

A Comparison of Kinematic vs. Photometric Decompositions of Disk Galaxies

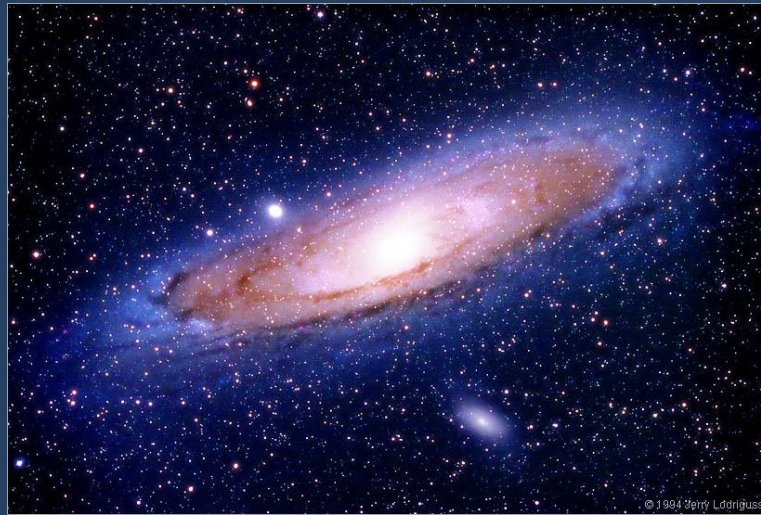
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The Light in Galaxies

- Measuring the radial light profiles of disk galaxies provides insight into their internal structures, formation and evolution
- These light profiles are usually divided into two components: disk and spheroidal bulge
- The ratio of light in bulge to light in disk (B/D) is often used as a proxy for their stellar mass ratios



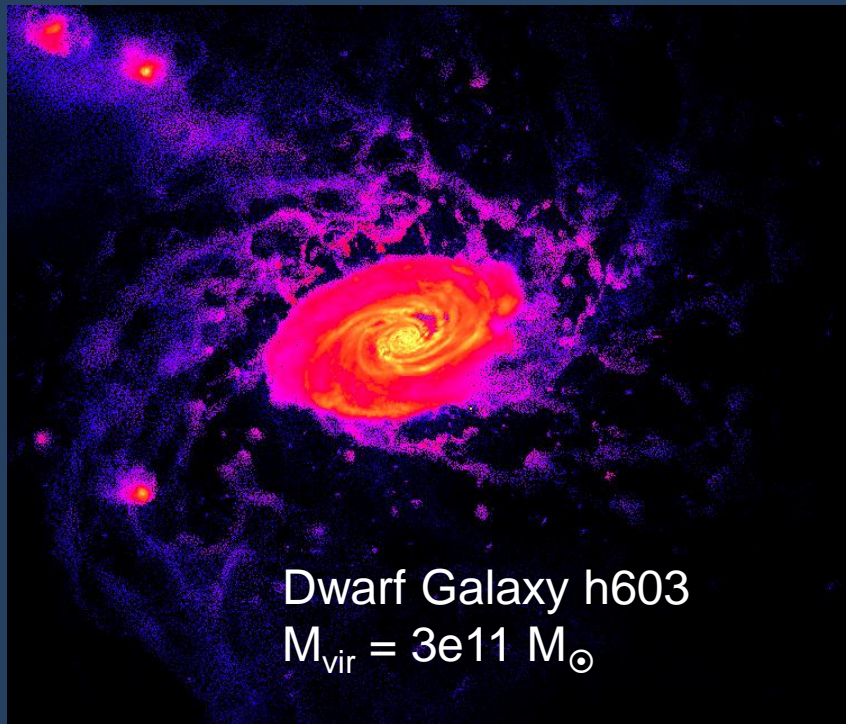
Motivation for Study?

