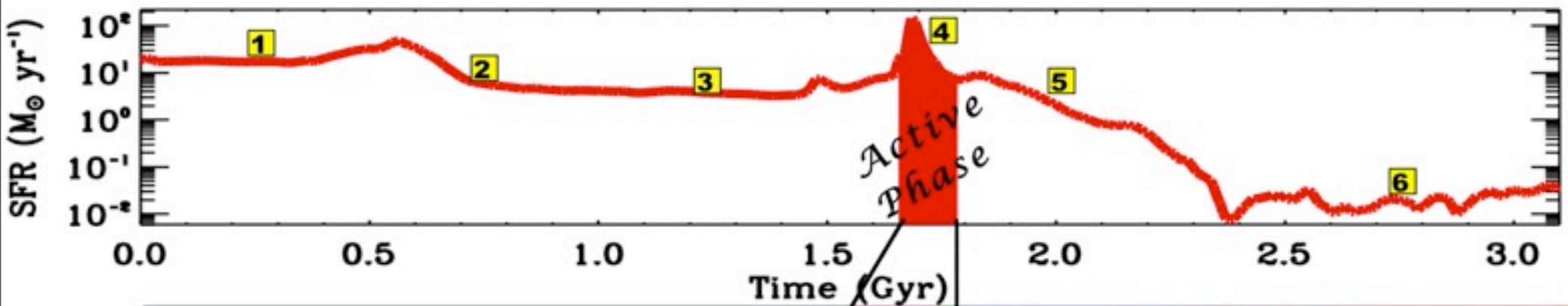


# Dealing with large ensembles of simulations

# Dealing with large ensembles of simulations: why?

- Beat down randomness/noise



### Multiple Nuclei

- the majority of stars are formed

**Starburst-driven (transitioning to QSO) winds**

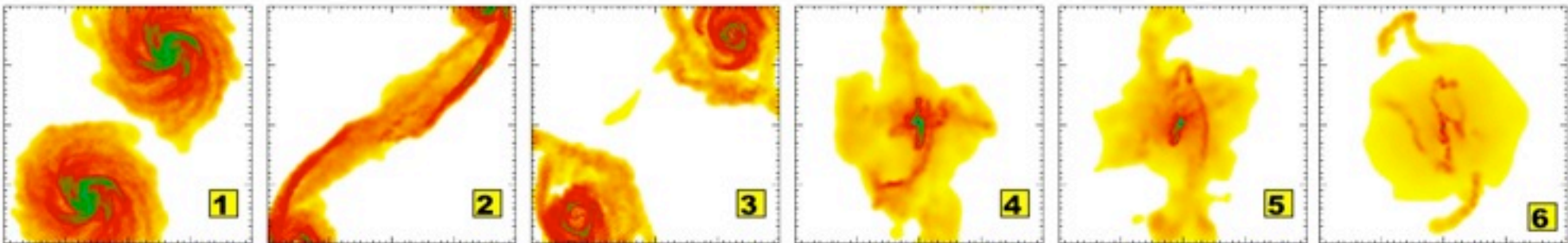
(U)LIRG

QSO

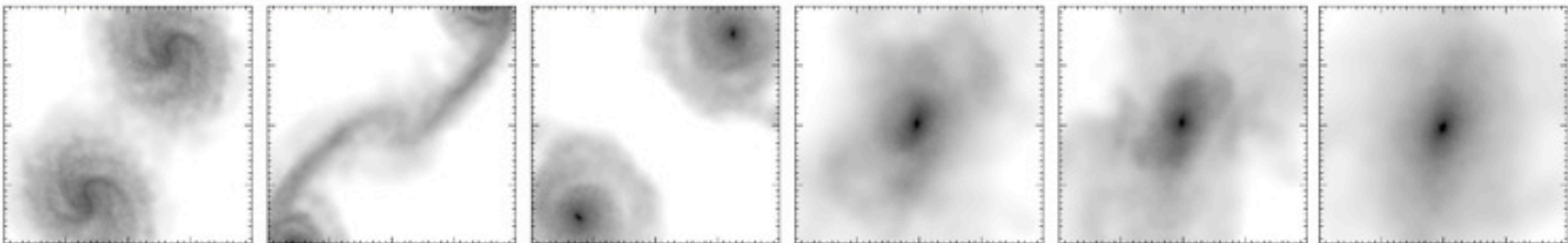
### Merger Remnant → Elliptical

- kinematics: tidal tails, shells, plumes & loops, kinematic subsystems
- colors redden
- formation of a hot gaseous halo
- declining AGN activity
- satisfies  $M_{BH} - \sigma$  & FP

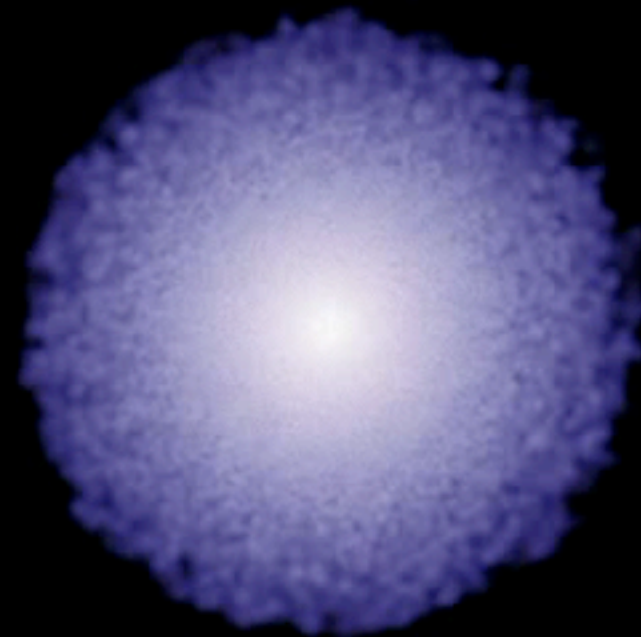
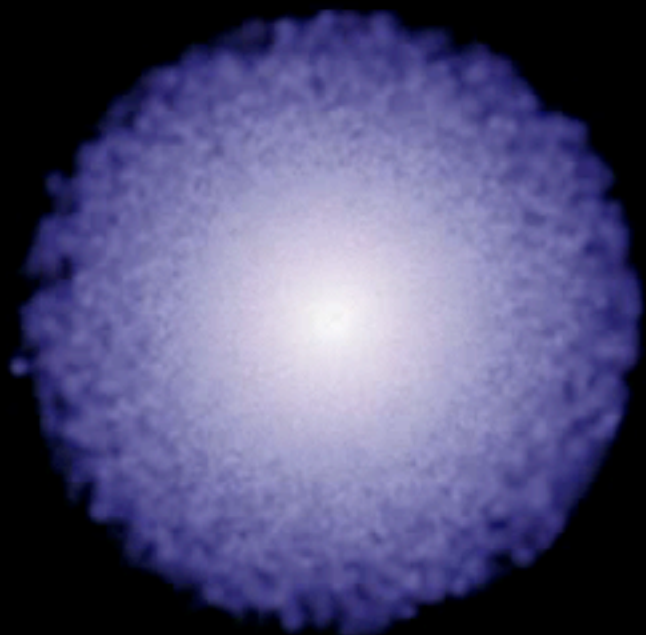
**Gas**




**Stars**



T = 0 Myr



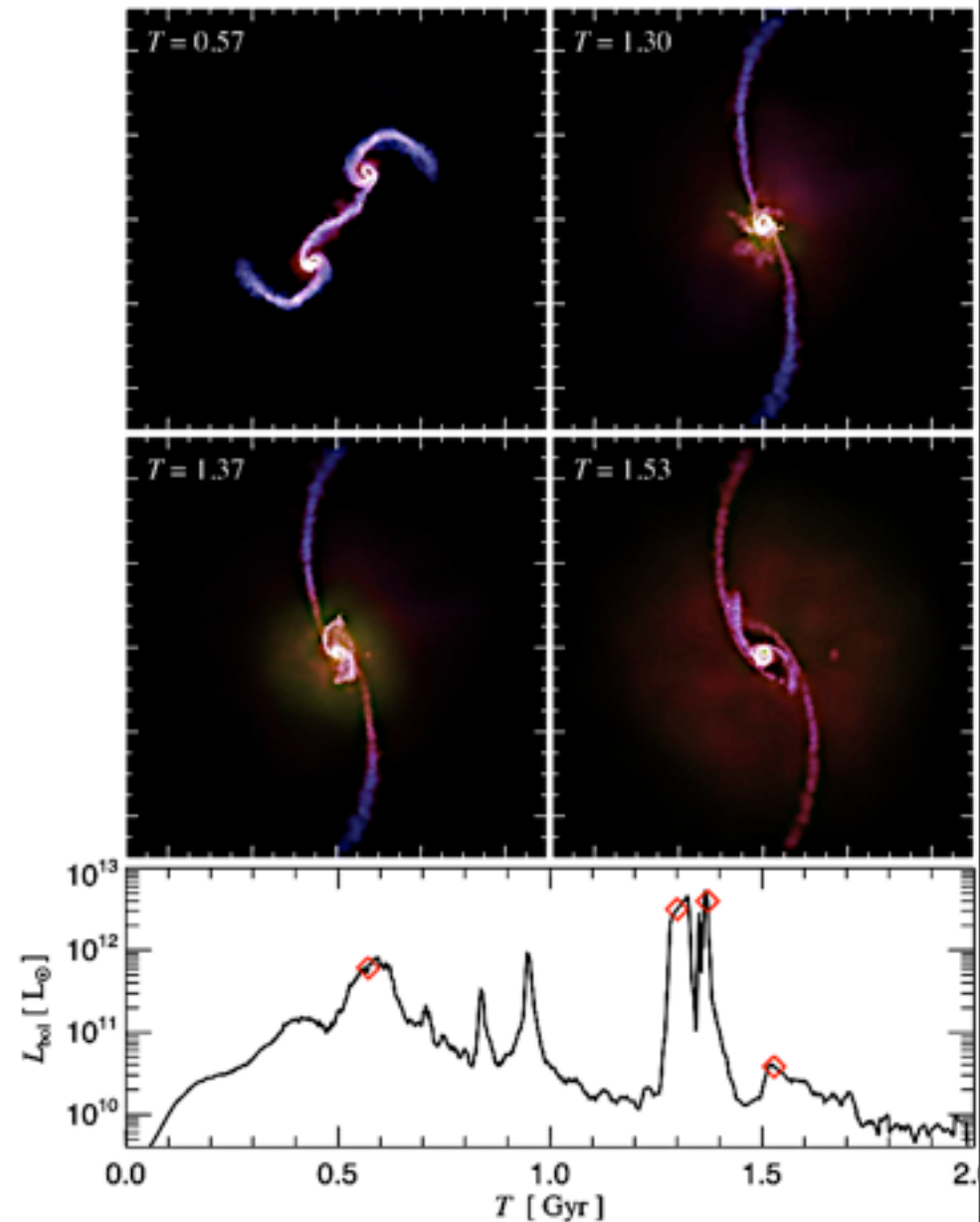
10 kpc/h





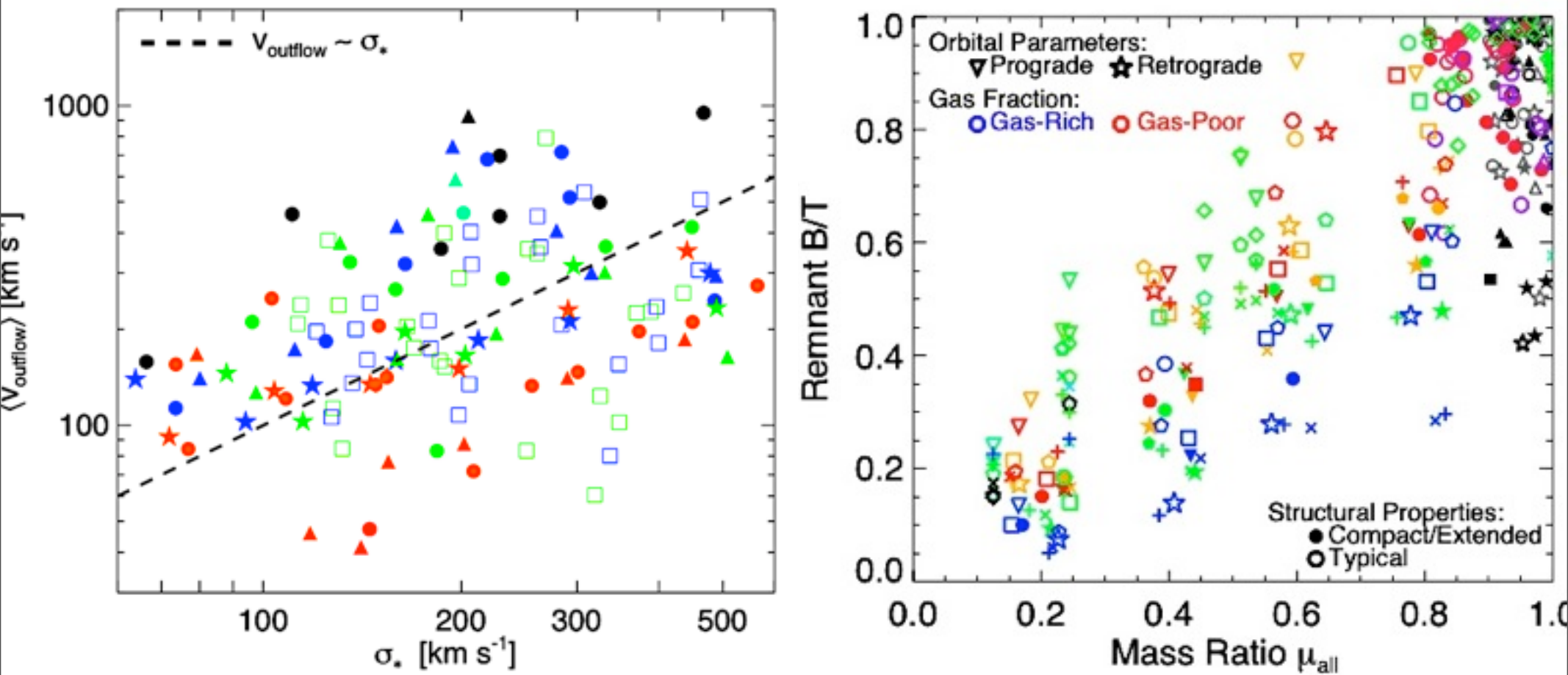
# Dealing with large ensembles of simulations: why?

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# Dealing with large ensembles of simulations: why?

