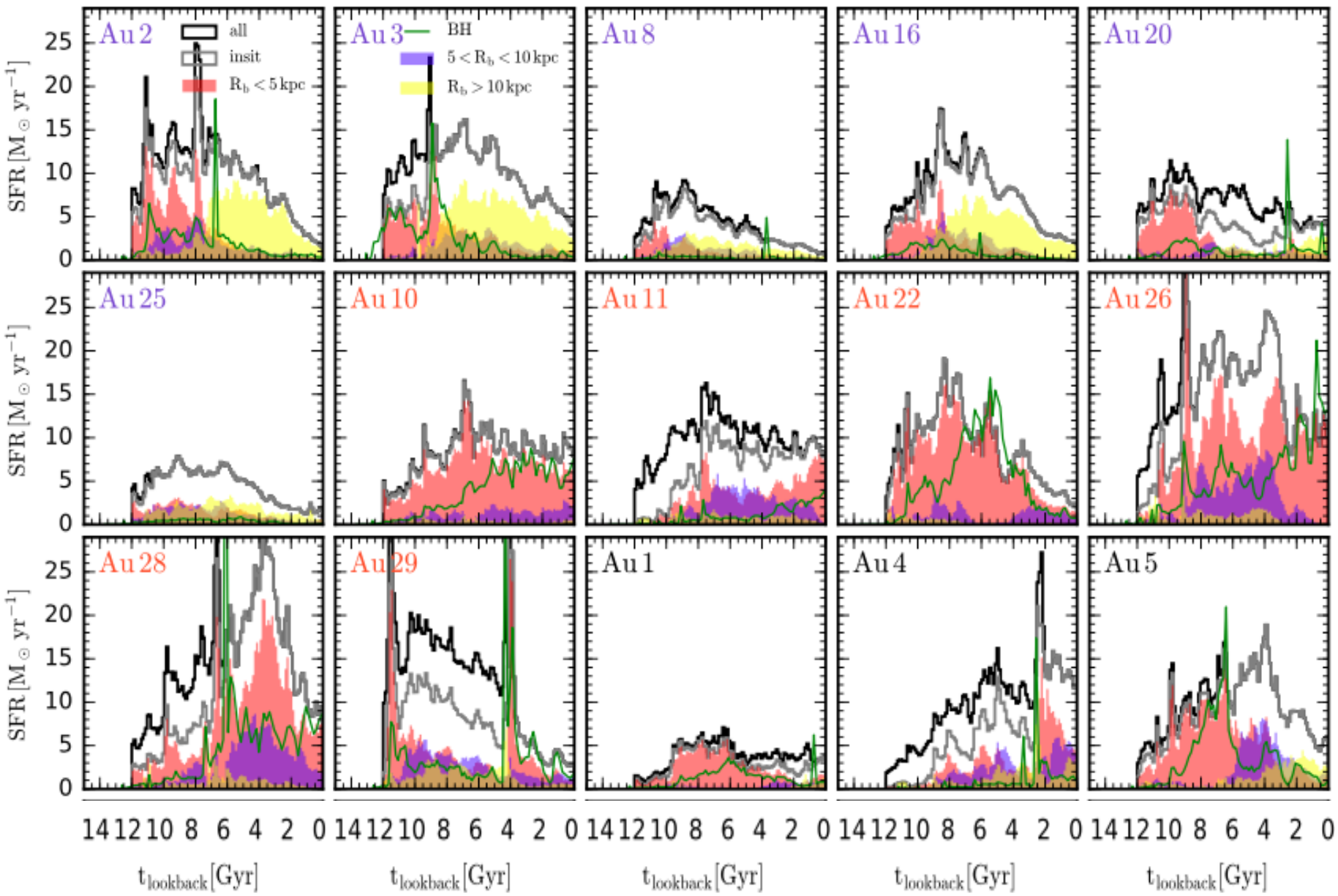
Disk rotation velocity as a function of radius

Grand et al 2017



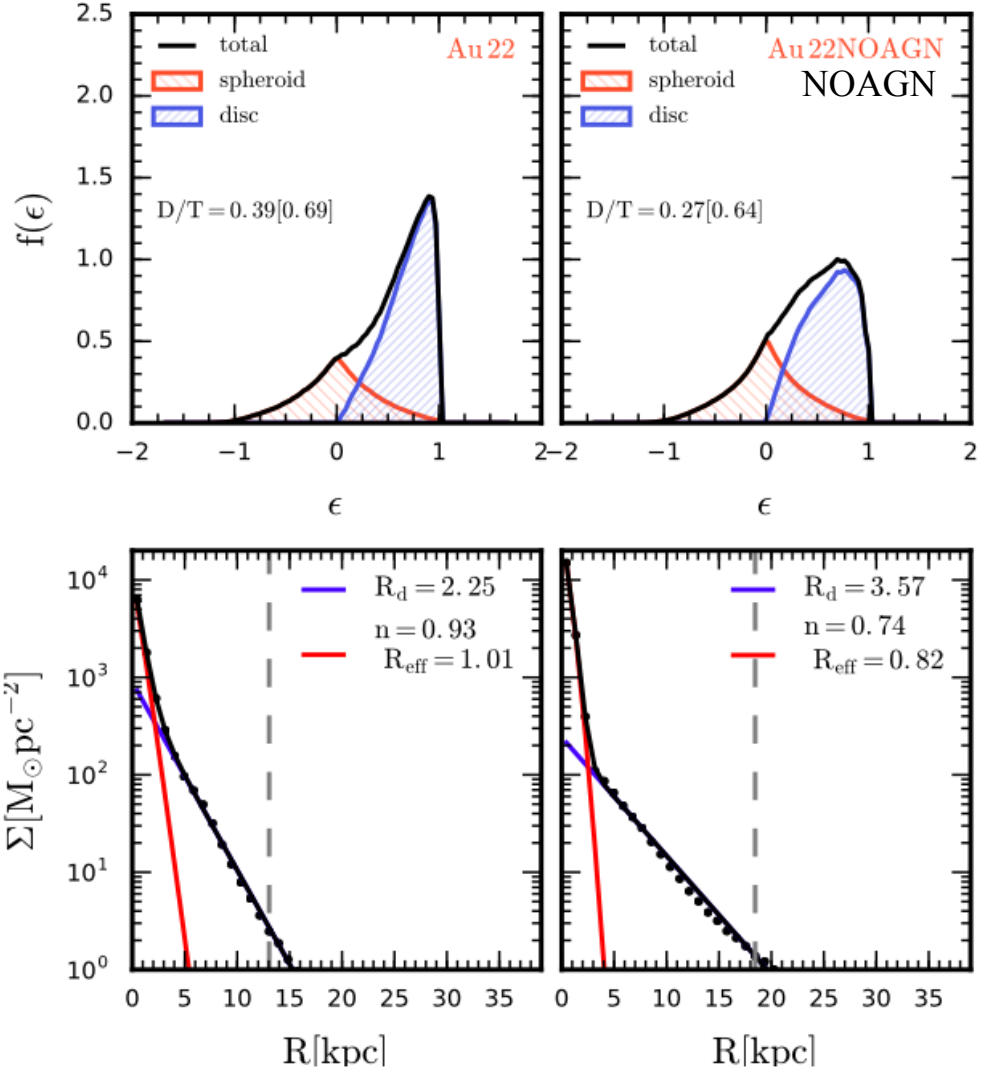
Formation histories for *in situ* and all stars