- Increasingly apparent that disk galaxies are complex dynamical systems
- They have stellar rings, bars, star streams in their halos, and pseudo-bulges.
- Even the disk is divided into thin and thick components with separate kinematic properties and stellar populations.
- **How to model light distribution?**



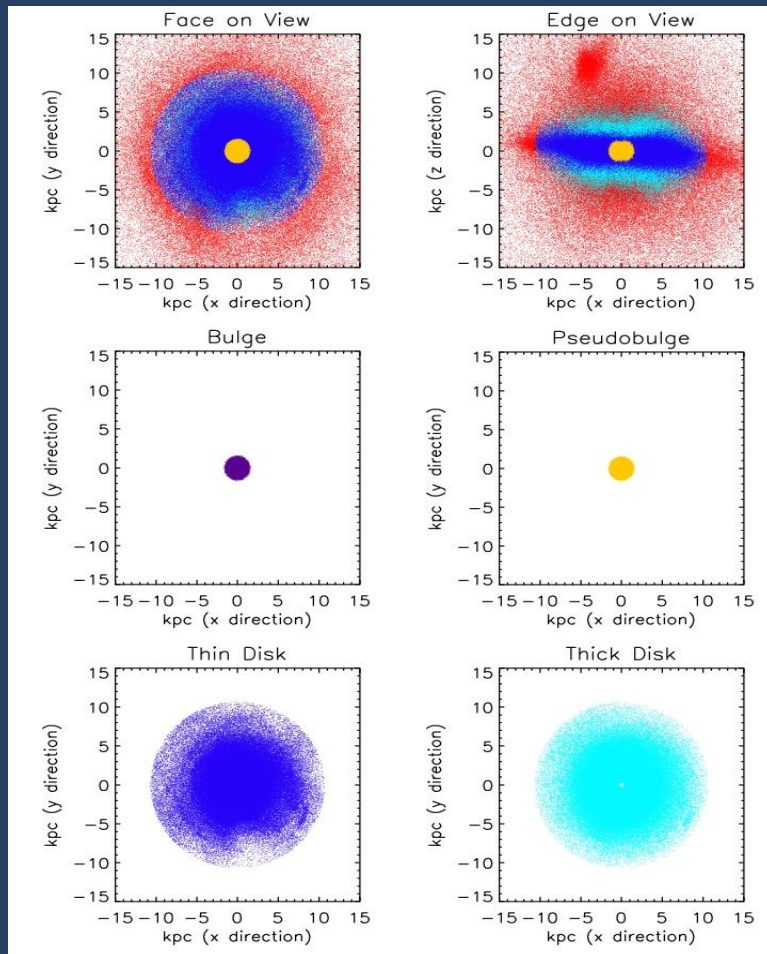
All images credit: NASA/ESA and The Hubble Heritage Team STScI/AURA)

Cosmological Galaxy Simulations in GASOLINE



We use high resolution simulations of disk galaxies to examine how the two-component decomposition based on light profiles relates to the underlying stellar mass distribution of the galaxy and its dynamical properties.