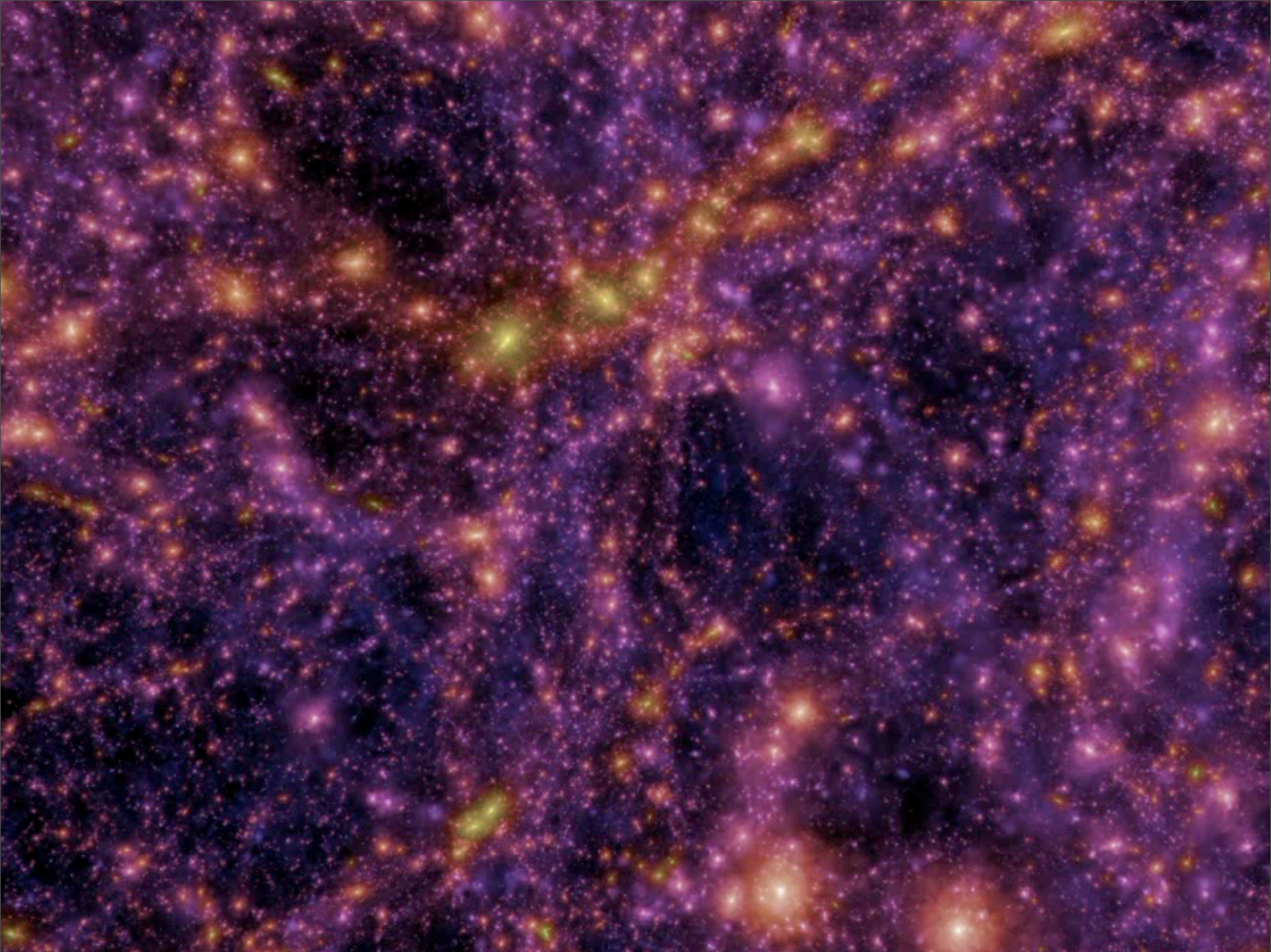
- Beat down randomness/noise



# Dealing with large ensembles of simulations: why?

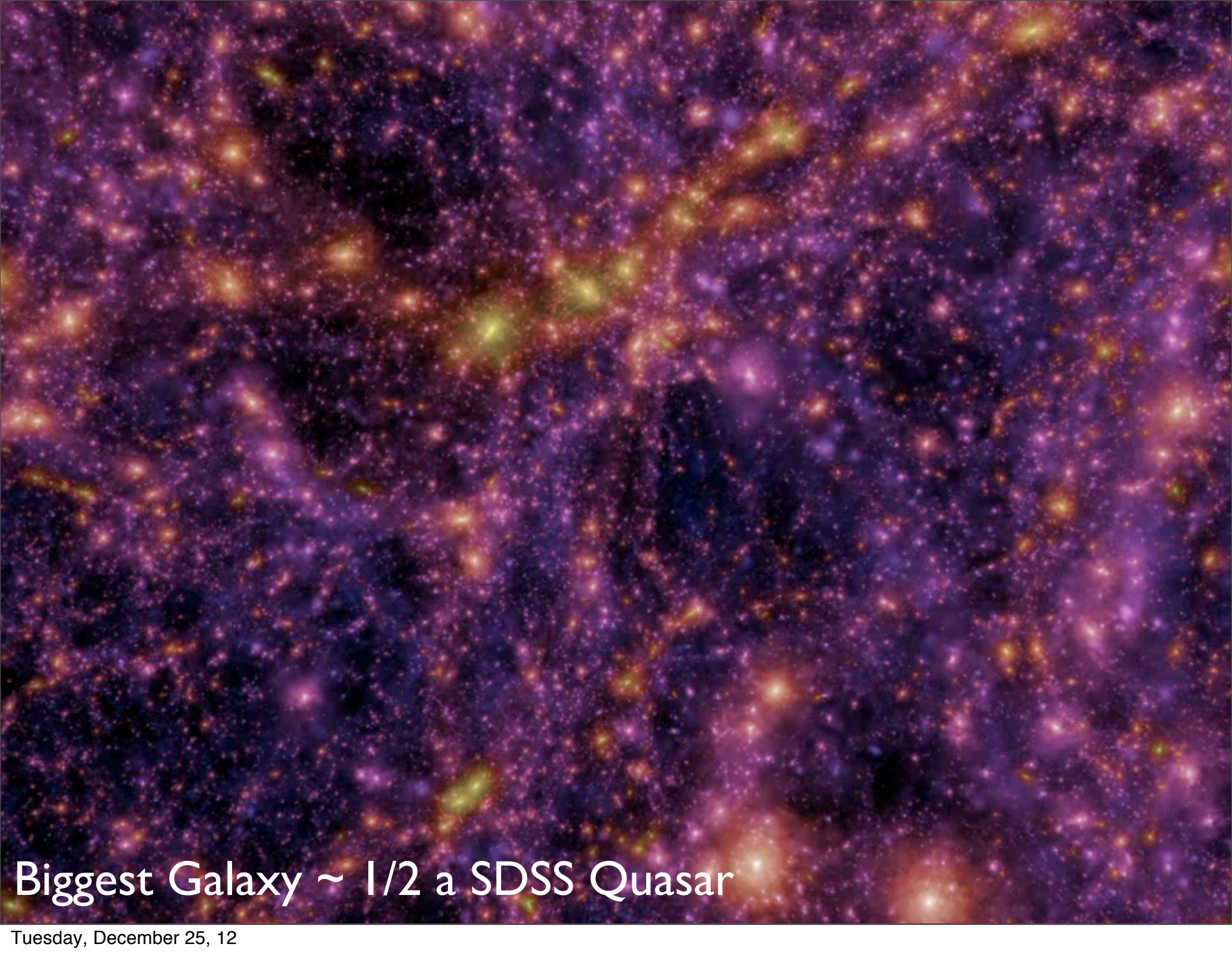
- Beat down randomness/noise
- Dynamic range
  - Cosmological:





Tuesday, December 25, 12

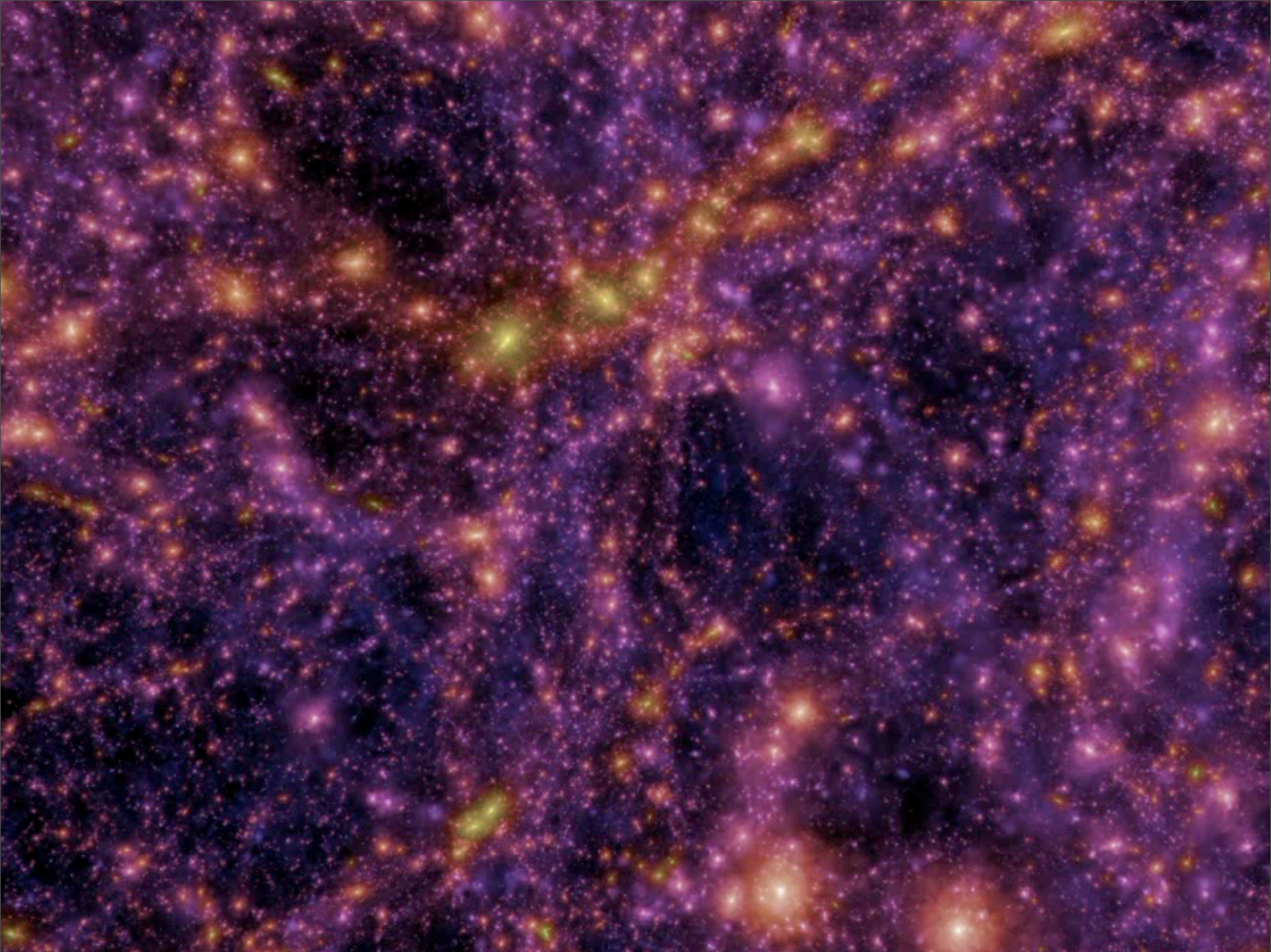




Biggest Galaxy  $\sim$  1/2 a SDSS Quasar

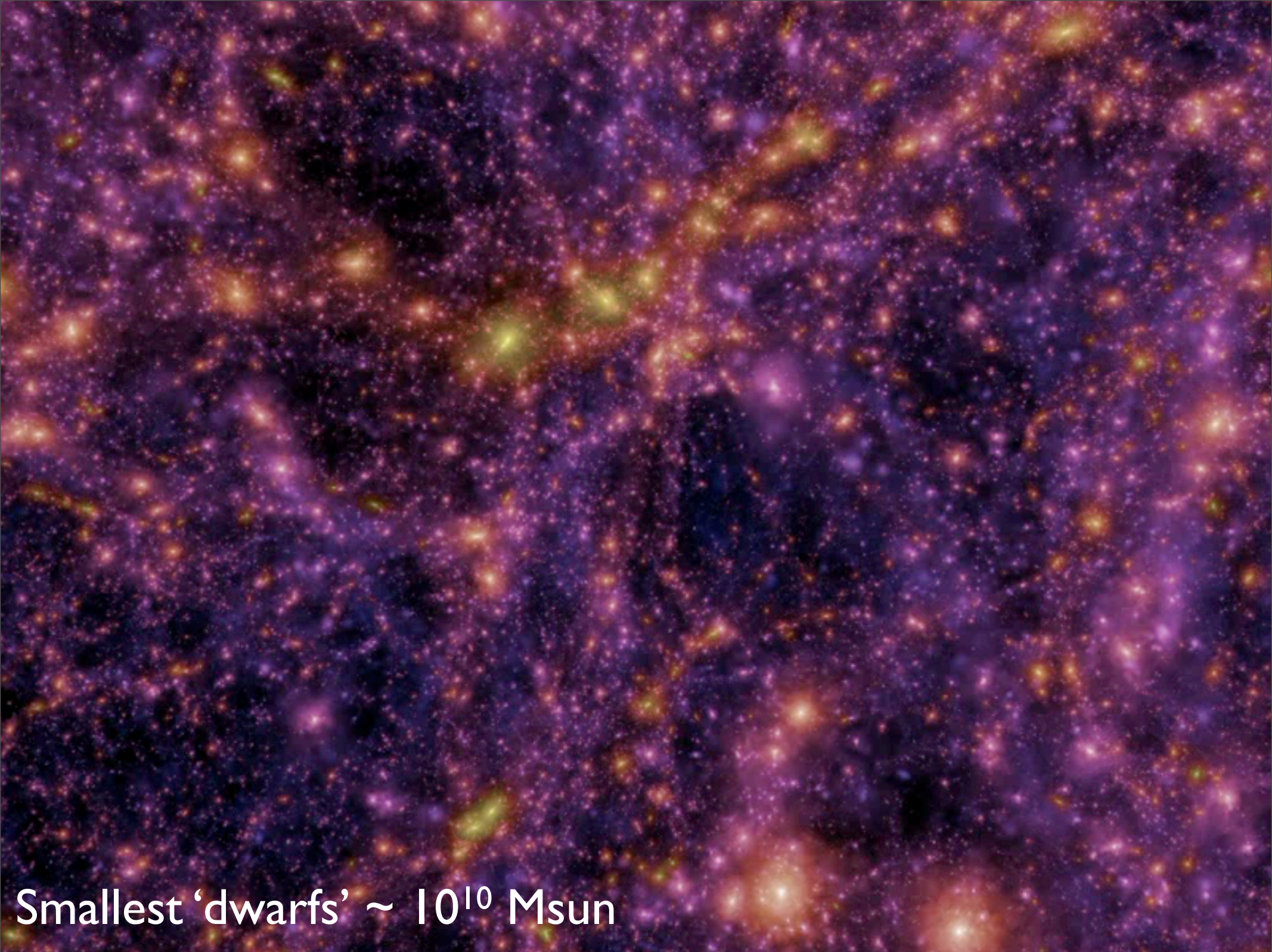
Tuesday, December 25, 12





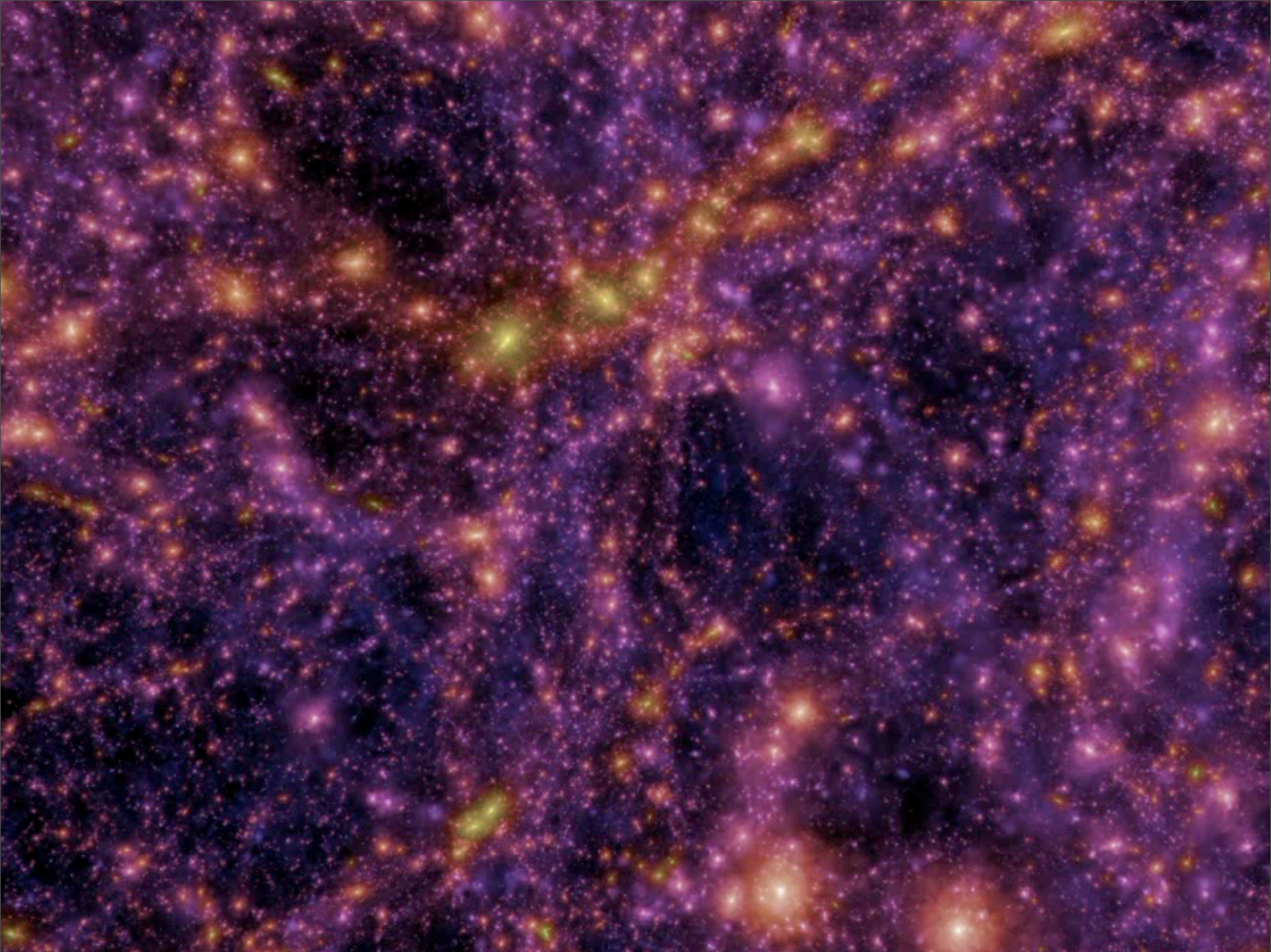
Tuesday, December 25, 12





Smallest 'dwarfs'  $\sim 10^{10}$  Msun





Tuesday, December 25, 12

# Dealing with large ensembles of simulations: why?

- Beat down randomness/noise
- Dynamic range
  - Cosmological:
  - ‘Re-simulation’ Techniques:

# Dealing with large ensembles of simulations: why?

- Beat down randomness/noise
- Dynamic range
  - Cosmological:
  - ‘Zoom-in’ Techniques:

# Dealing with large ensembles of simulations: why?

- Beat down randomness/noise
- Dynamic range
- Parameter Studies



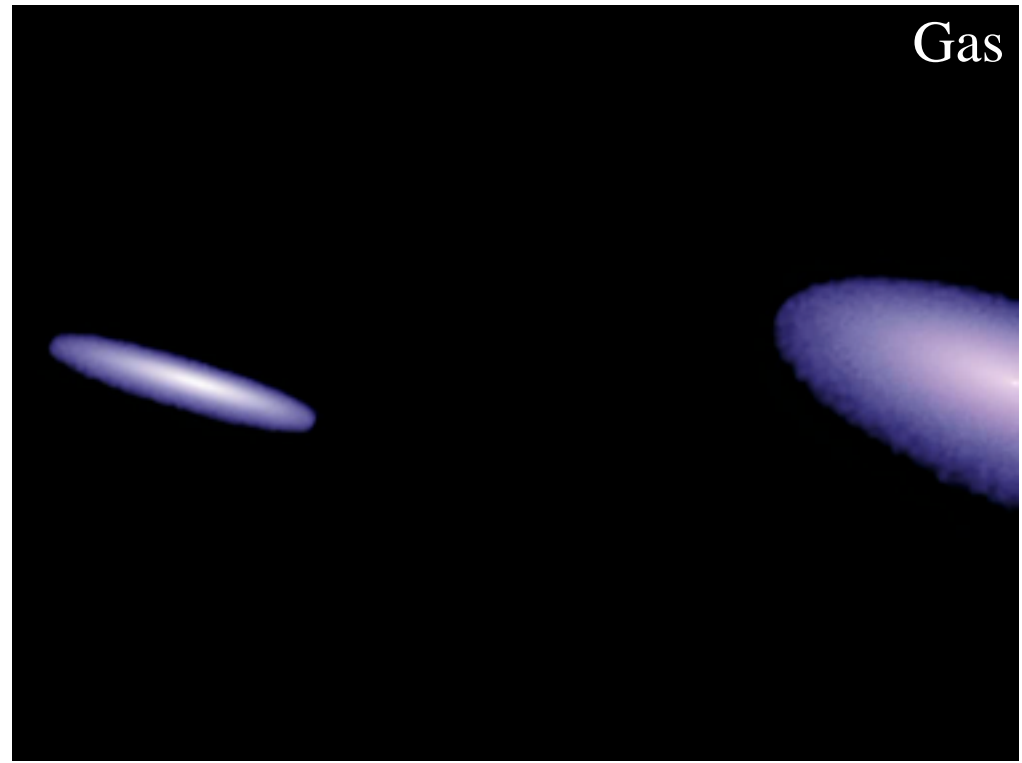
# Gas-Poor vs Gas-Rich Merger

Gas-Poor(ish) ( $f_{\text{gas}} \sim 0.1$ )