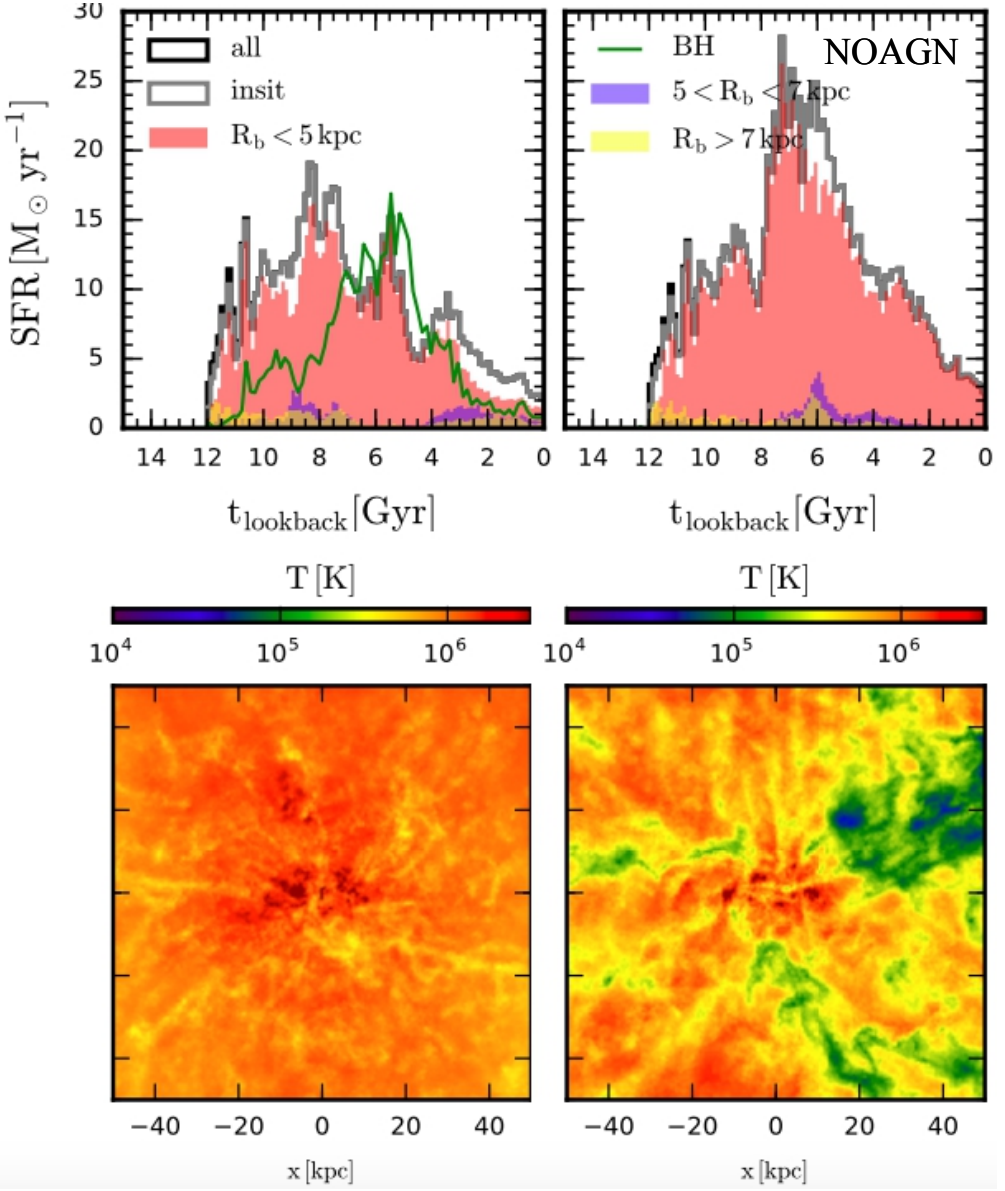
Grand et al 2017



The effects of AGN feedback on disk formation