Kinematic Decomposition

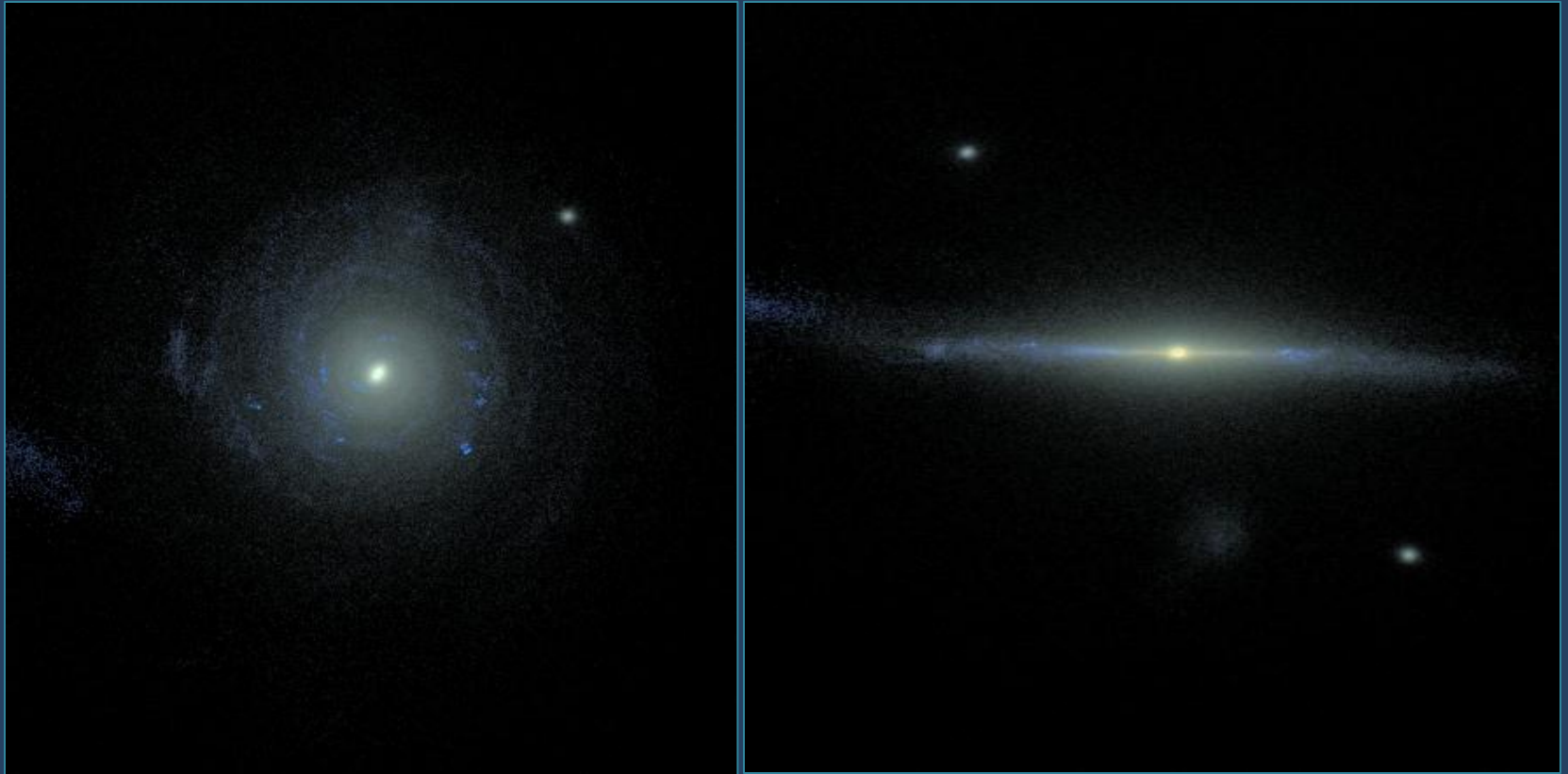


- The kinematic decomposition divides up a simulated galaxy using the kinematics and binding energy of each stellar particle.
- Thin disk, thick disk and pseudo-bulge are usually grouped to define kinematic B/D.

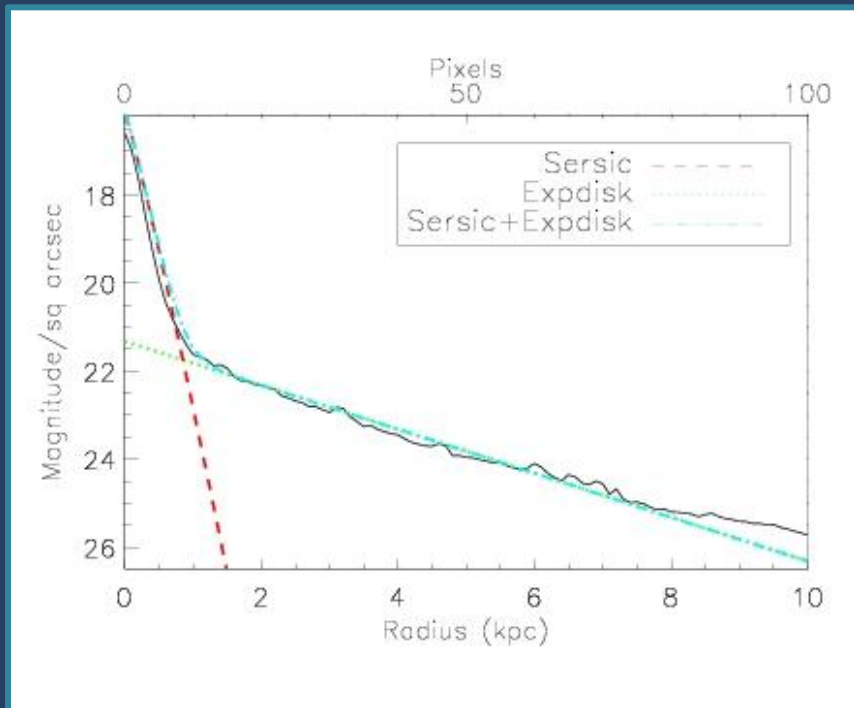
Photometric Decompositions?