Stars

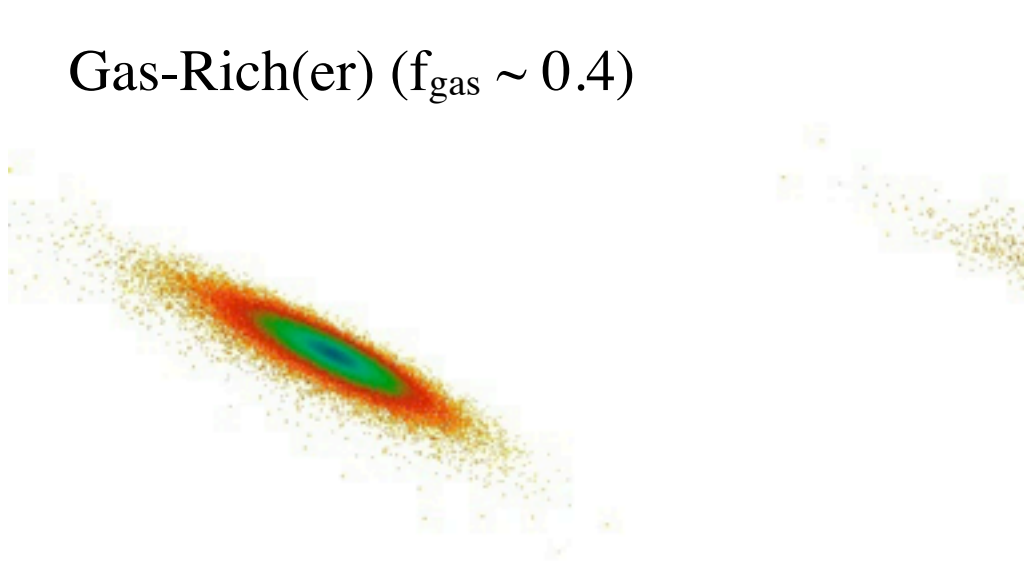


Gas



Gas-Rich(er) ( $f_{\text{gas}} \sim 0.4$ )

stars



gas



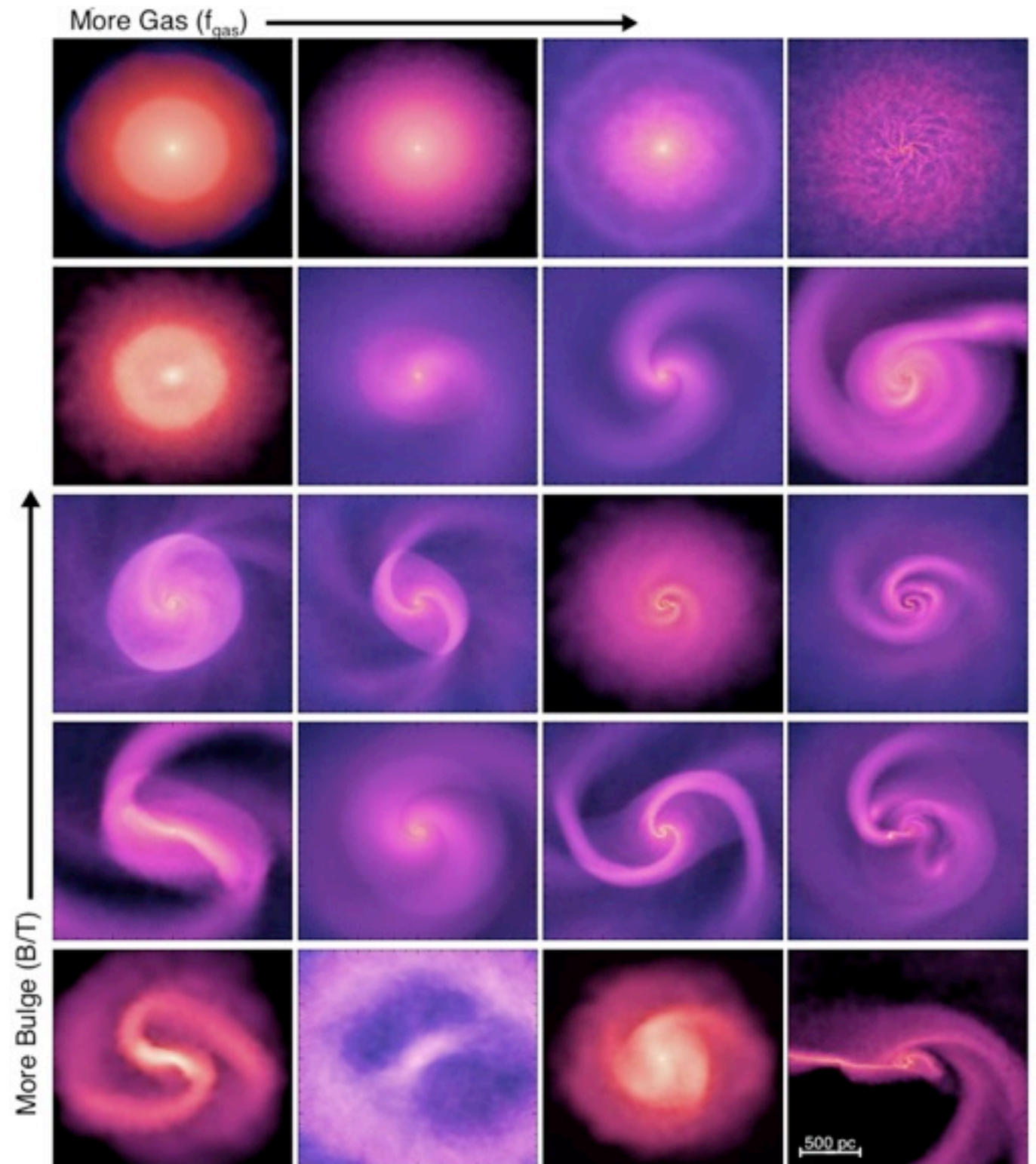
# Dealing with large ensembles of simulations: why?

- Beat down randomness/noise
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- Parameter Studies
  - “Known Unknowns” (e.g. dynamics)

“known  
unknowns”



“known  
unknowns”

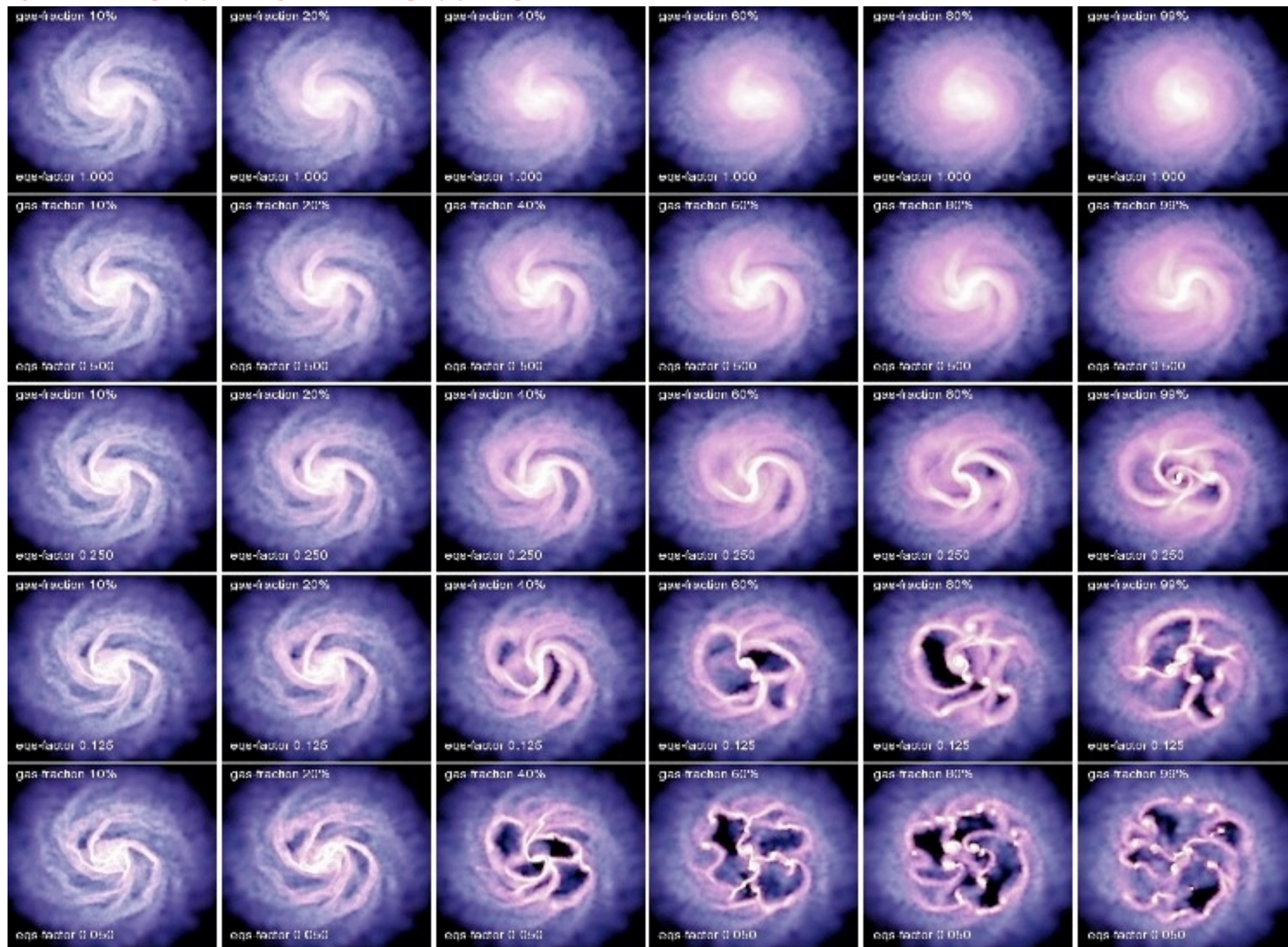


# Dealing with large ensembles of simulations: why?

- Beat down randomness/noise
- Dynamic range
- Parameter Studies
  - “Known Unknowns” (e.g. dynamics)
  - “Unknown Unknowns” (e.g. feedback)



# “unknown unknowns”



# Sampling: How to Do It?

- Cosmological Simulations
- ‘Uniform’

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# Sampling: How to Do It?

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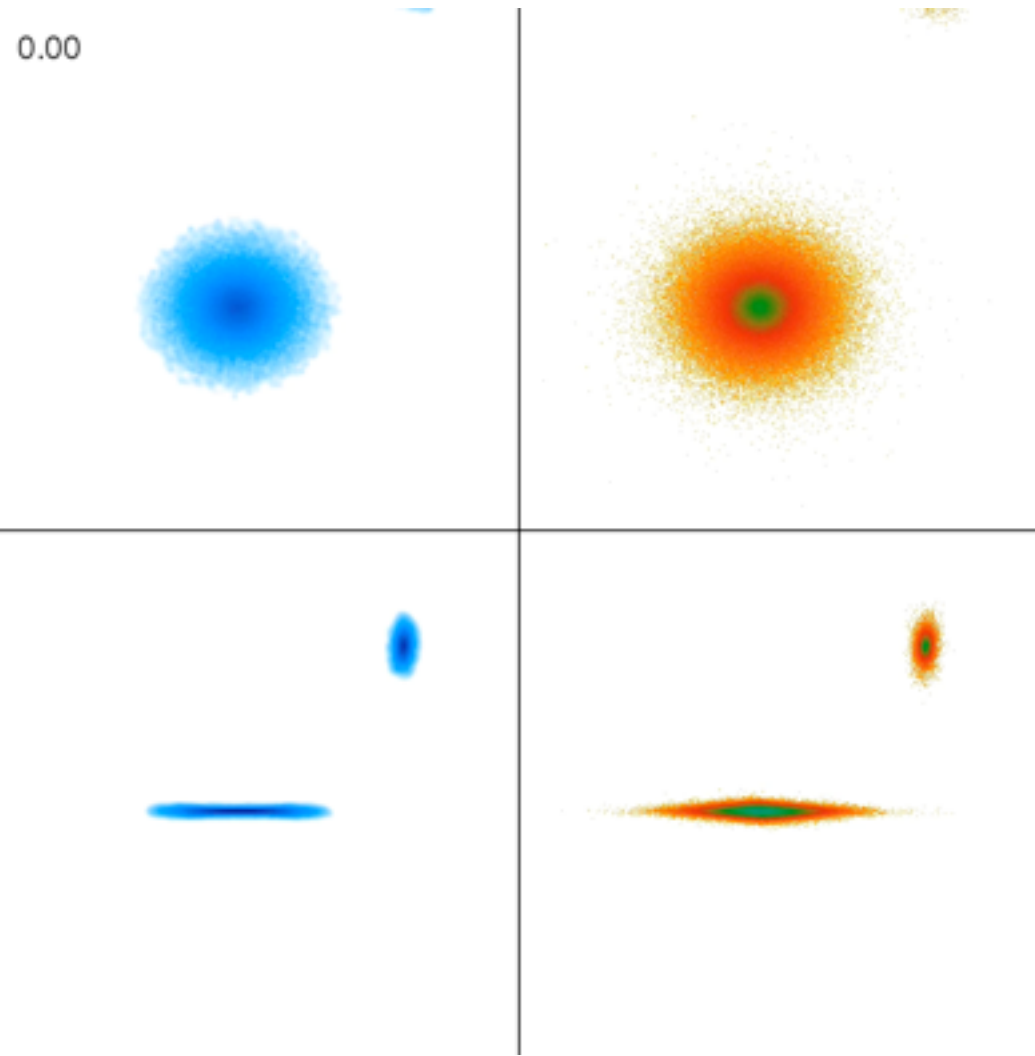
# Sampling: How to Do It?

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  - How densely do you need to sample?

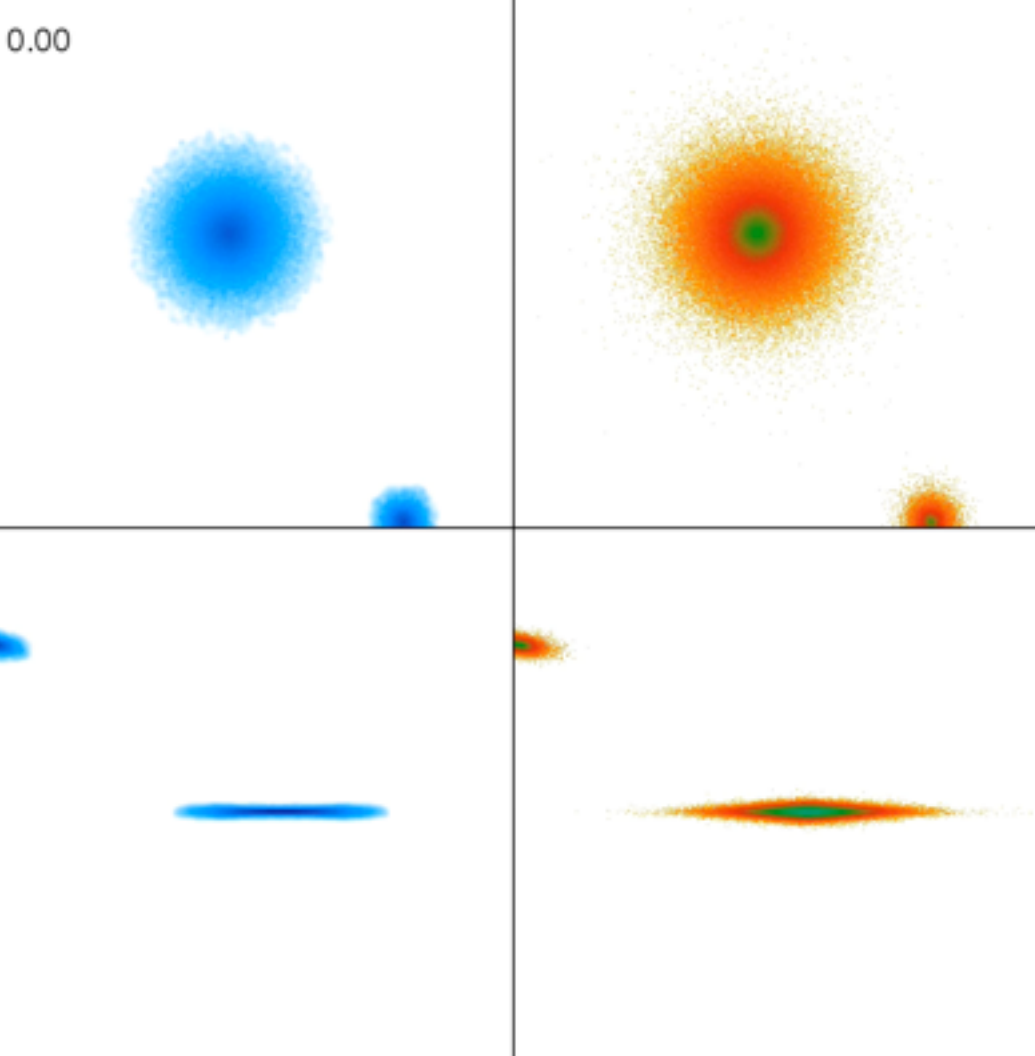
# Sampling: How to Do It?

- ‘Uniform’
  - What does that mean?
  - Where do you cut off?
  - How densely do you need to sample?
  - How do you compare to observations?