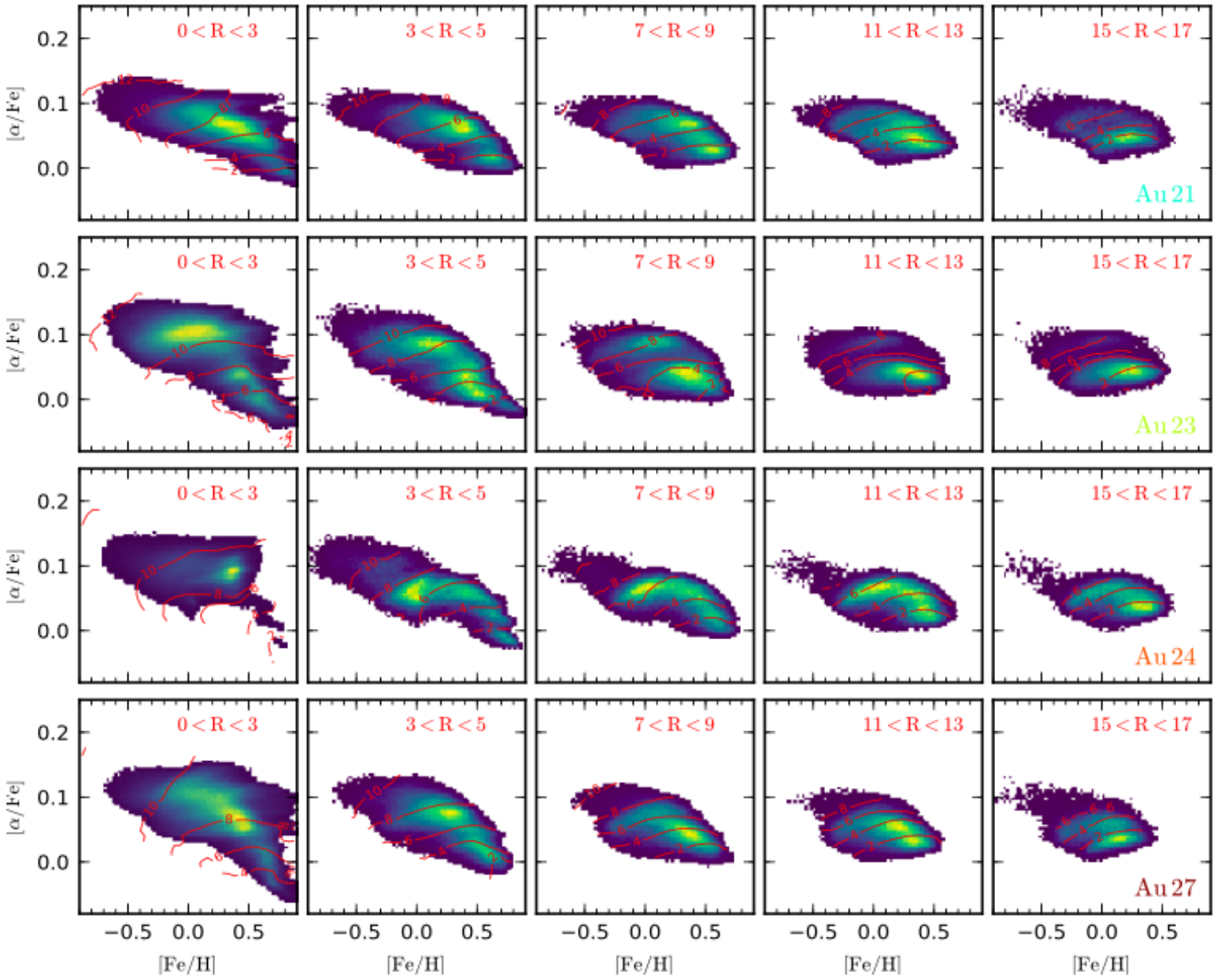
Grand et al 2017



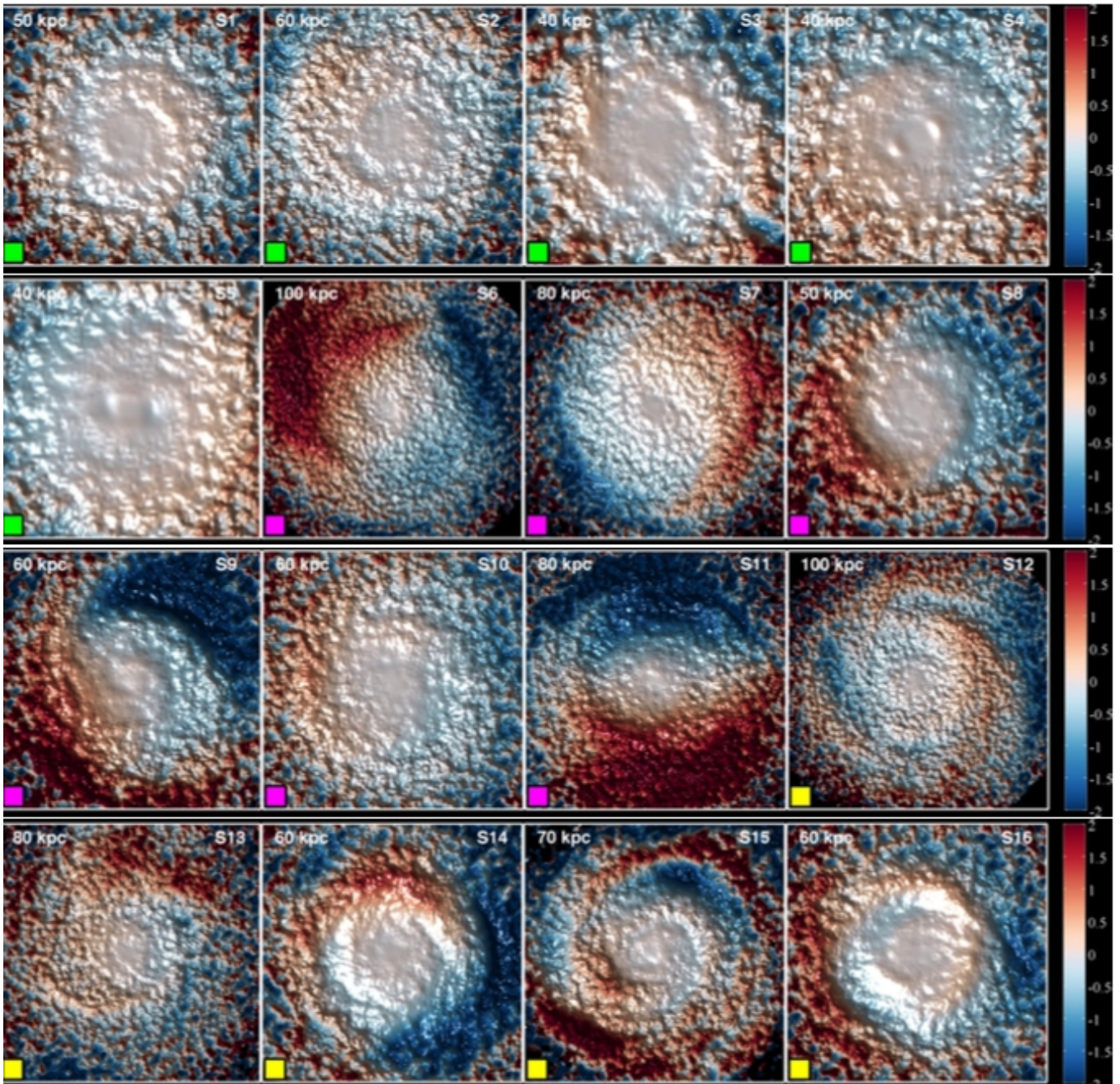


Multiple chemical sequences in disks?