- Remember, this is the classic observation-style decomposition...
- But we have simulation data – particles representing big star clusters. What to do?
- Use the SUNRISE software package to produce observation-style images from simulation data

Example of Galaxy Simulation Processed with SUNRISE

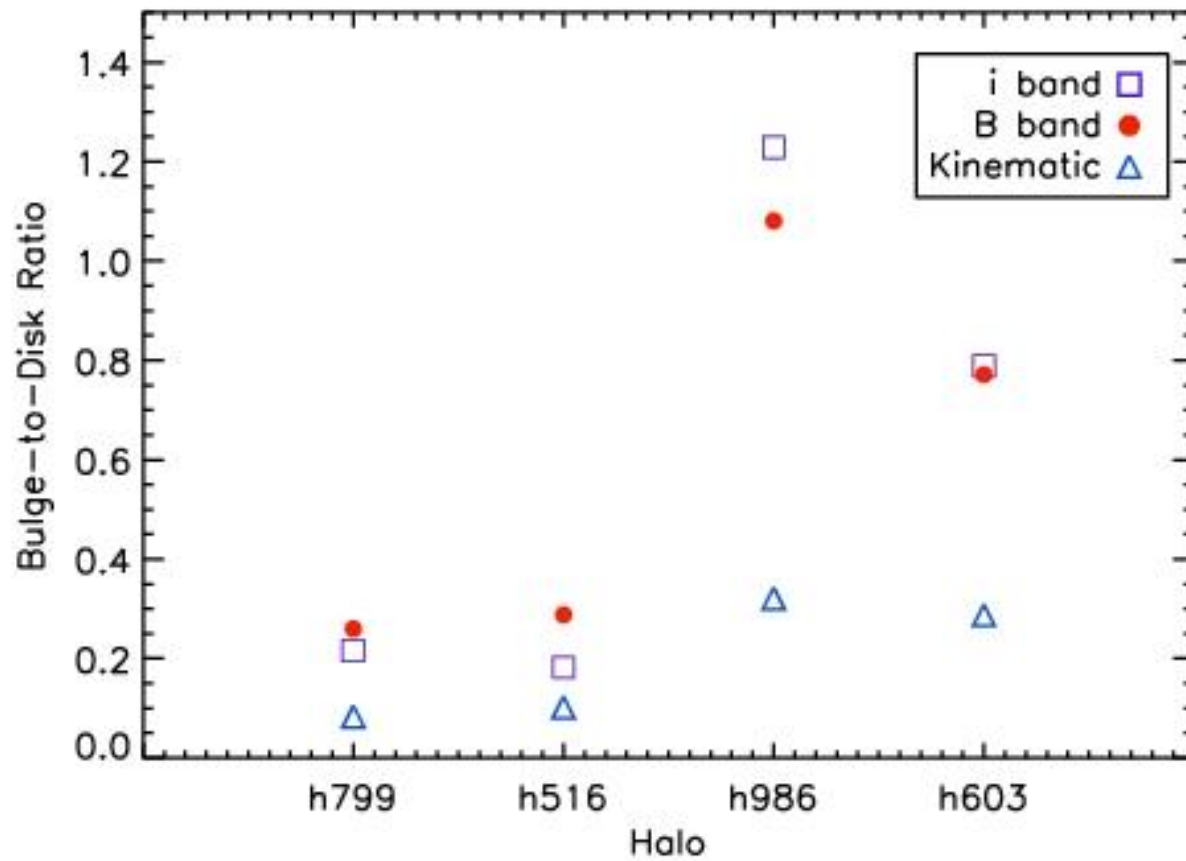


Photometric Decompositions!