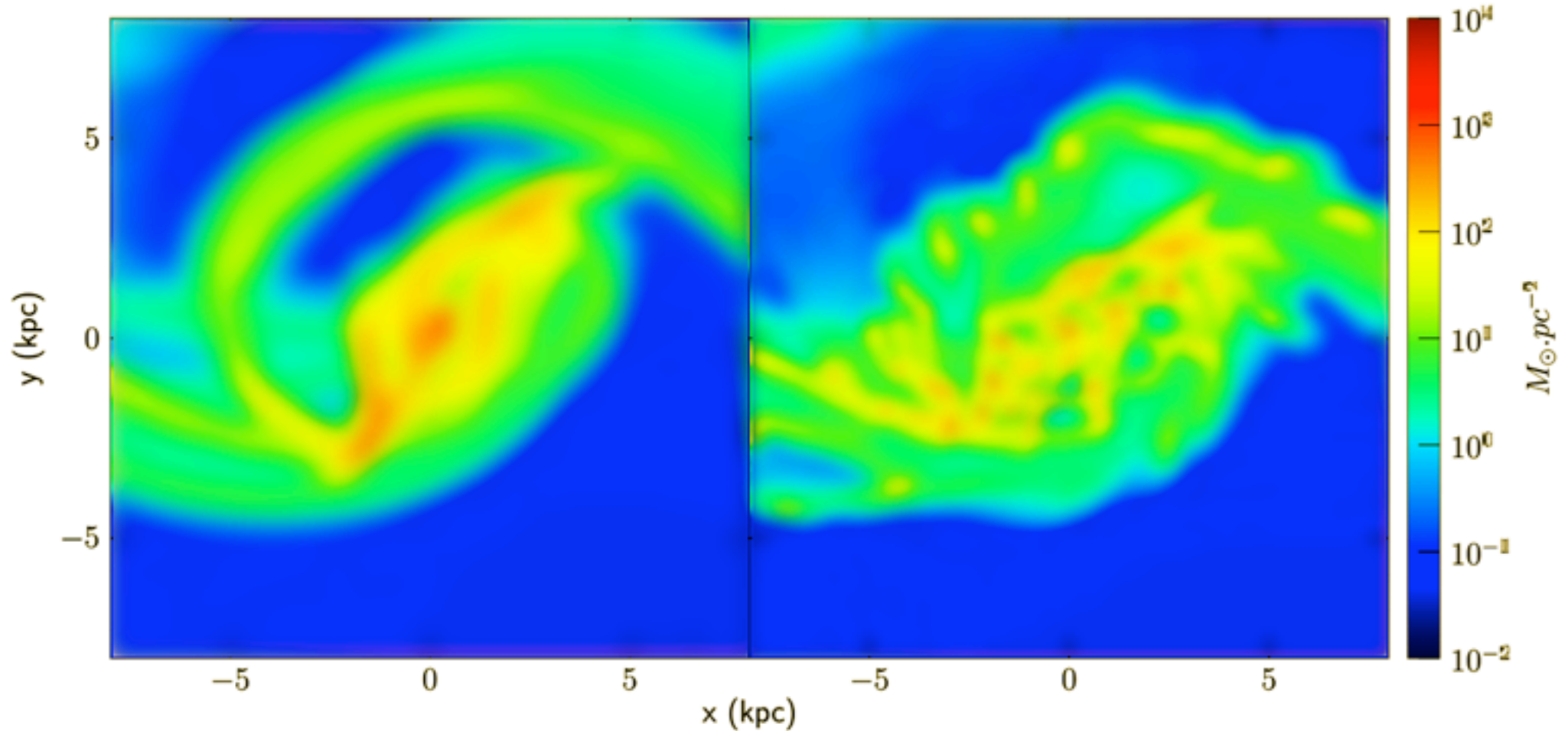
minor merger: prograde



minor merger: retrograde



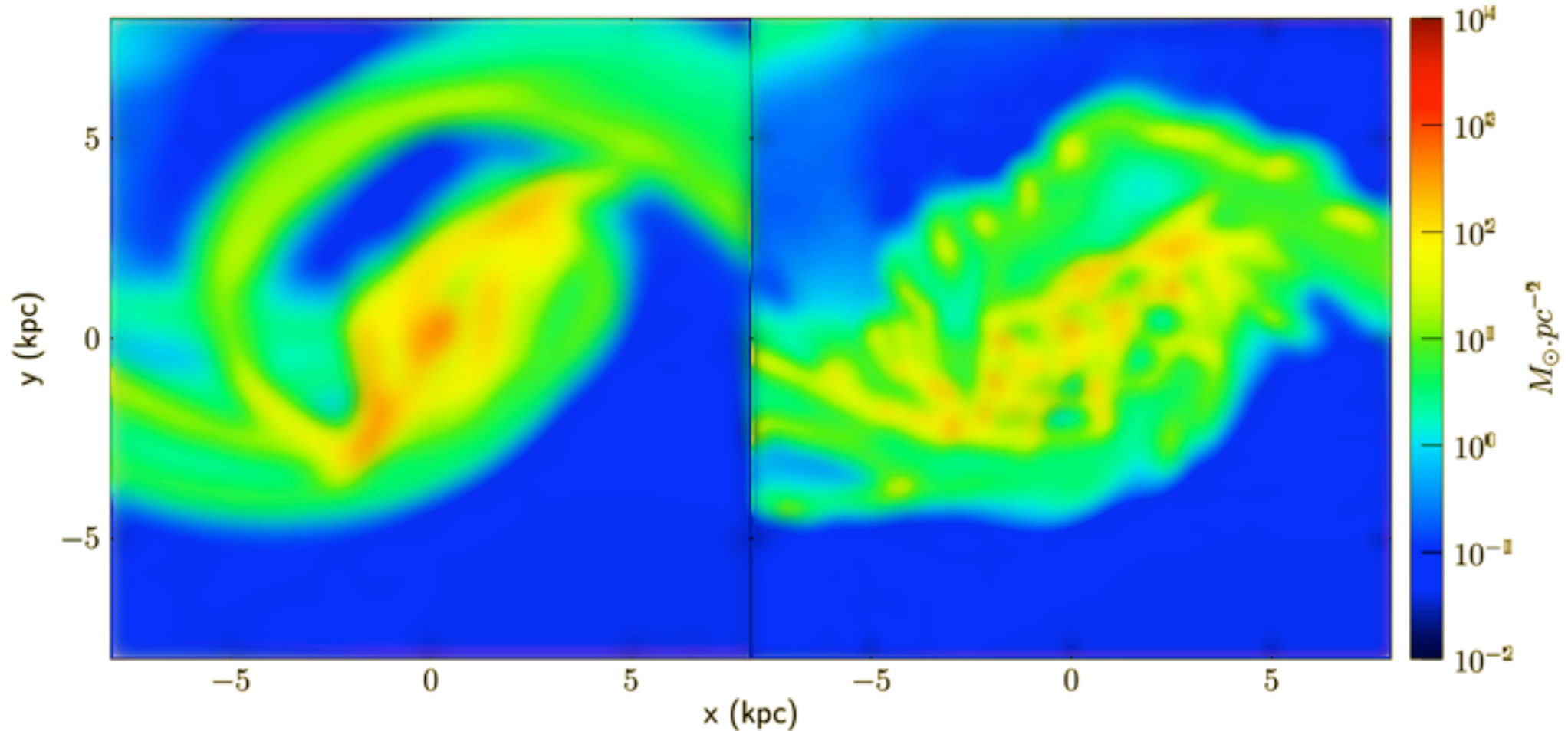
# Sampling: How to Do It?



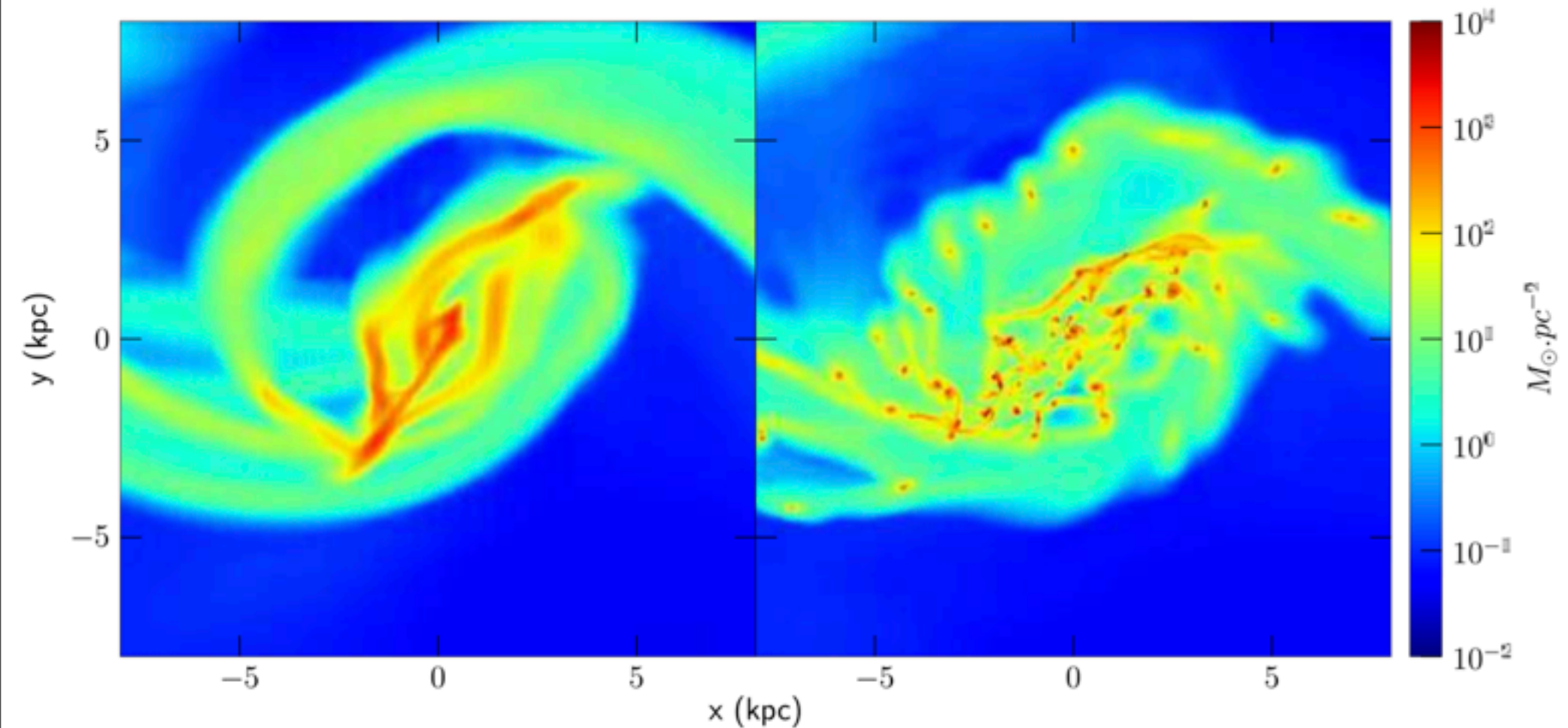


# Sampling: How to Do It?

- Low-Res to High?

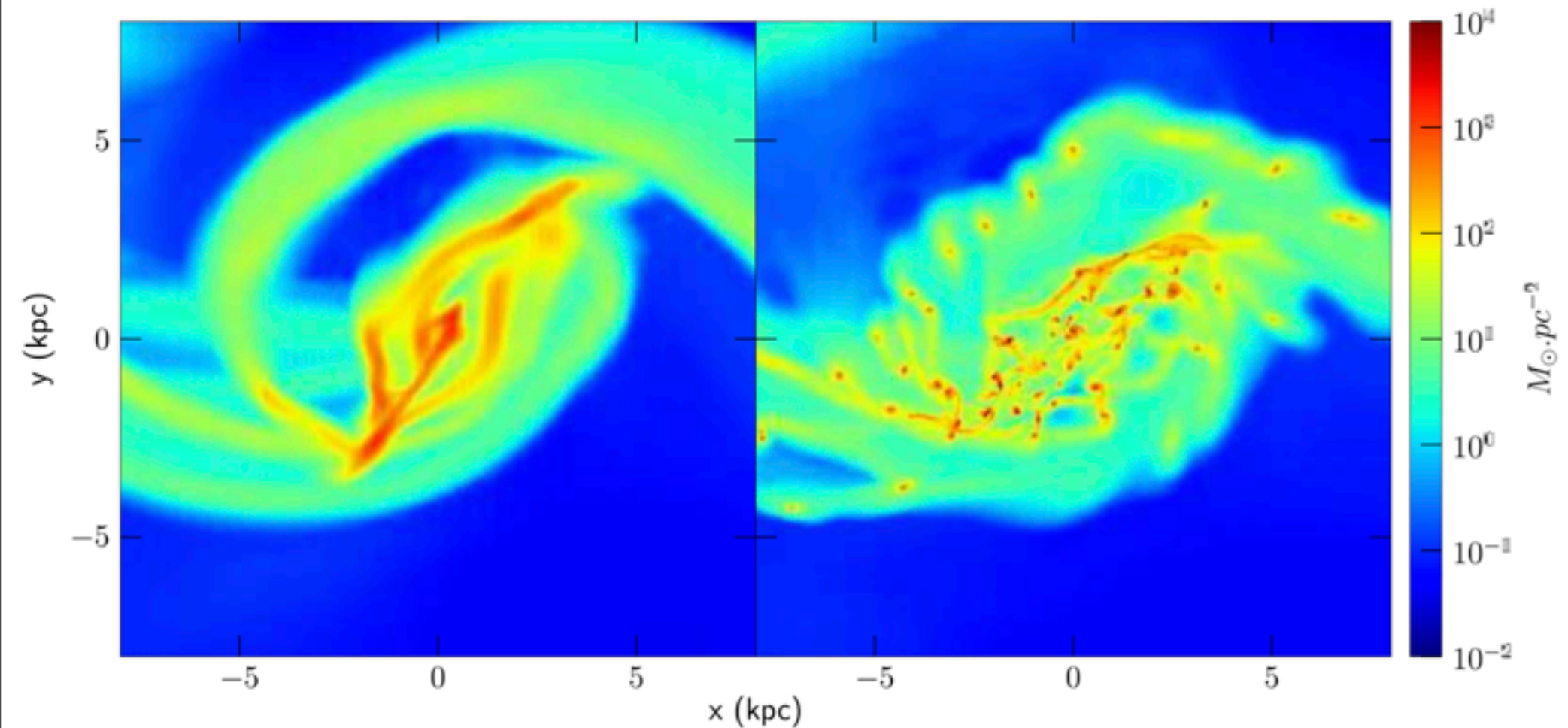


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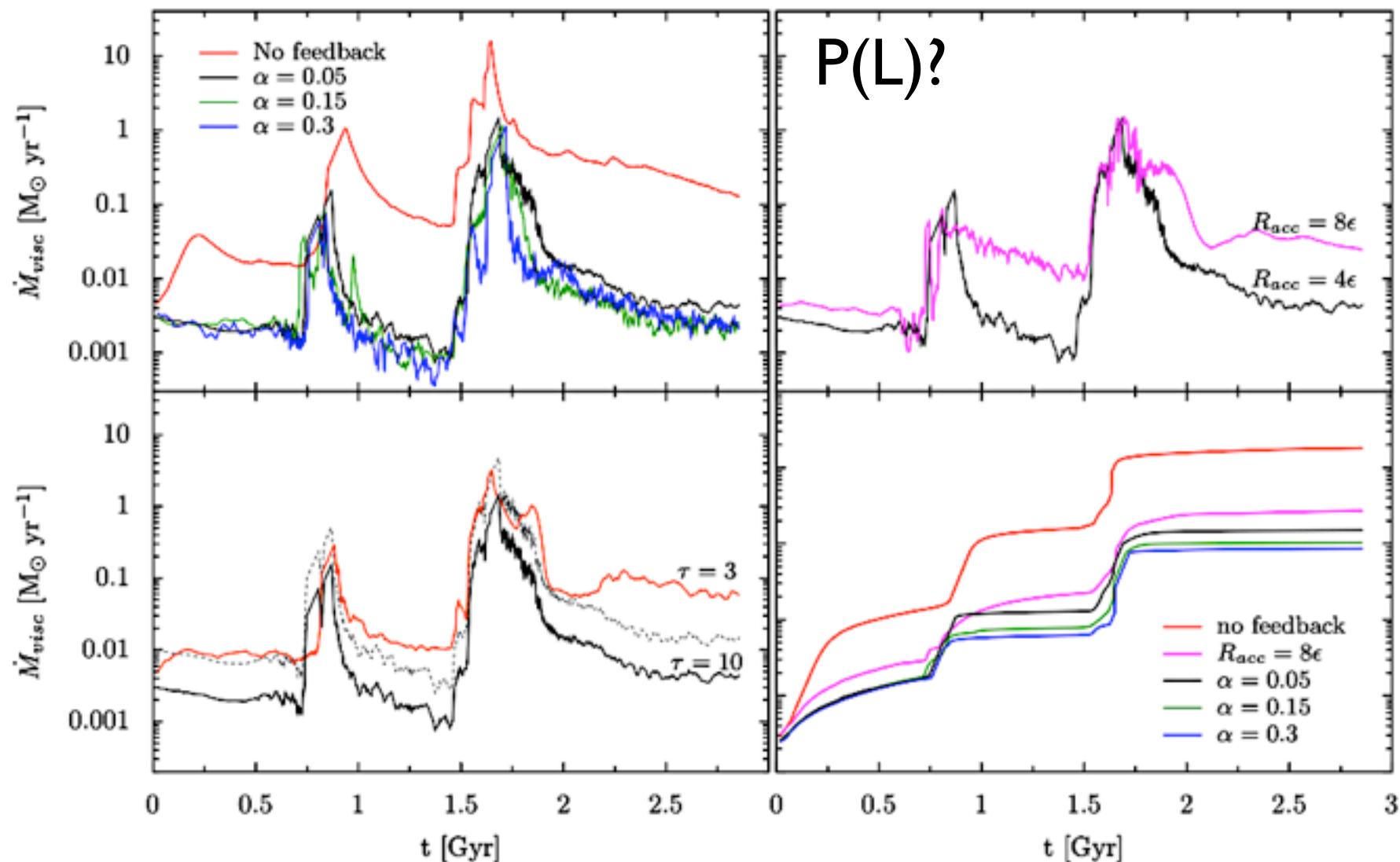


# Sampling: How to Do It?

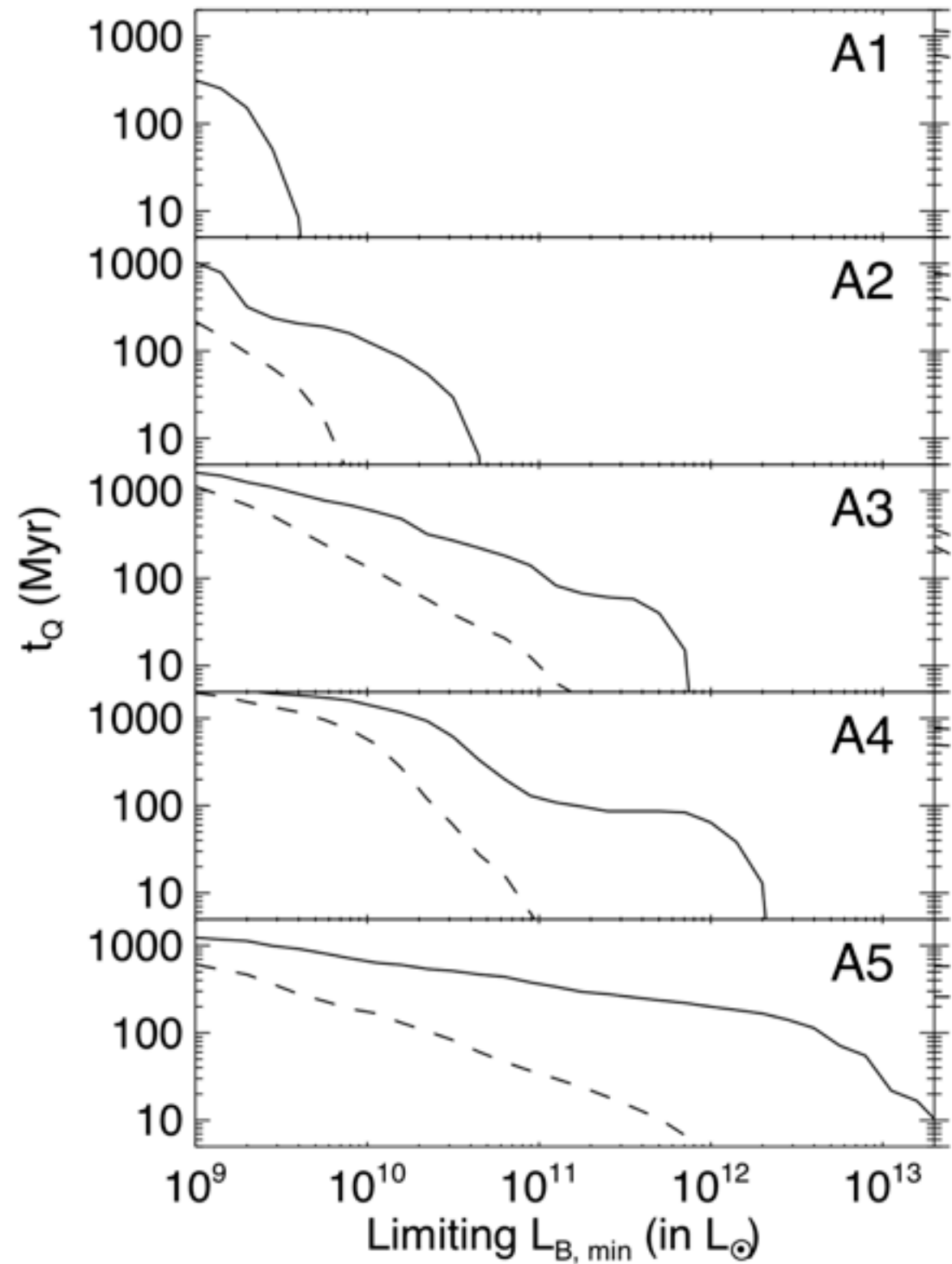
- Low-Res to High?