Grand et al 2017b



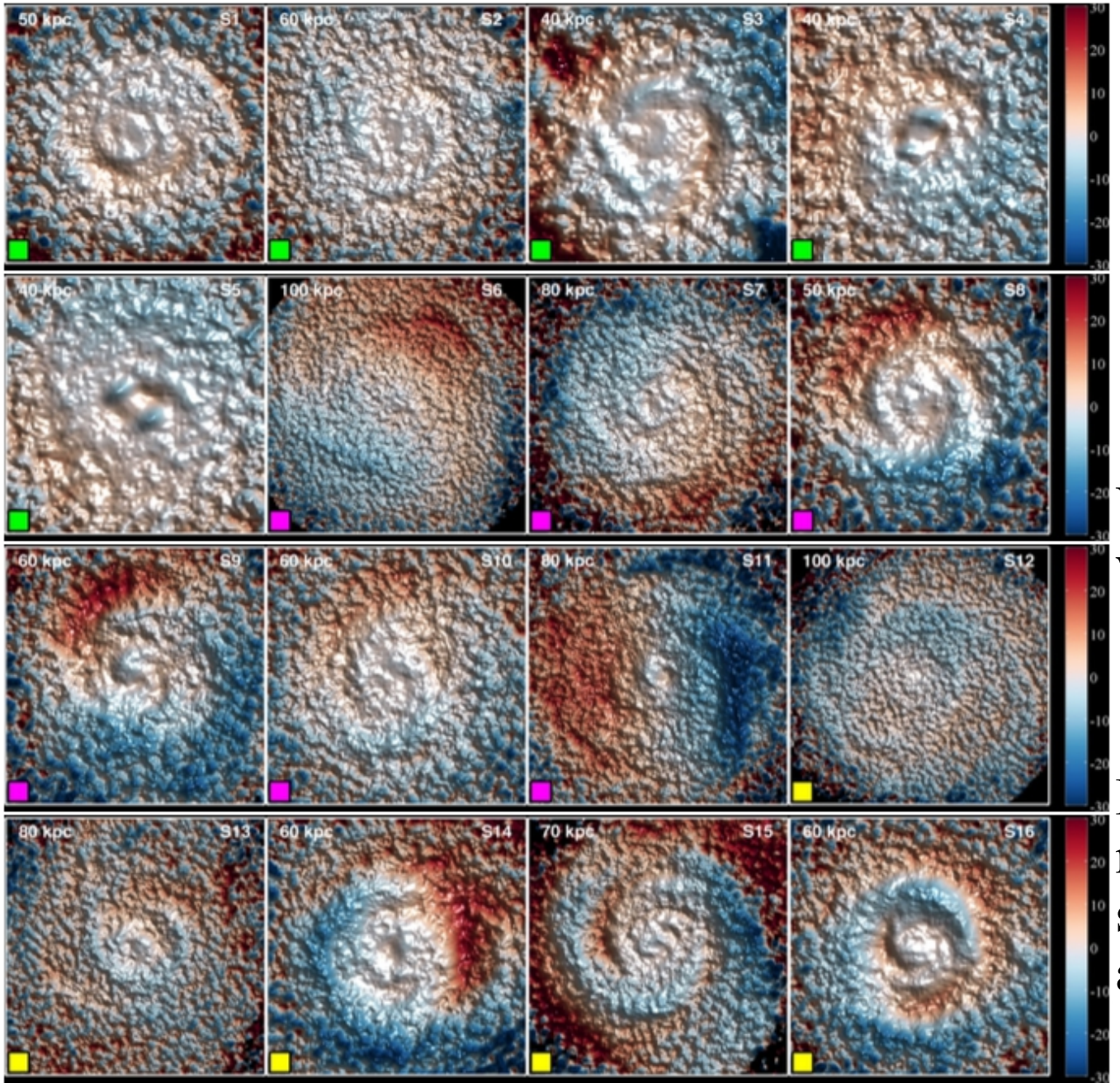
Warps and corrugations in Auriga disks



Gomez et al 2017

Height variations above and below the disk plane

Warps and corrugations in Auriga disks