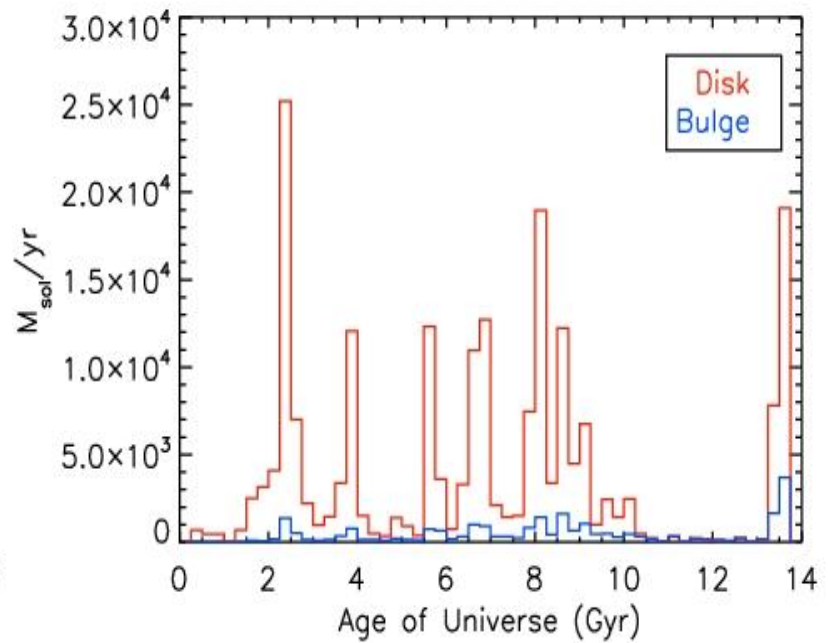
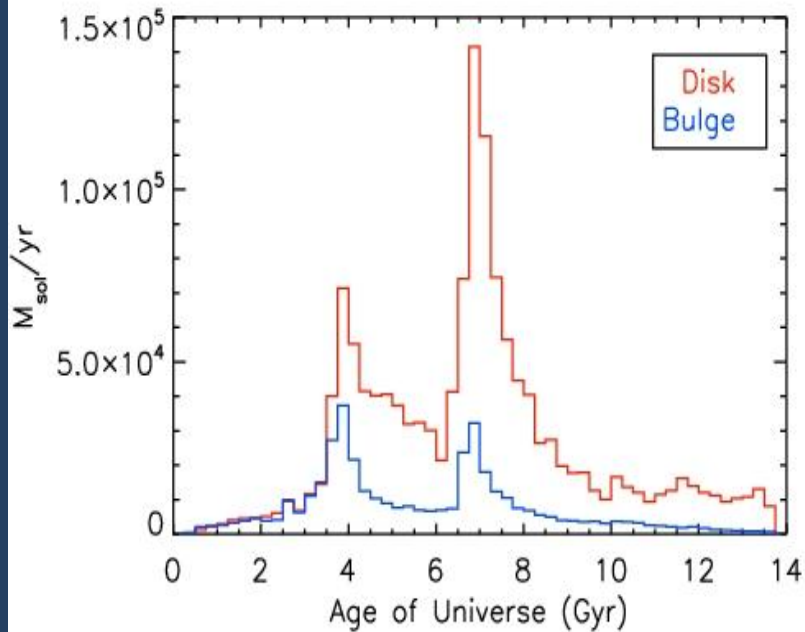


- Photometric decomposition performed using GALFIT
- Simultaneously fit bulge and disk components to images
- B/D is the ratio of the central surface of the bulge to the central surface brightness of the disk.

Results:



Star Formation Histories



Conclusions

- In all four cases considered, kinematic B/D ratio is significantly lower than photometric B/D ratio. This is due to the fact that photometric “bulges” include contributions from halo and pseudo-bulge stars.
- The bulge-to-disk ratios of the more massive galaxies are higher than the dwarf galaxies
- The kinematic decomposition yields realistic star formation histories which suggests that the kinematic decomposition correctly traces underlying mass distribution.

Next Steps

- Refine photometric decompositions (photometric B/D still too high)
- Develop some relationship between kinematic and photometric B/D useful to observers!
- Improve simulations themselves (black hole feedback!)