# Ok, so you have your simulations... now what?



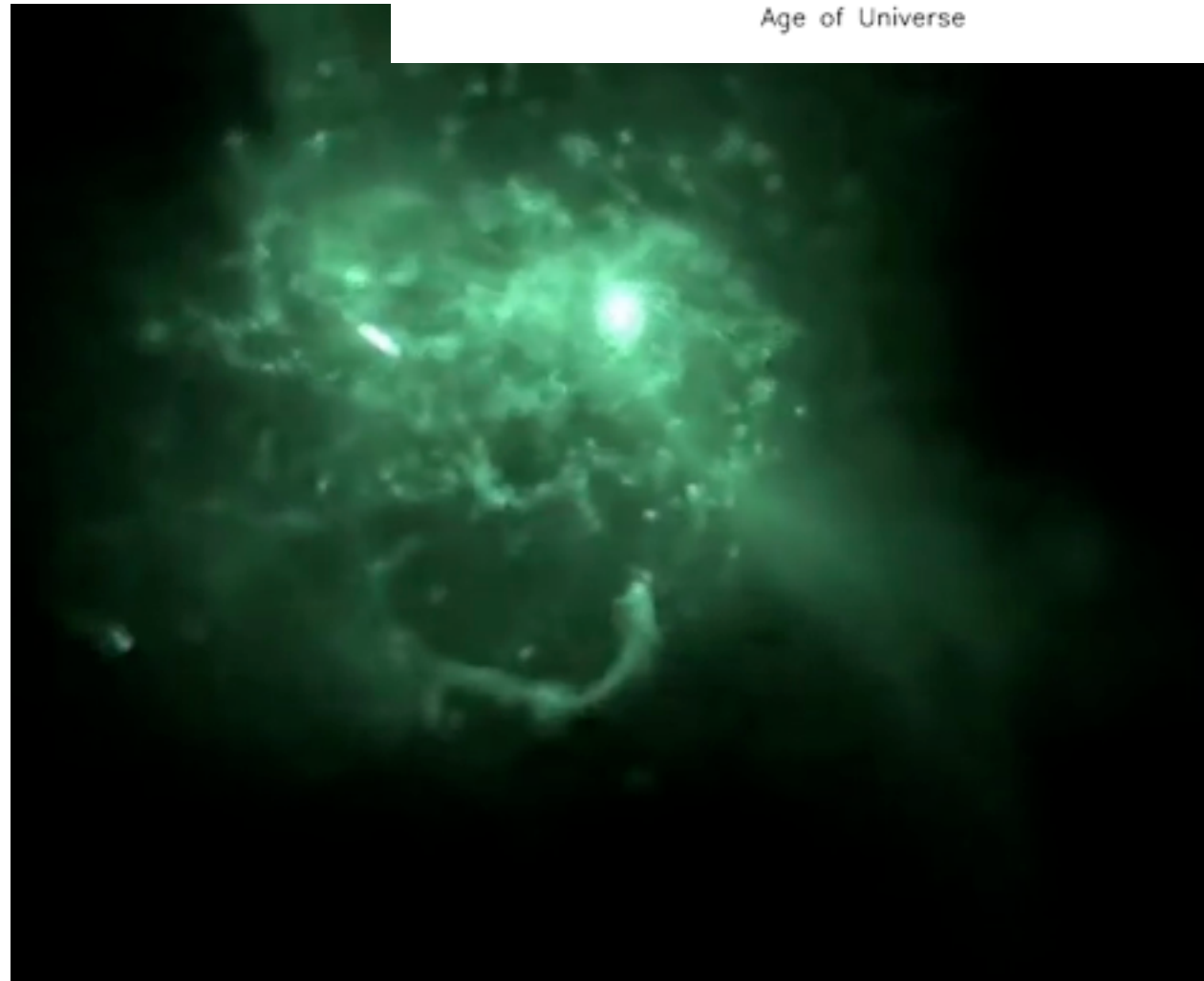
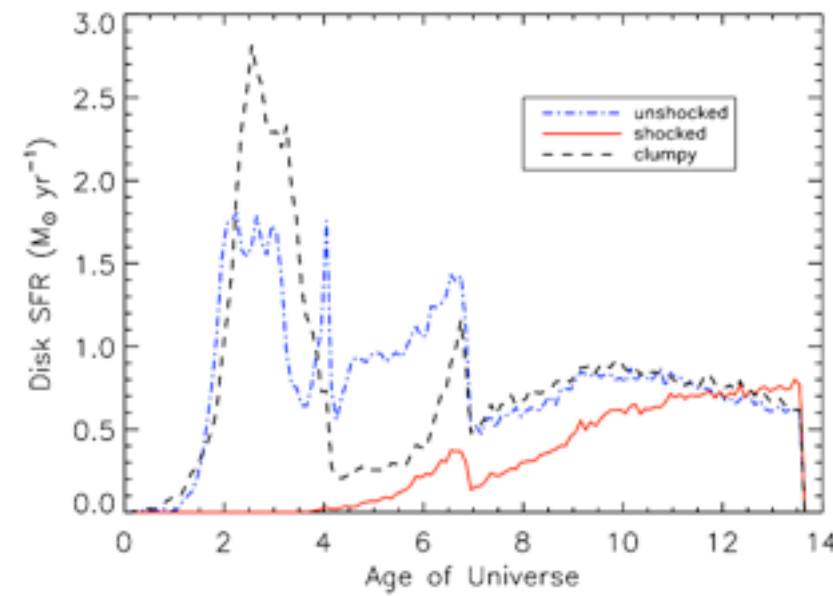
Define  
robust  
quantities:



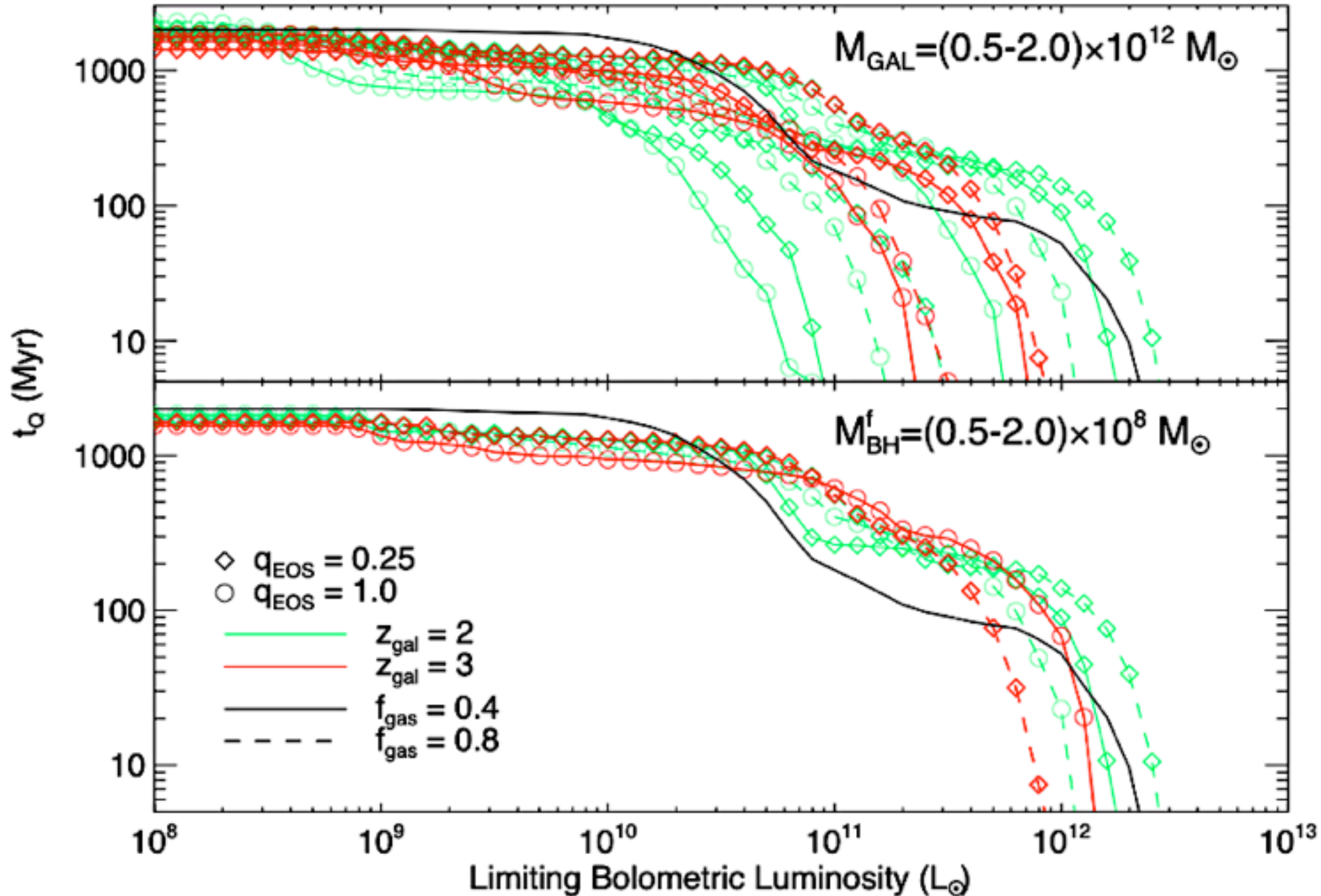




- When is the merger?
- What are the gas fractions?
- Mass ratio: when? what? how?
- What do you define a 'starburst' relative to?

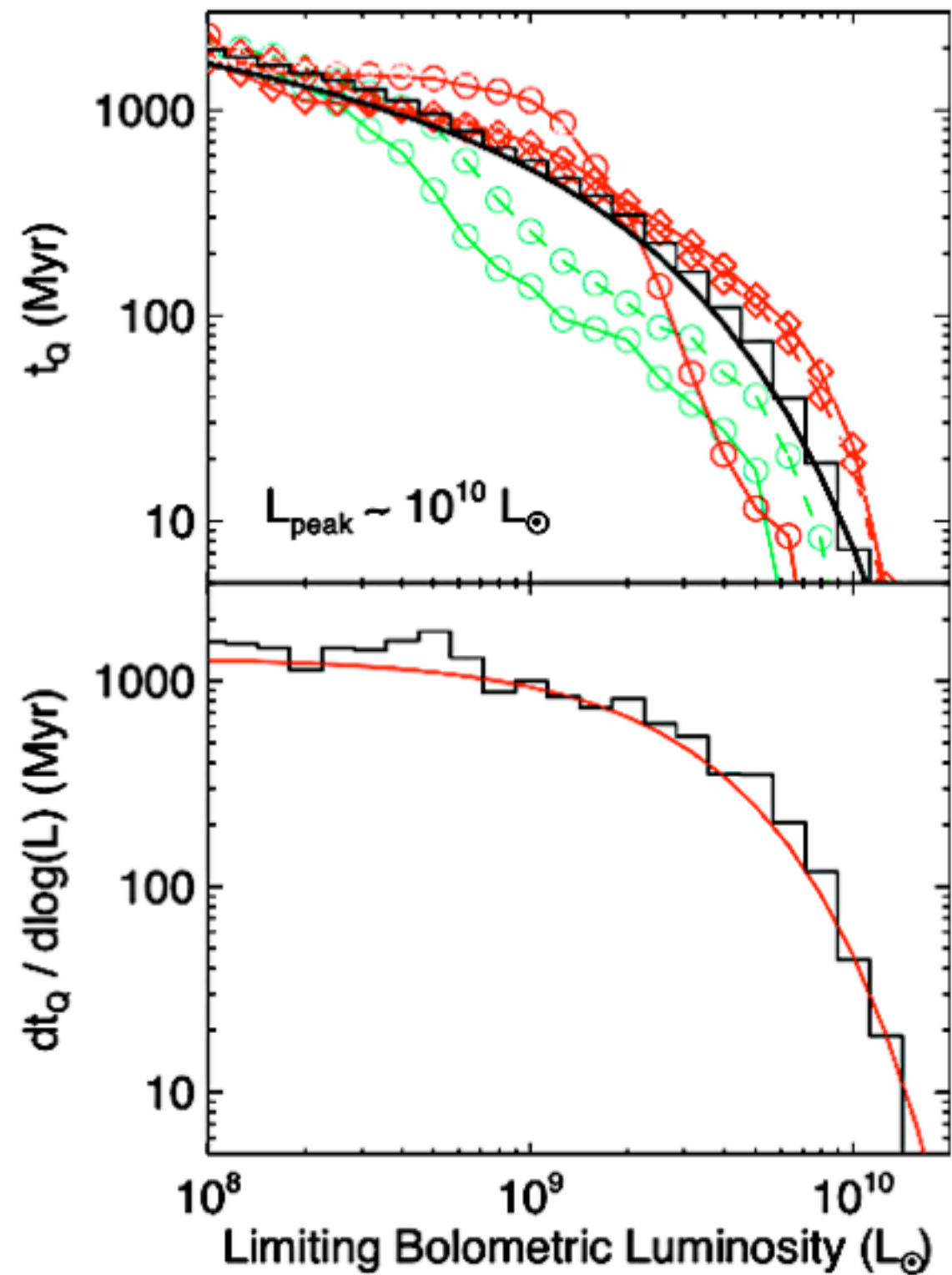


Look for what controls the outcomes:

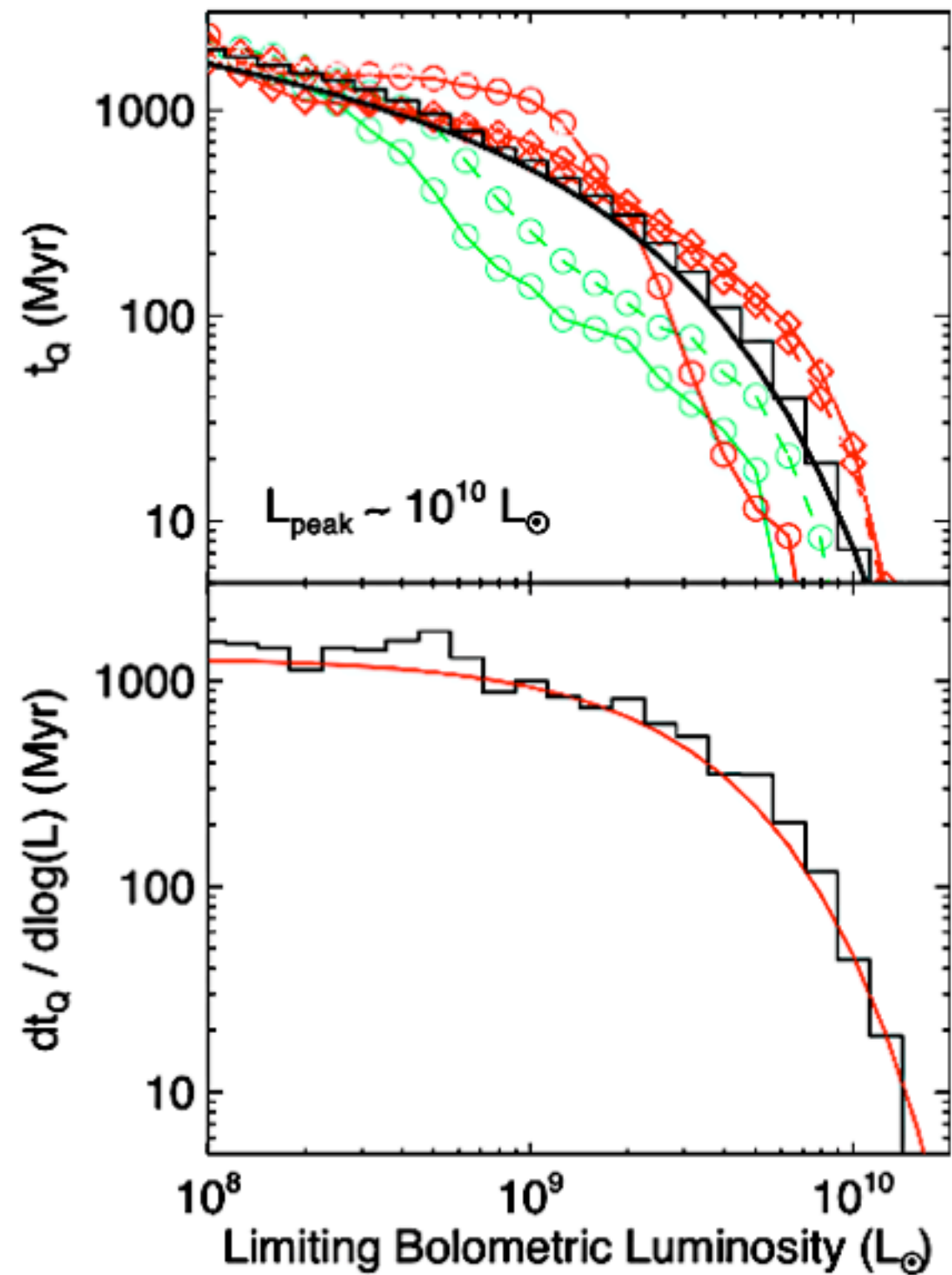




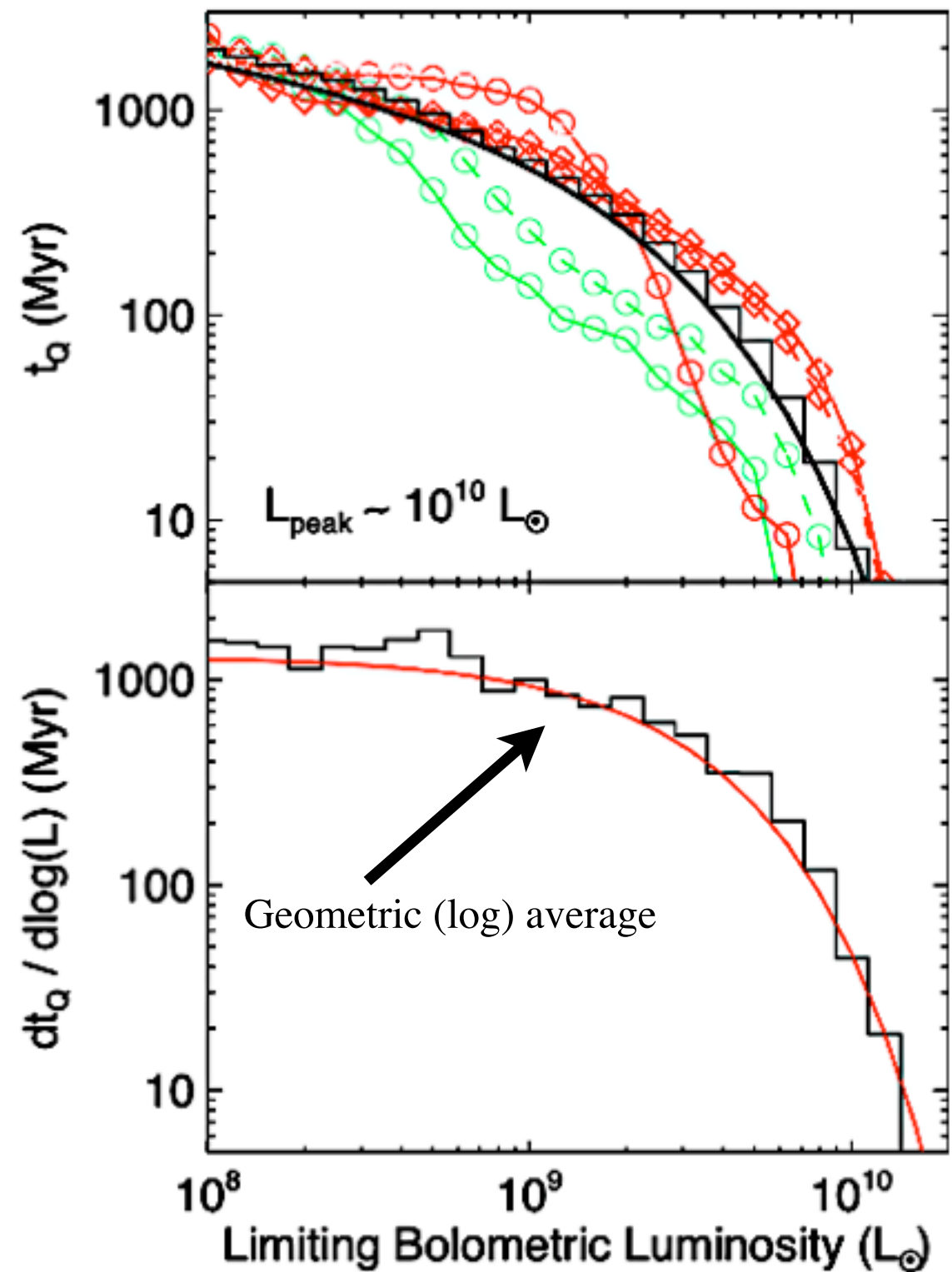
Defining 'typical':