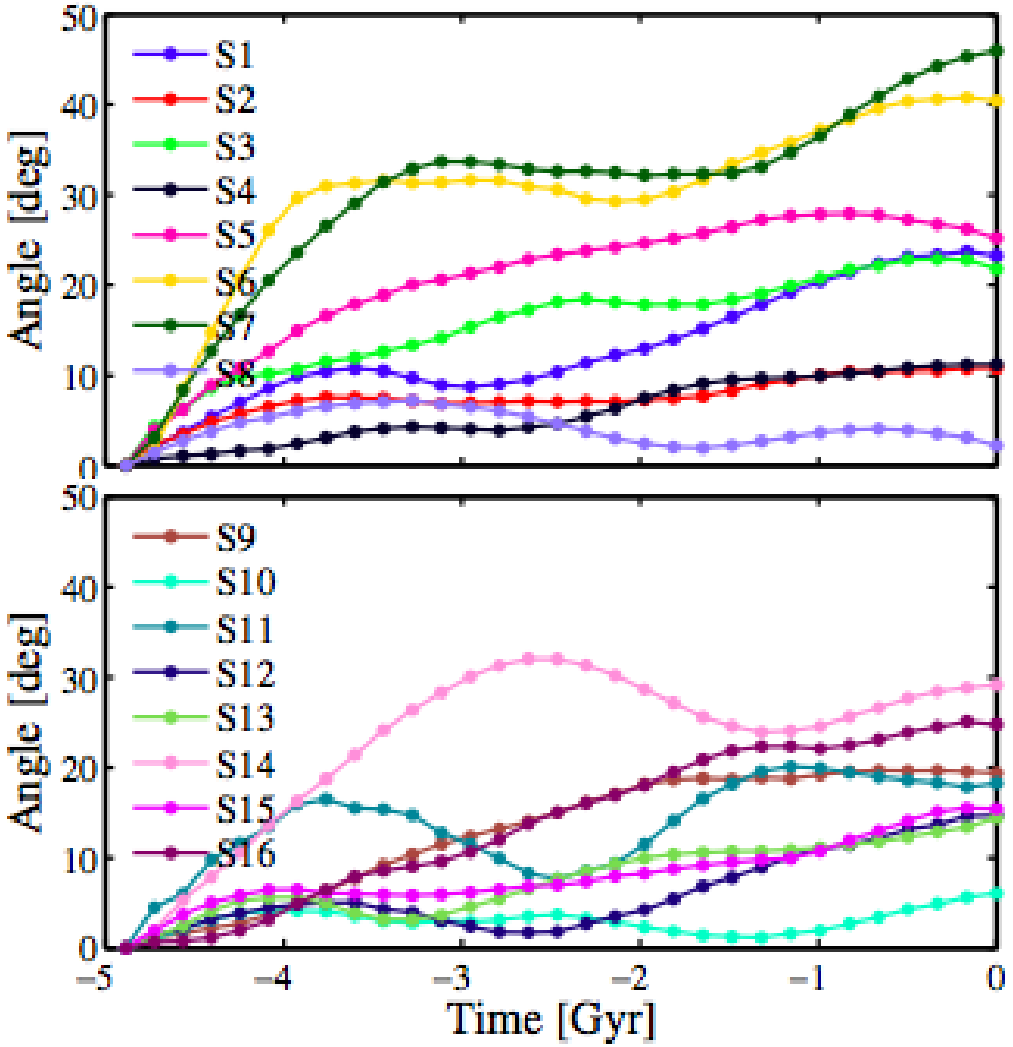
Gomez et al 2017

Vertical velocity variations w.r.t. the disk plane

Perturbations are due mostly to satellites but are sometimes caused by mis-aligned accretion of gas

Tilting of Auriga disks

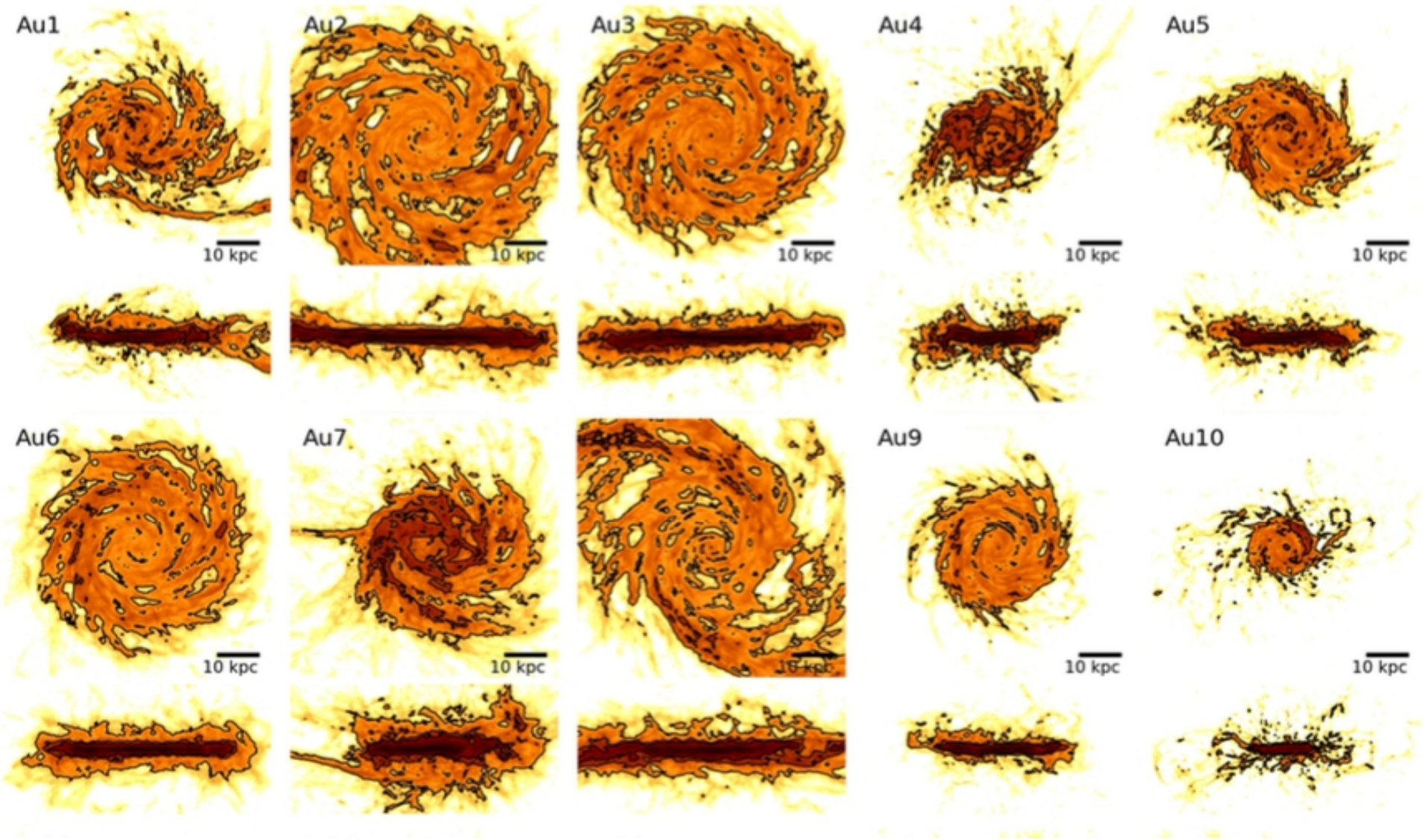
Gomez et al 2017



Disks typically tilt by 10° to 40° over the last 5 Gyr

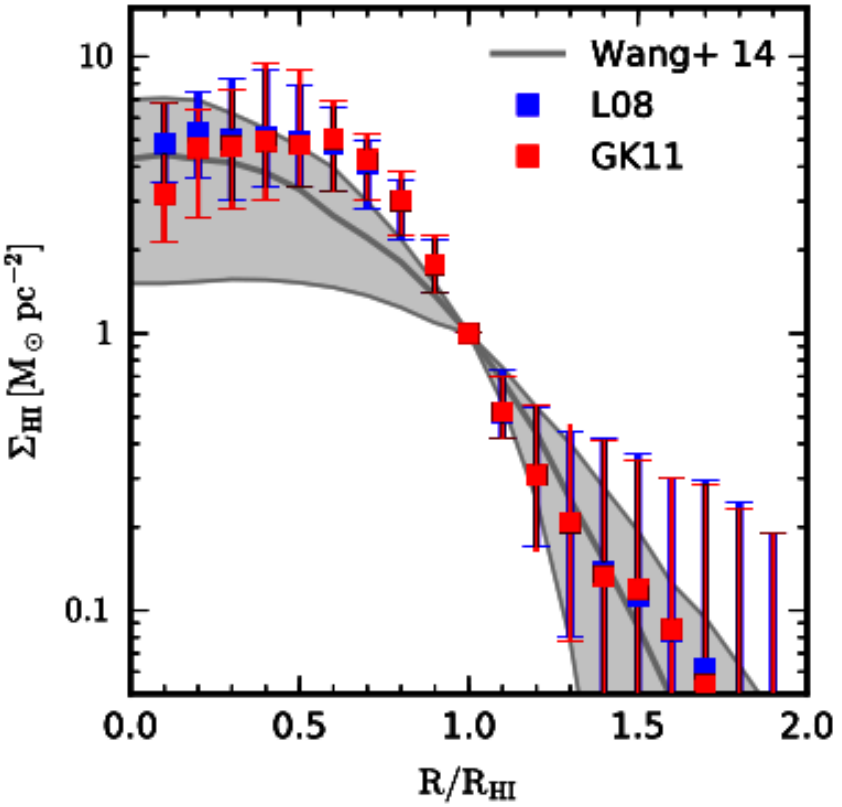
HI disks in Auriga

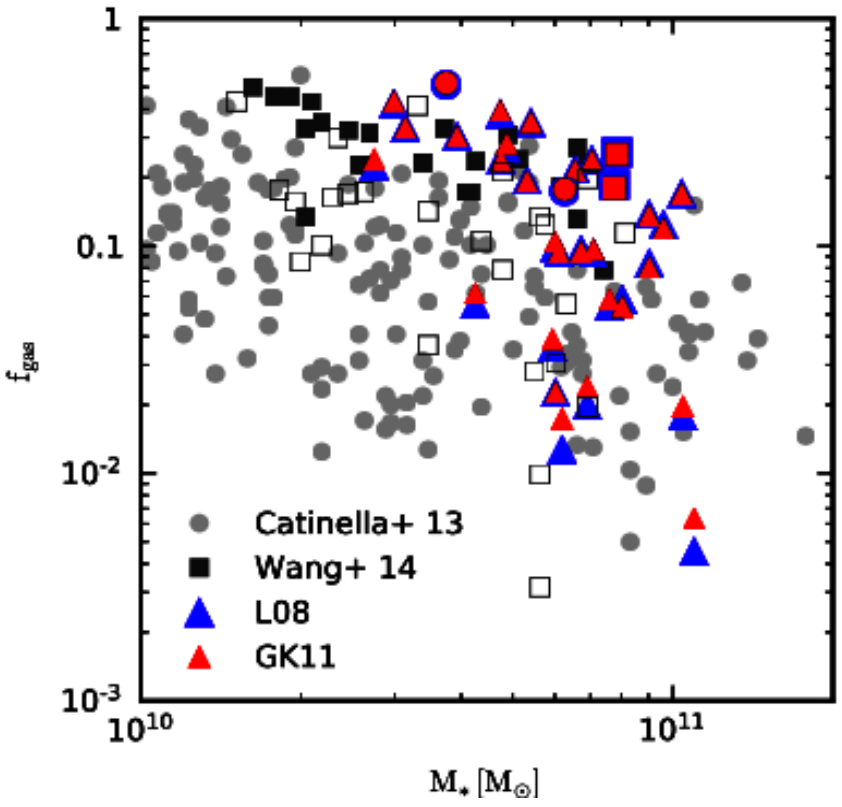
Marinacci et al 2017



HI disks in Auriga

Marinacci et al 2017

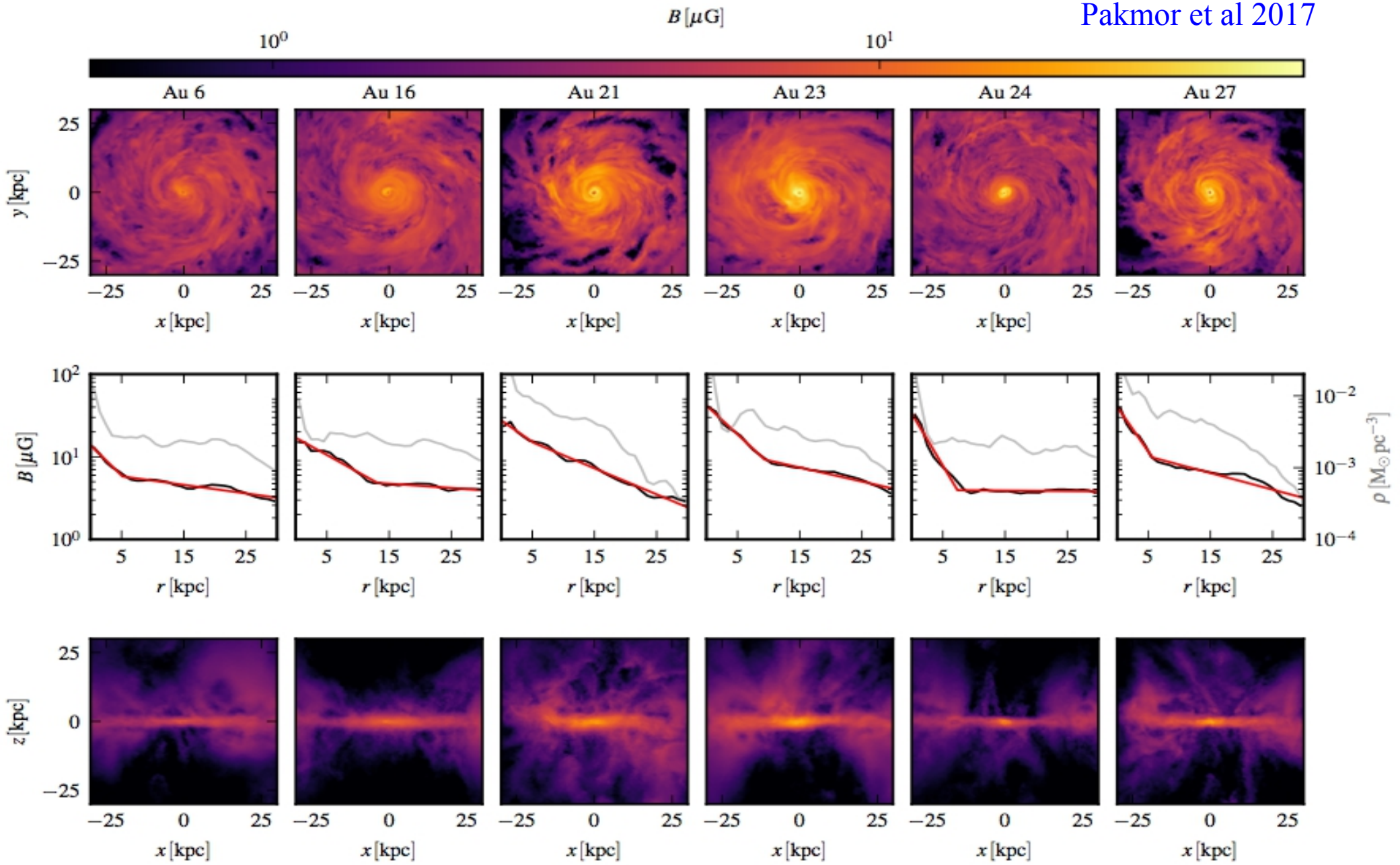




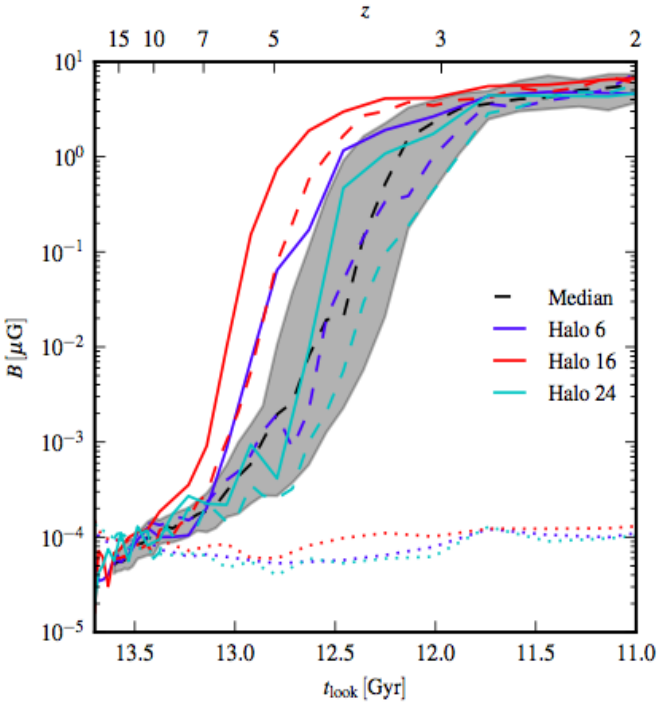