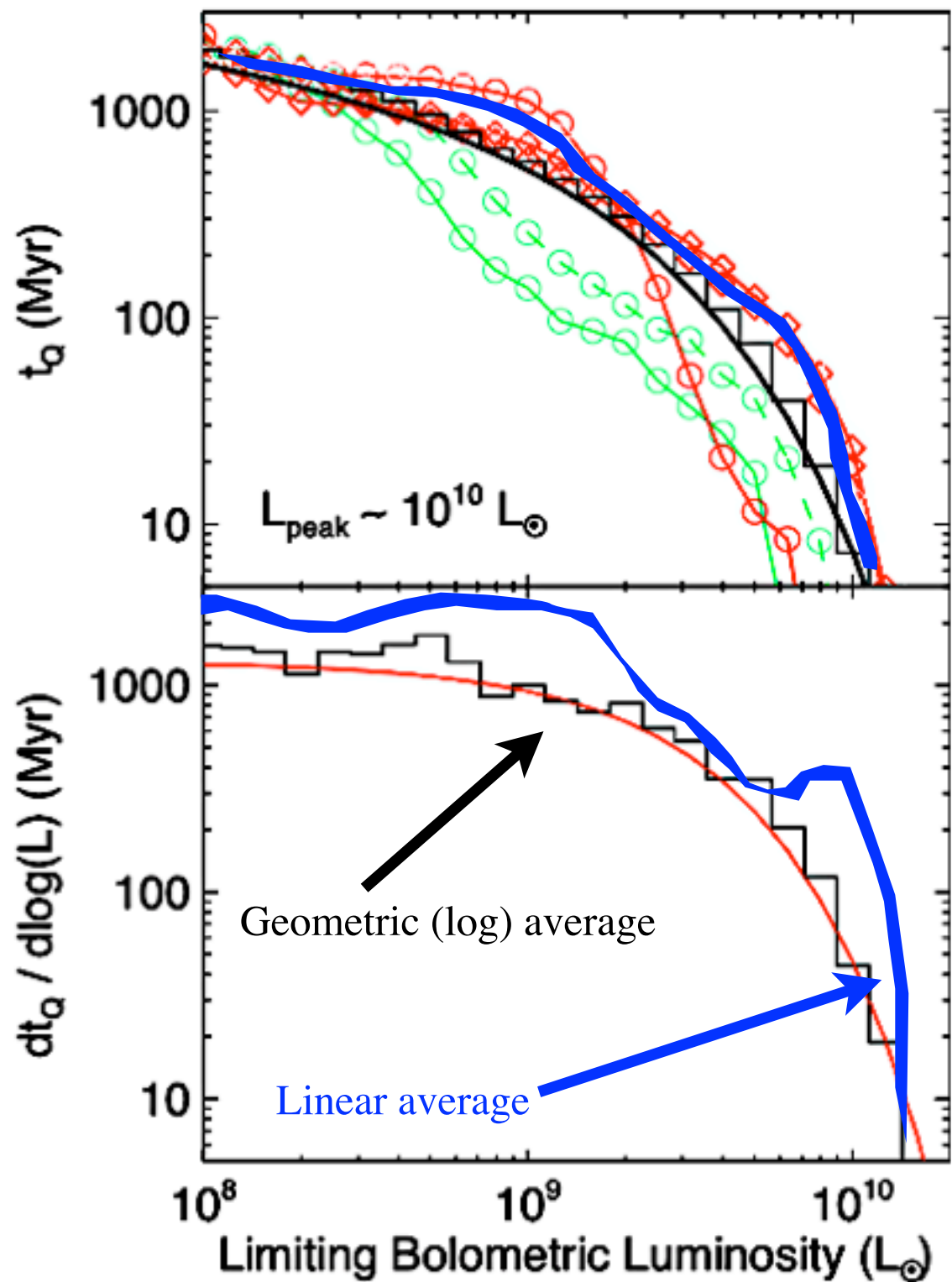
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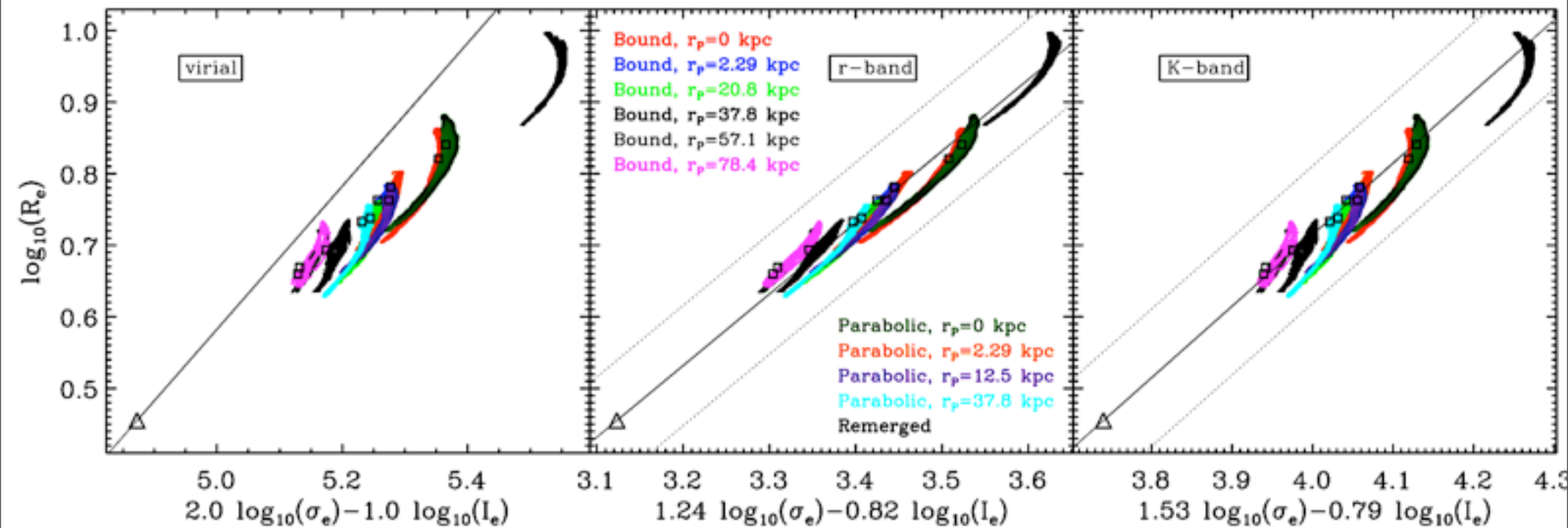
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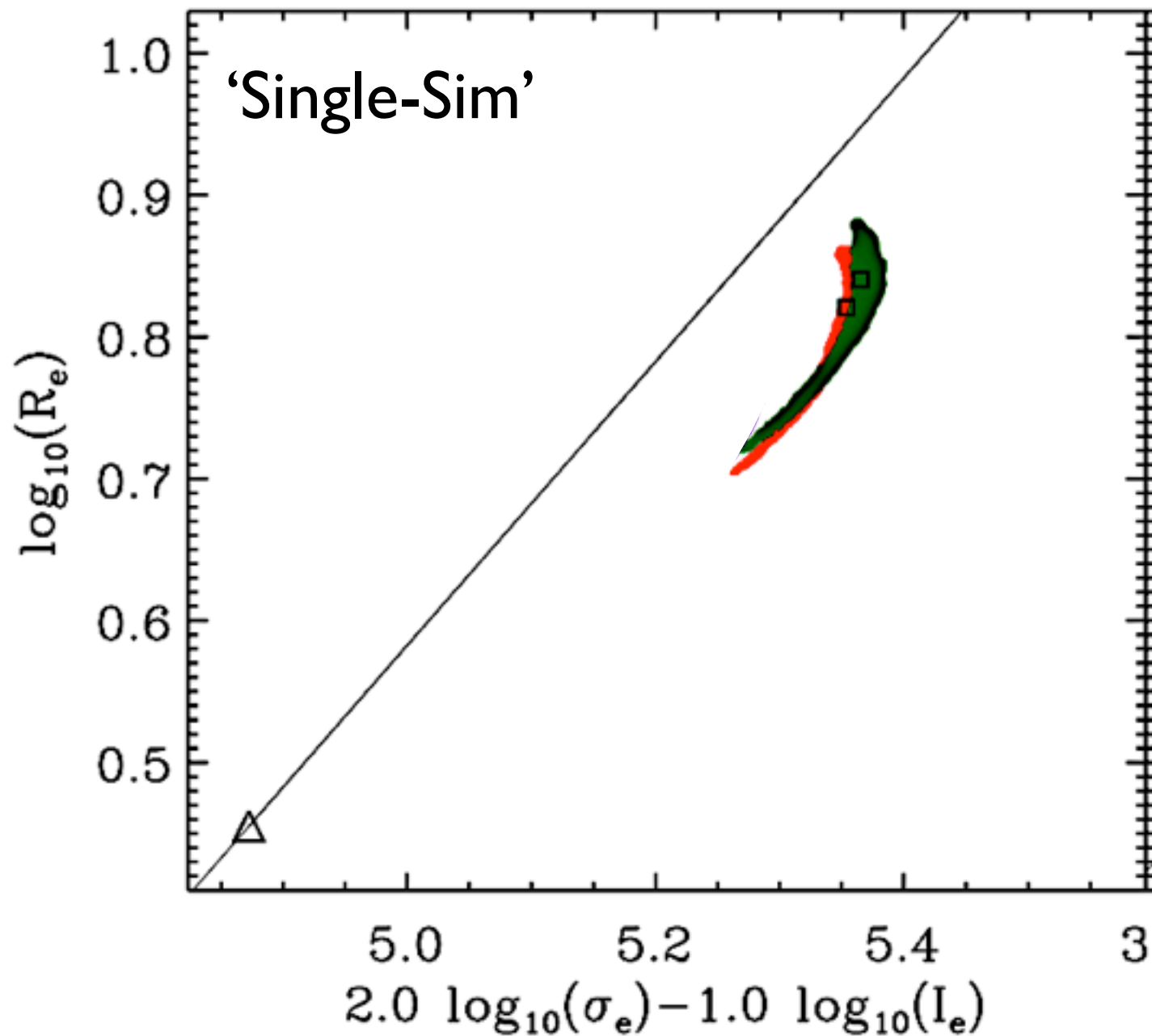
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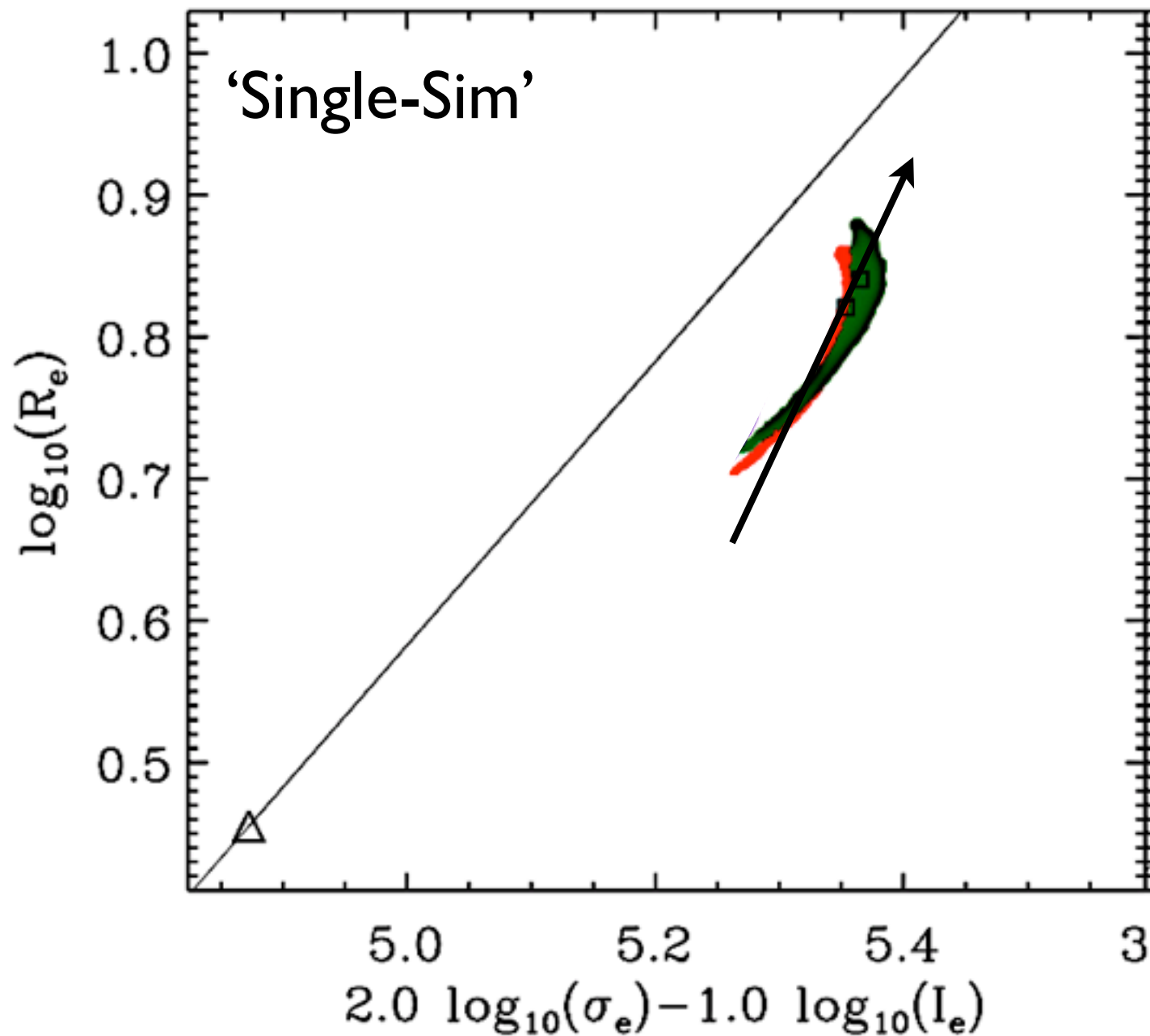
So we define something... How do you 'fit' it?