The HI profiles are the right shape but contain too much gas

Magnetic fields in Auriga disks

Pakmor et al 2017



Magnetic fields in Auriga disks

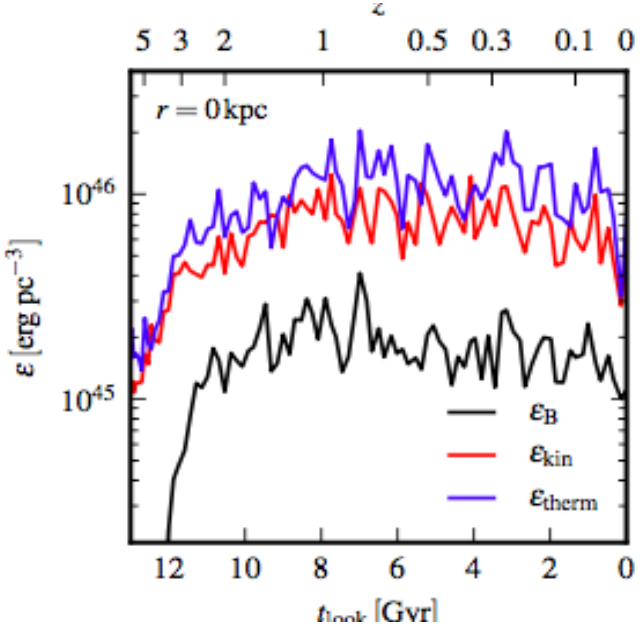


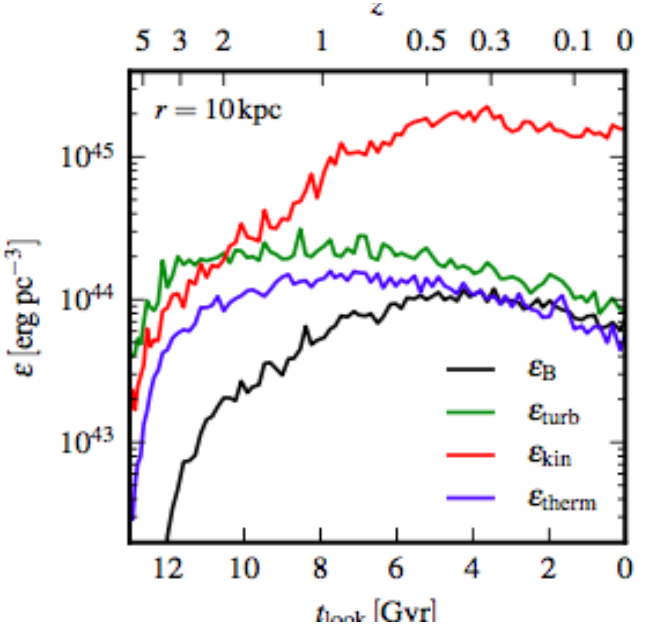
Pakmor et al 2017

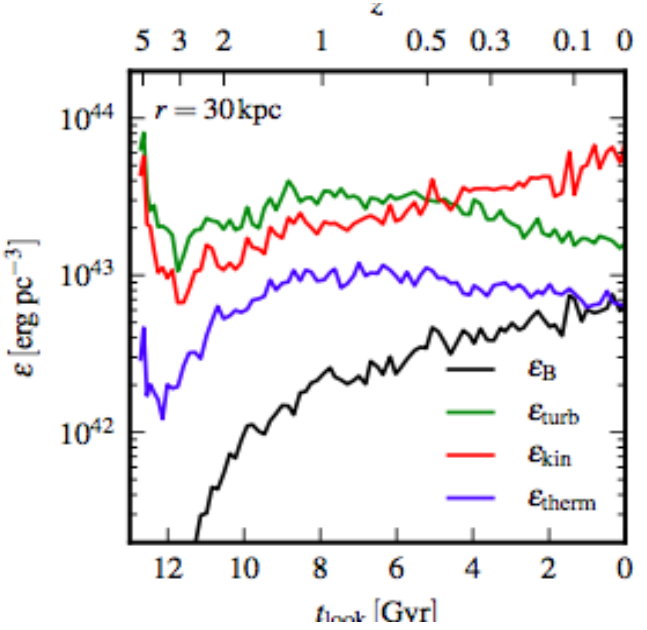
The initial field amplifies exponentially by more than four orders of magnitude in |B|

The field saturates below equipartition and has relatively minor dynamical effects

The next phase will be to include cosmic rays







Is Auriga good enough?

- Many properties are close (and converged) but some are clearly off
- ISM structure needs to be treated explicitly
- Wind generation and black hole growth need to be properly treated
- Comparison with the CGM remains to be done
- The relativistic particle component should be included
- Halos of other masses have to be considered