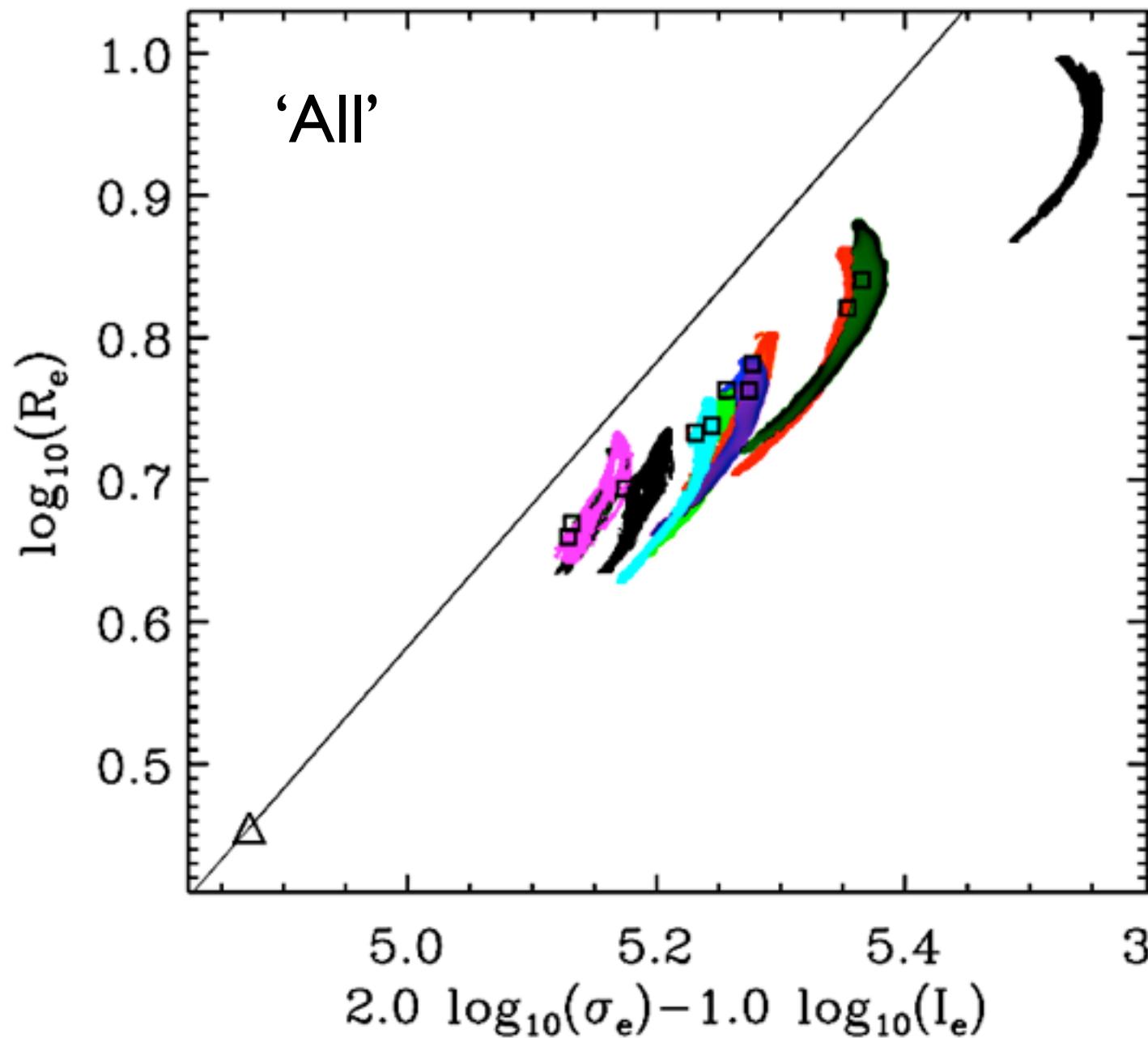
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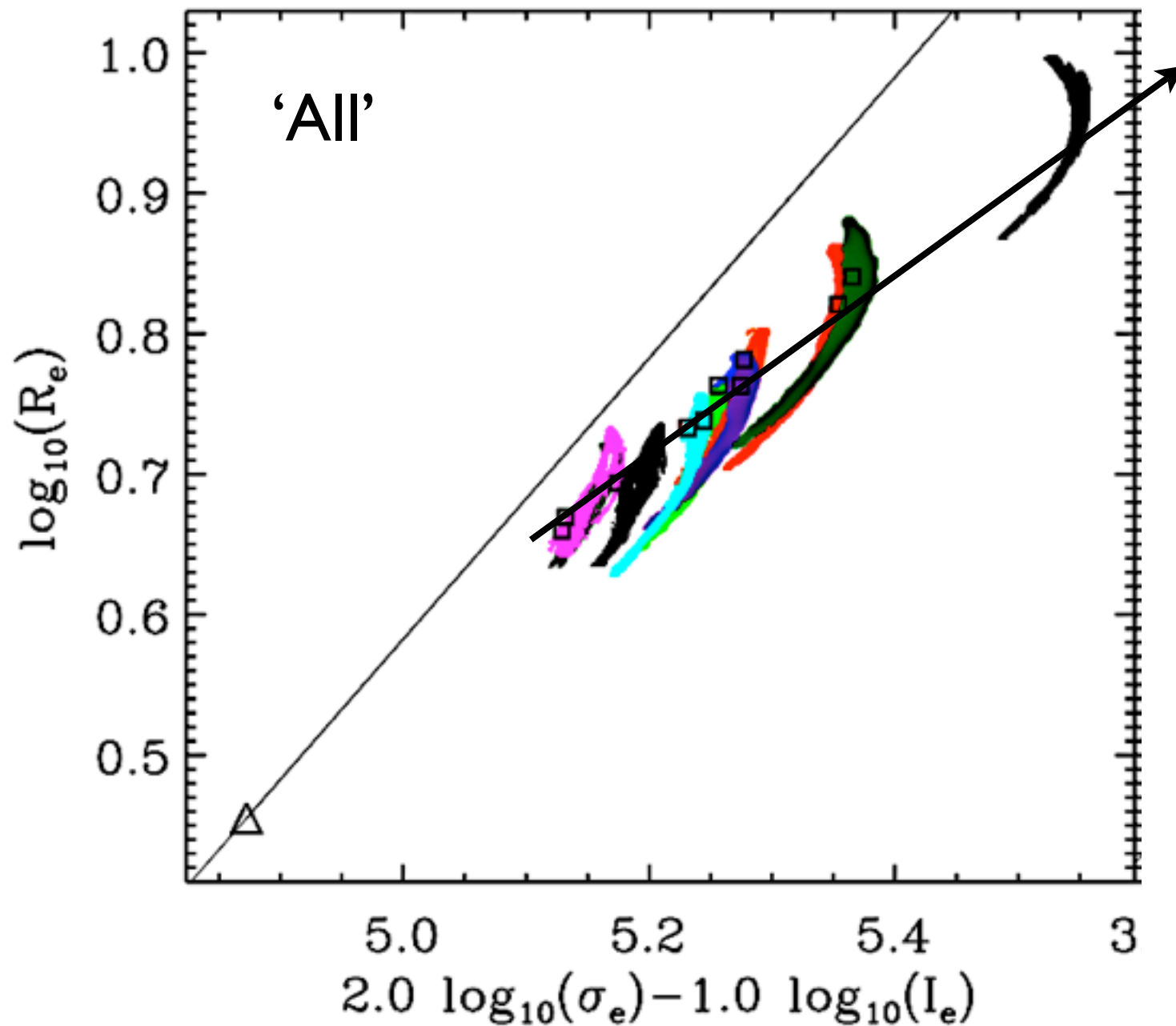


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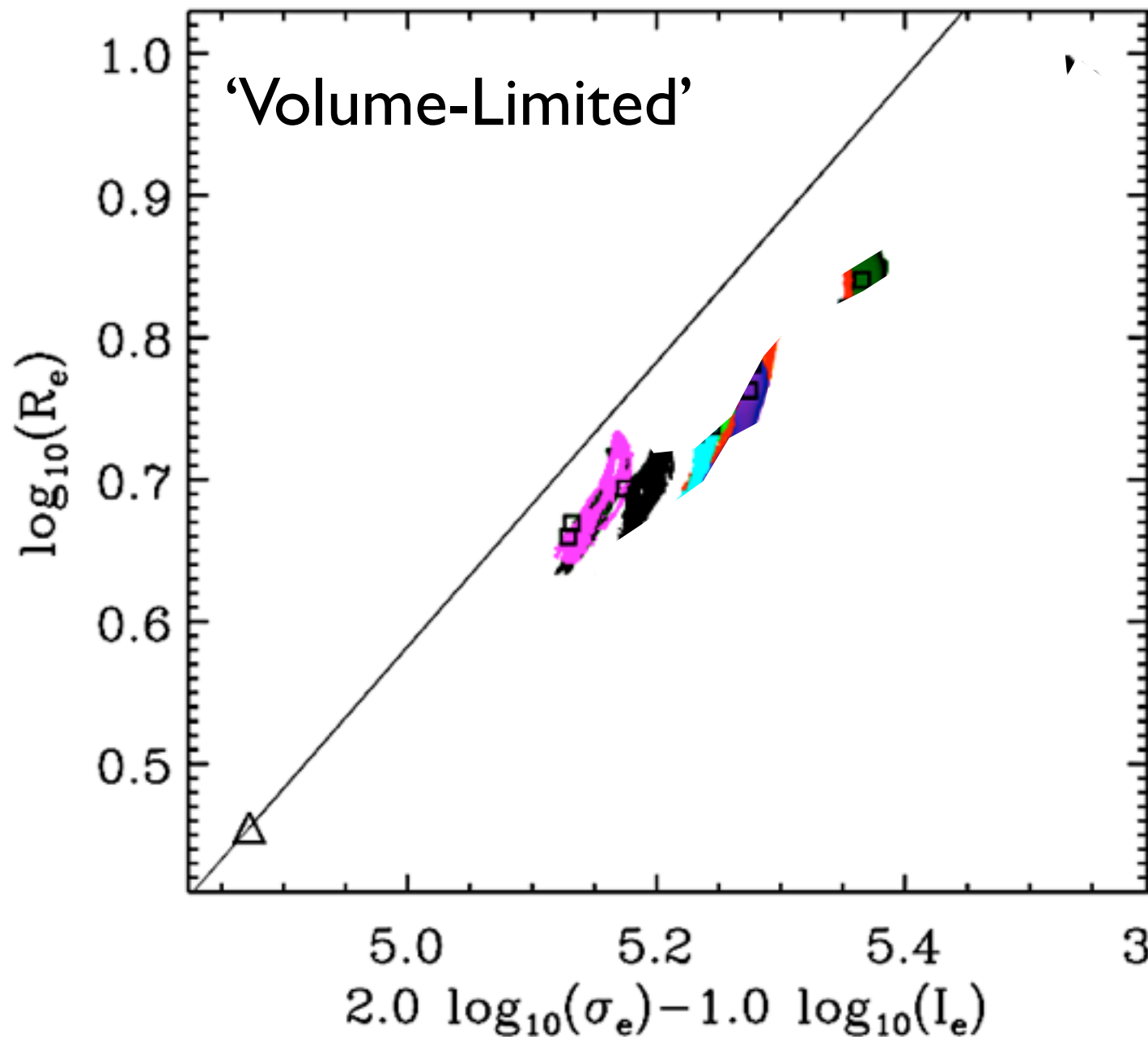




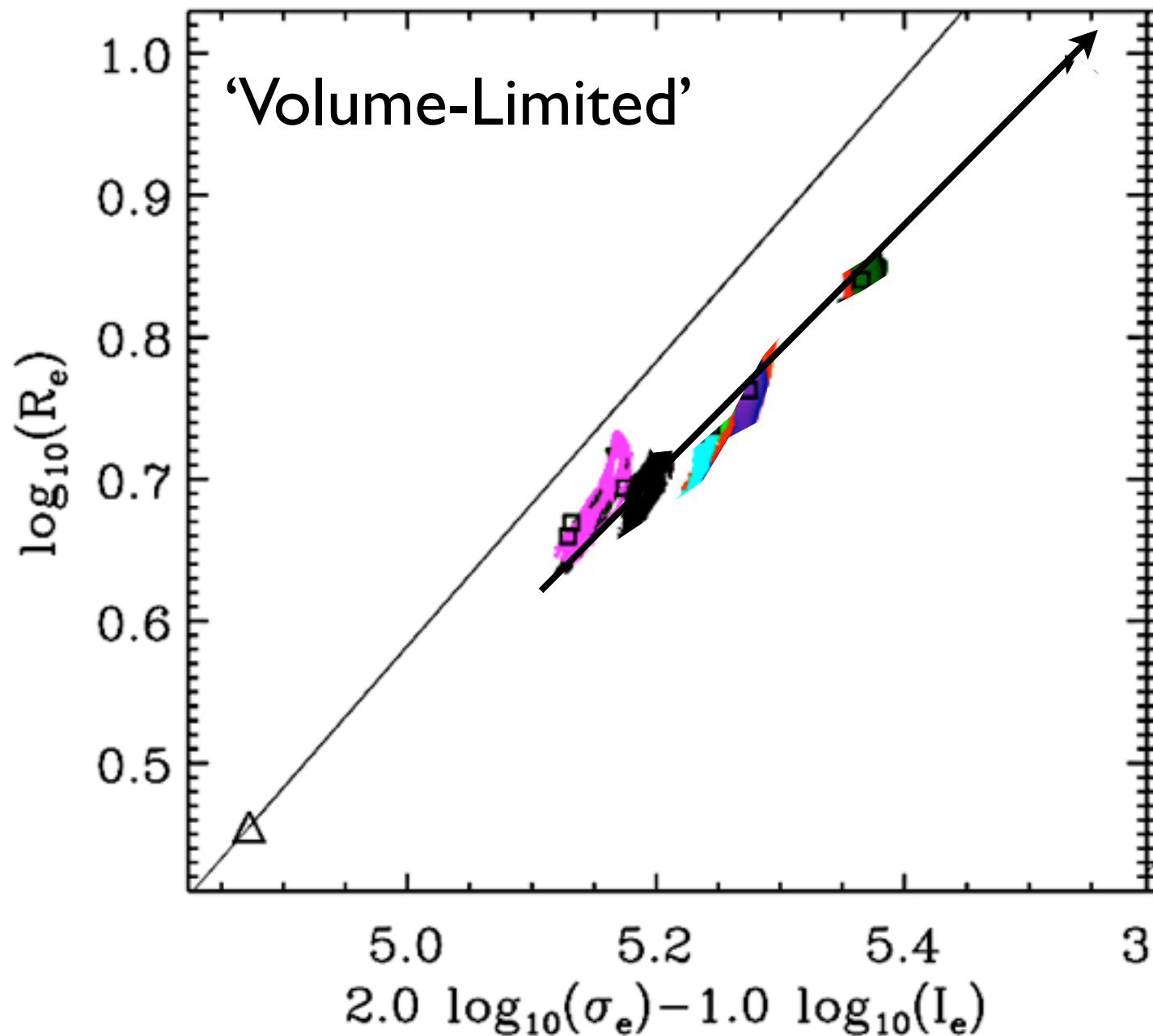
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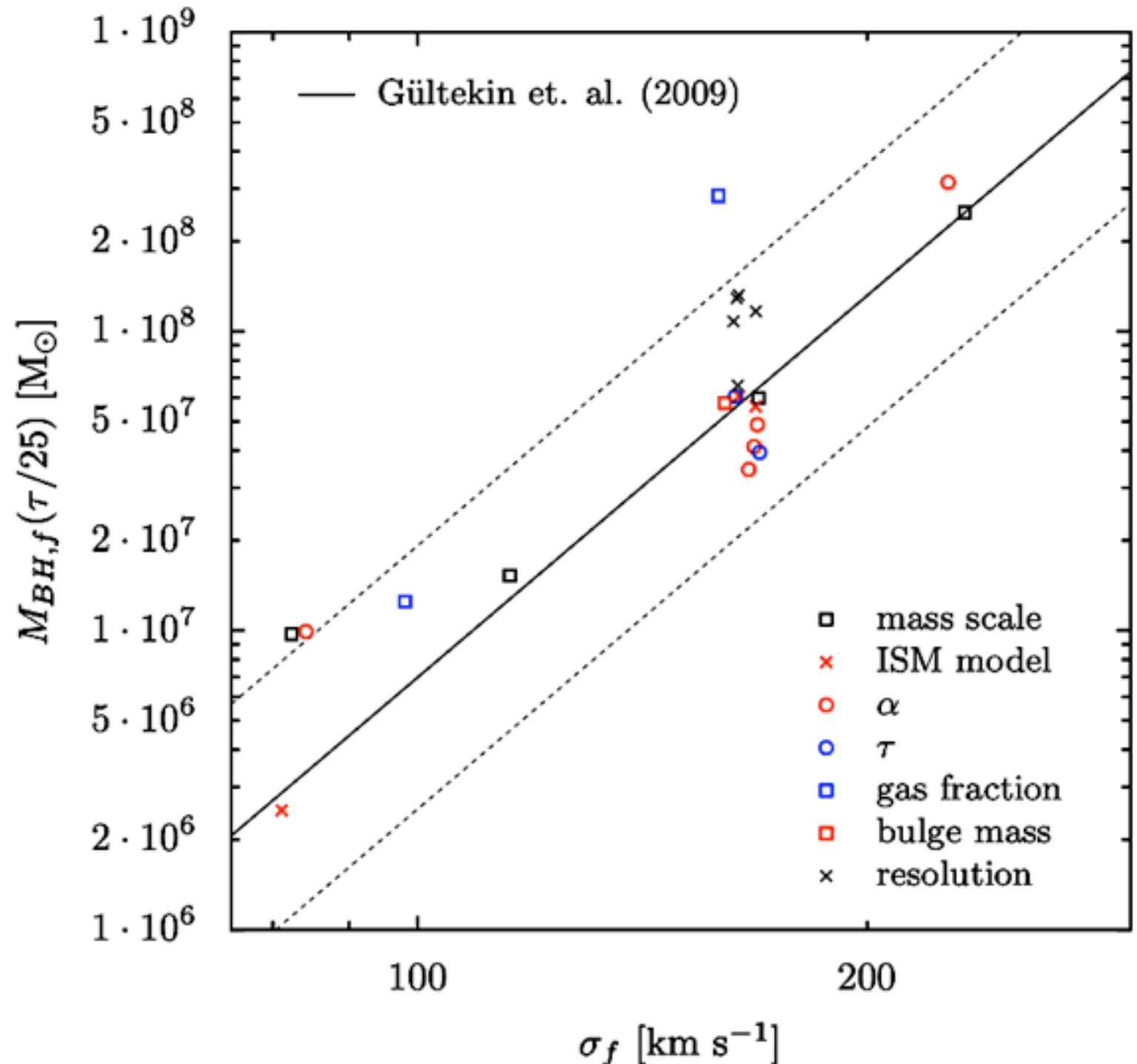
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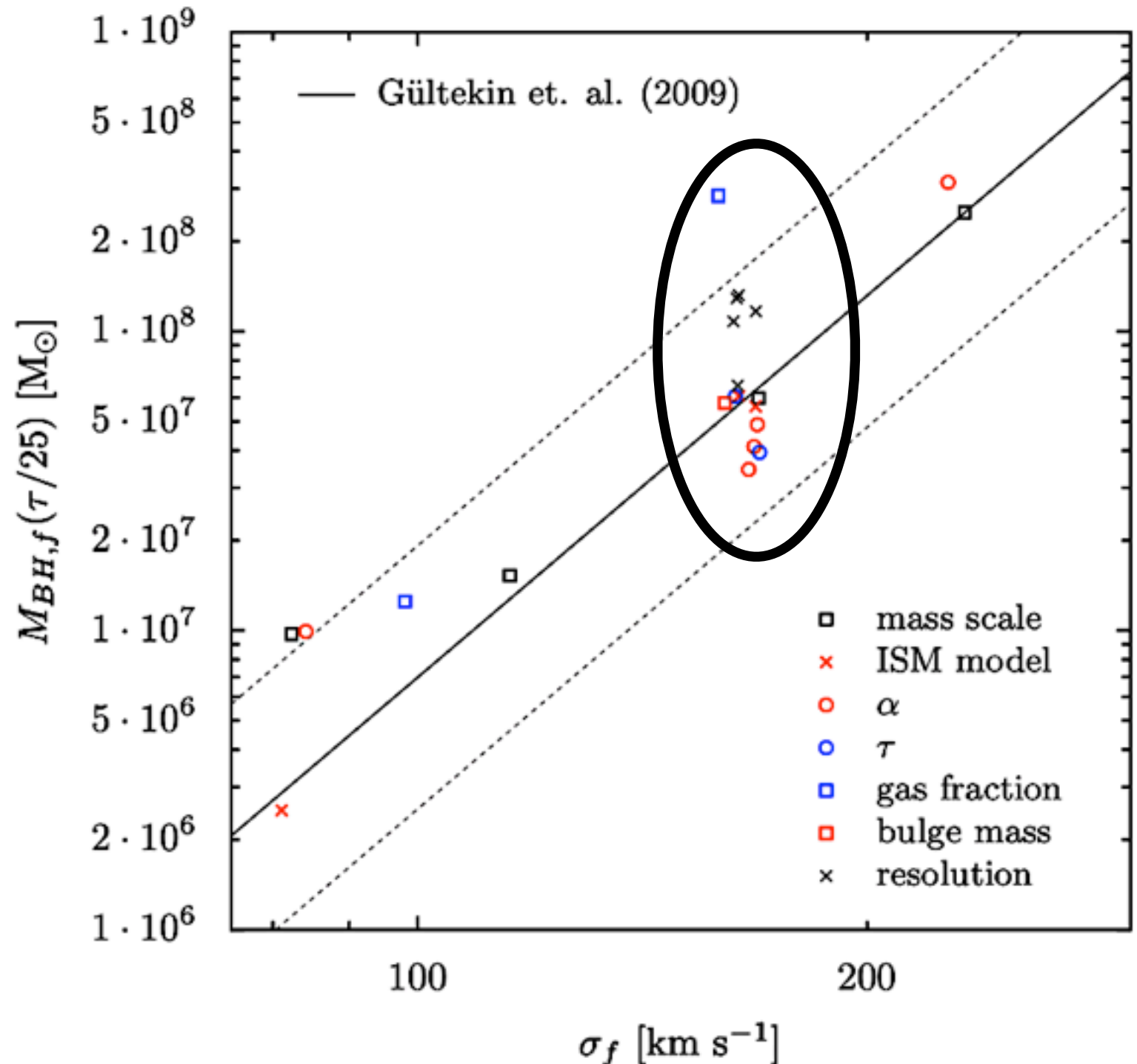
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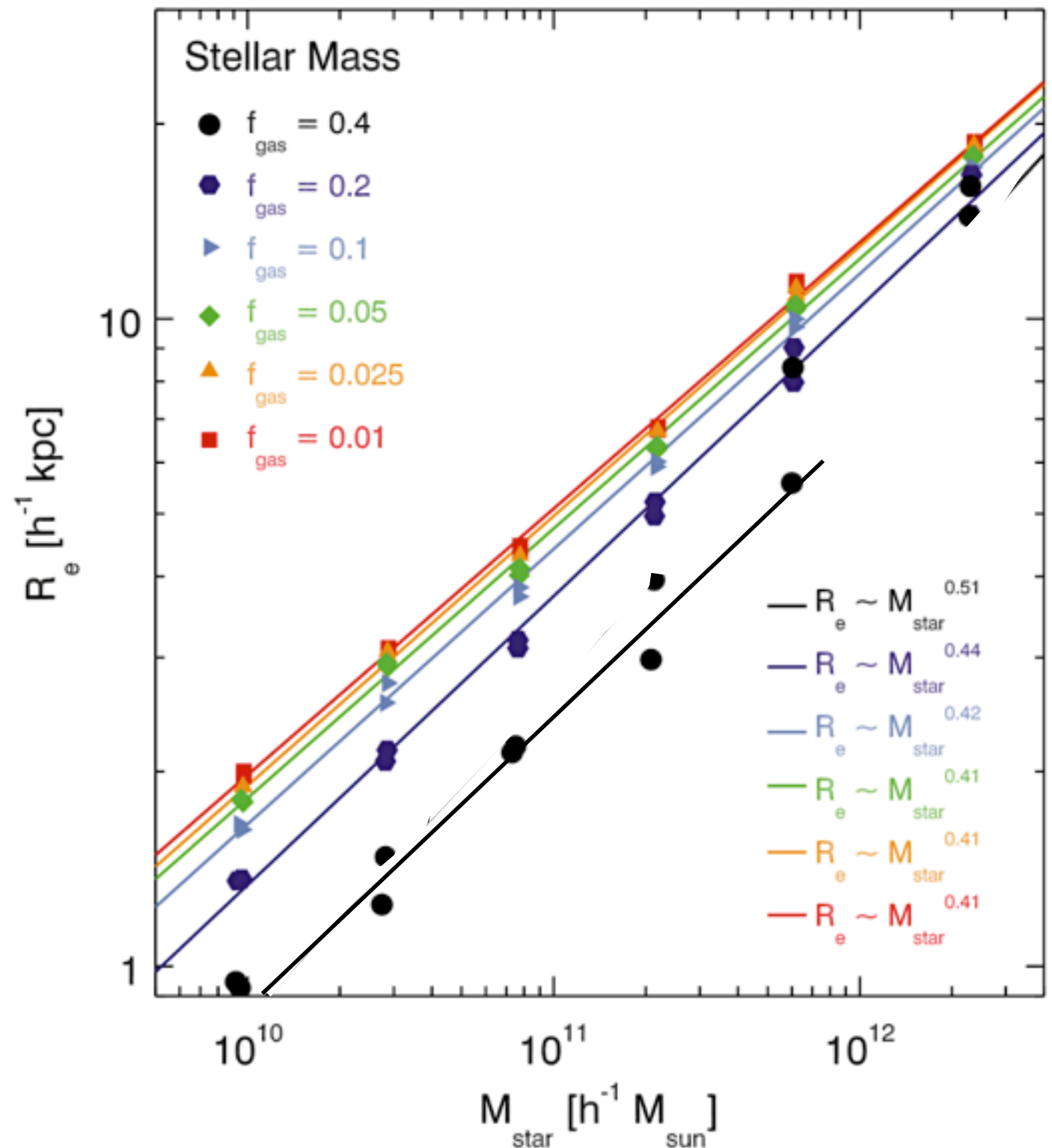
Even reduced to one point per simulation:



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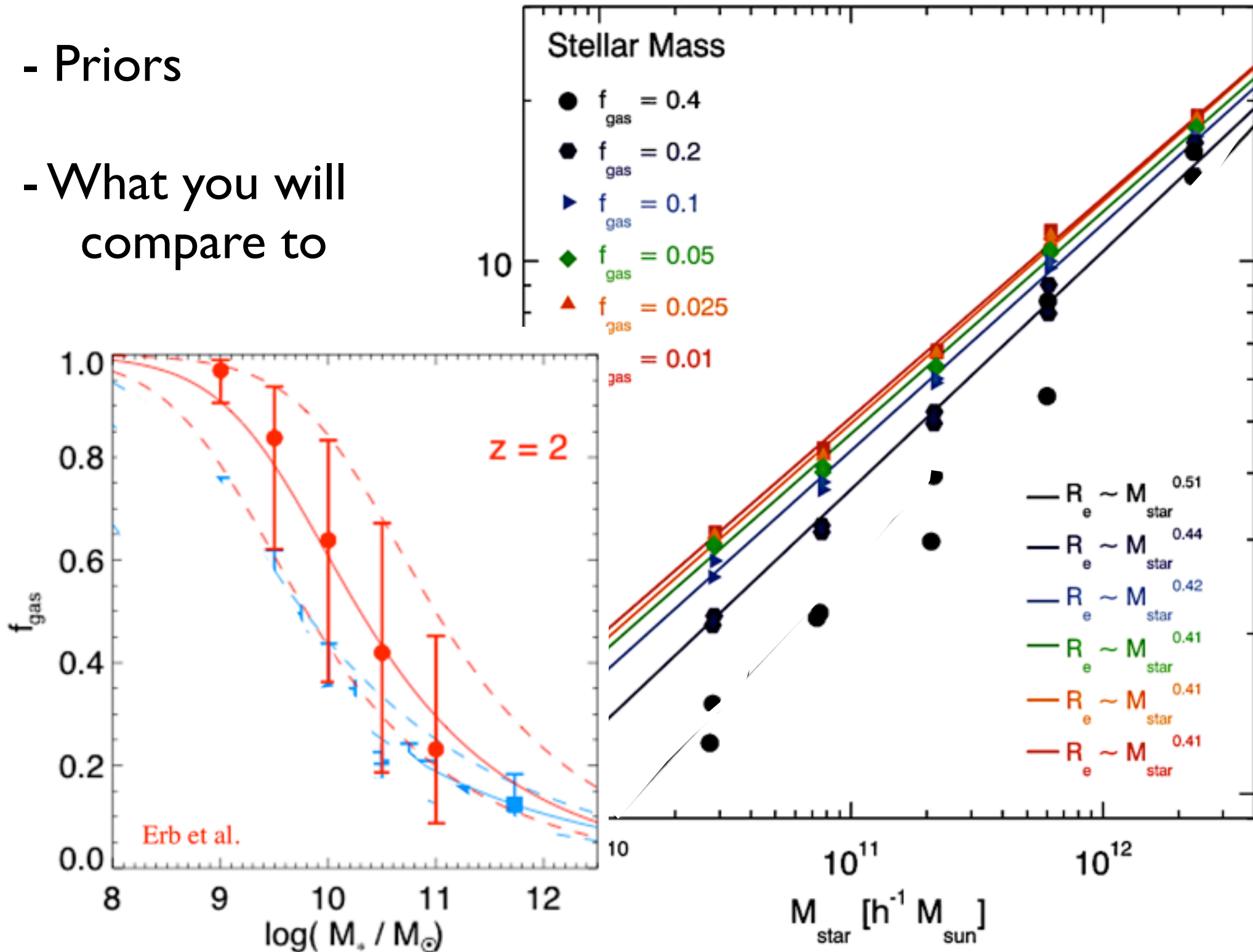


- Priors
- What you will compare to



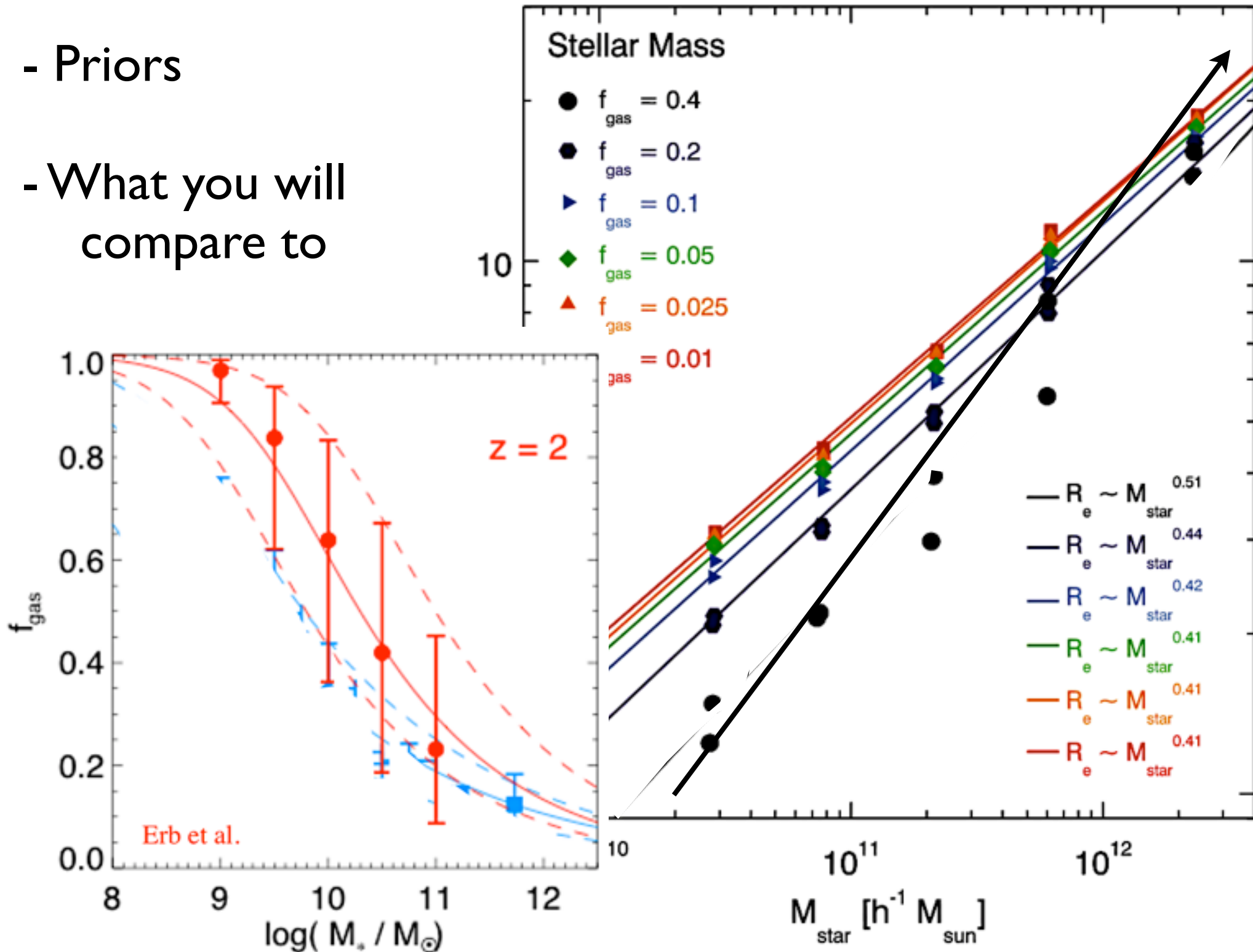
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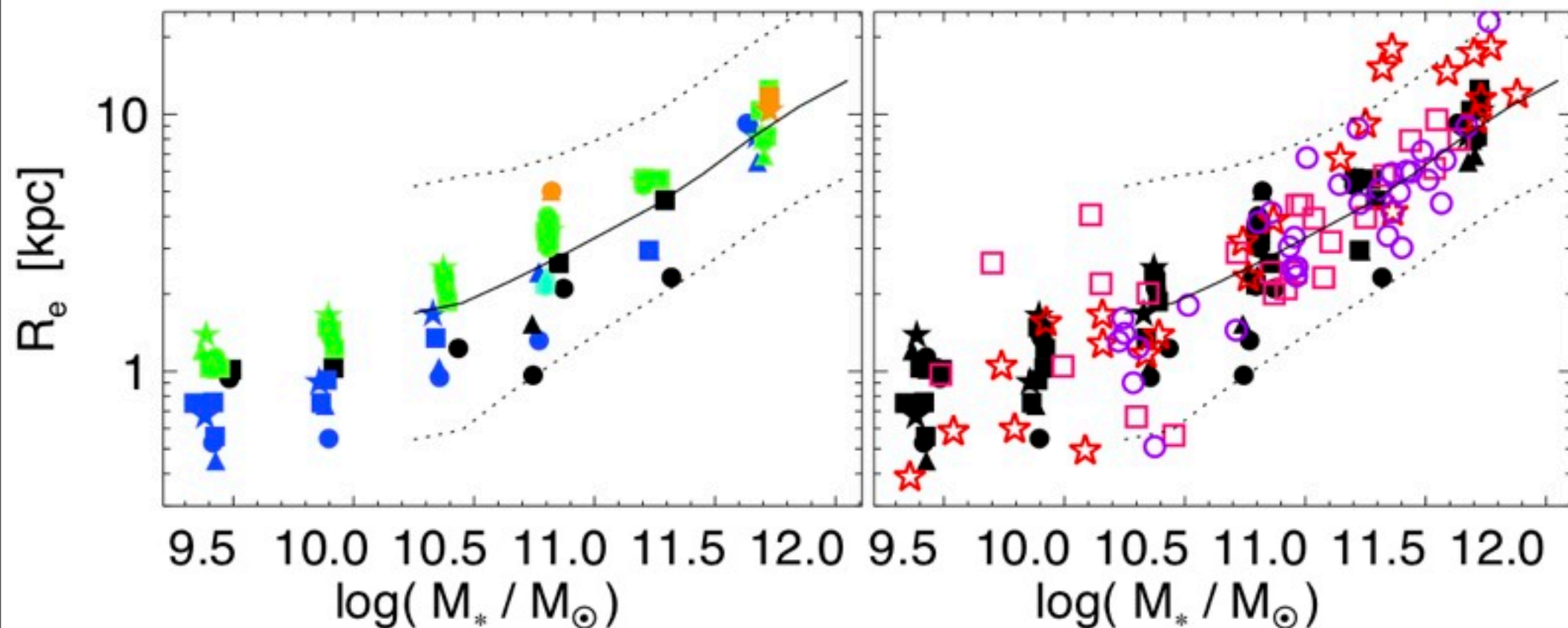
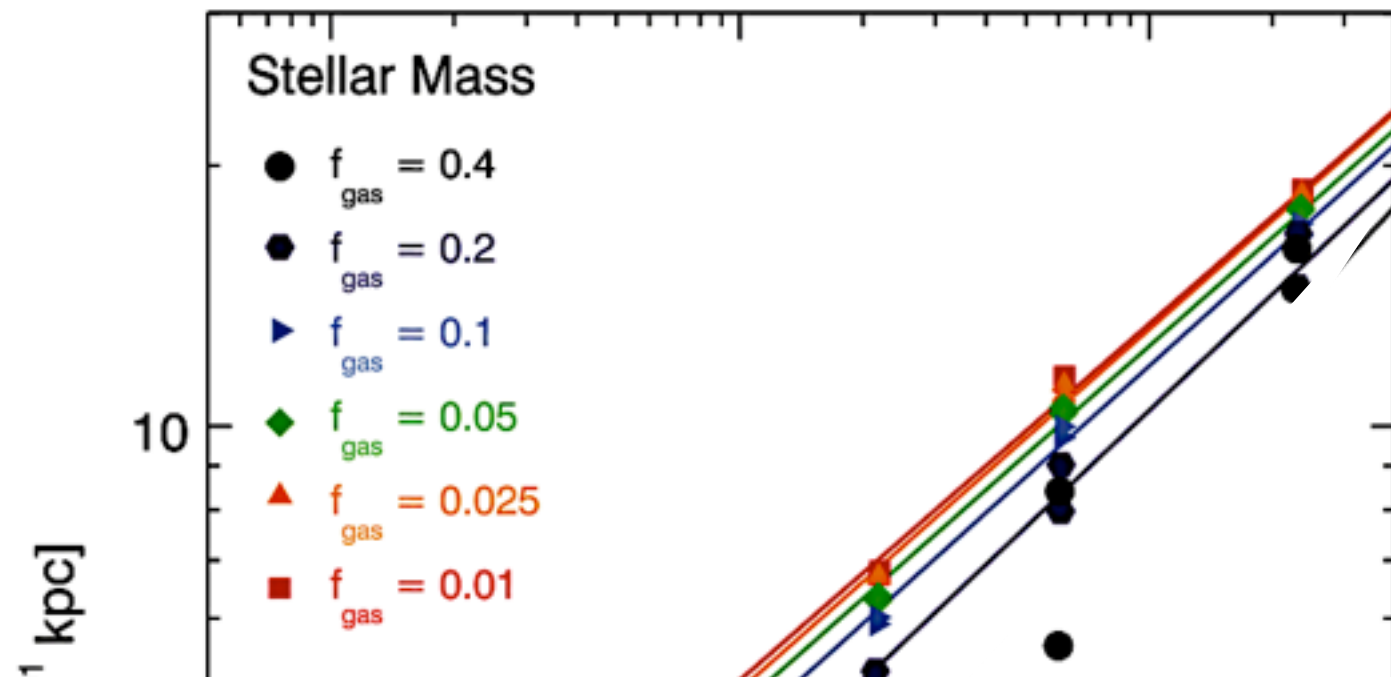
- Priors

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- Priors
- What you will compare to



# Summary

- Lots of for large simulation ‘surveys’
- Measure twice, simulate once:
  - think carefully about how to sample
  - if you’re going to iterate, be careful with res.
- Try to understand the parameters that matter
- Don’t just plunk everything down!
  - know the observations you’re comparing with
  - construct appropriate sub-samples: priors matched
  - try to get as close as possible to observable quantities