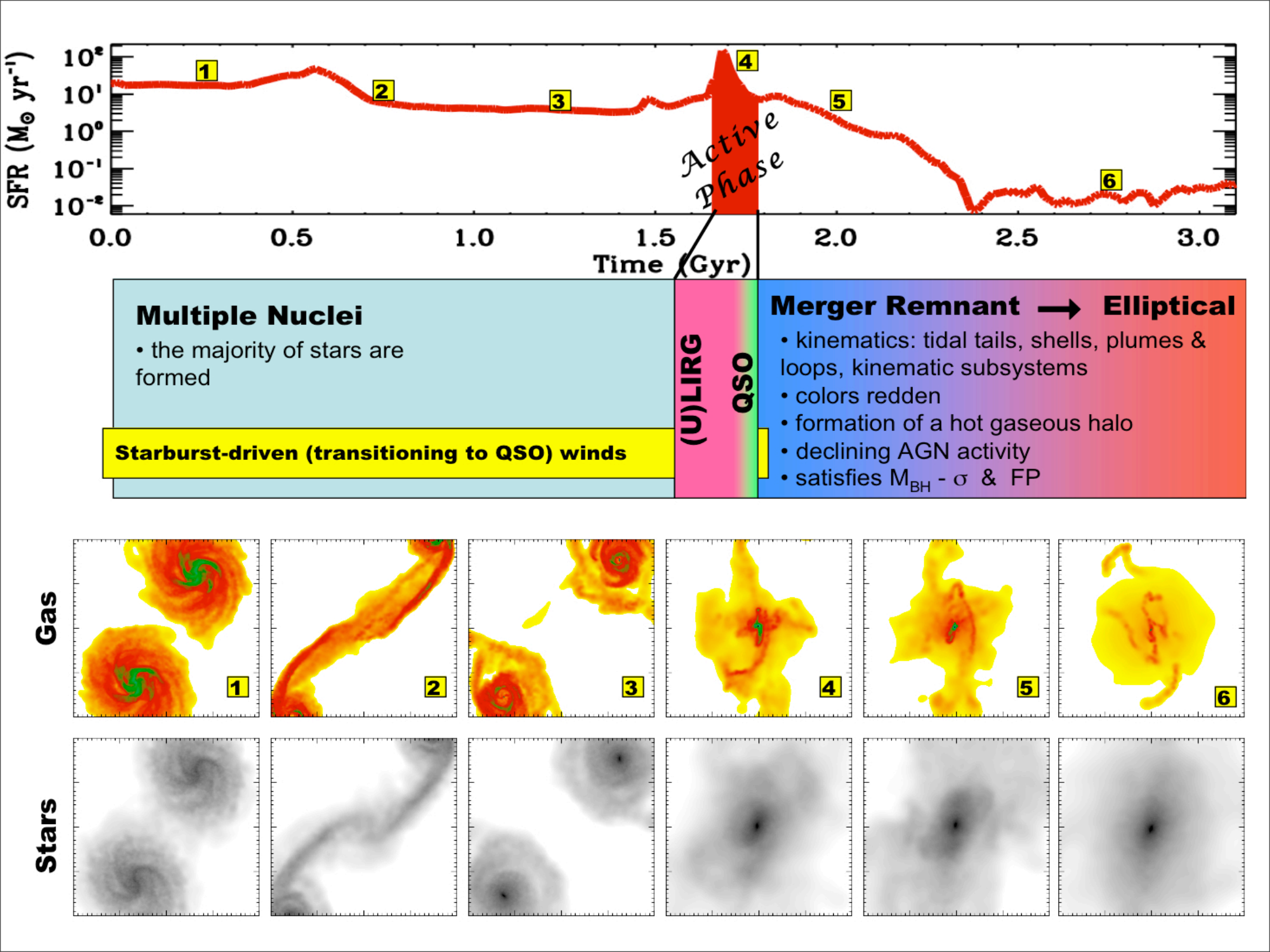
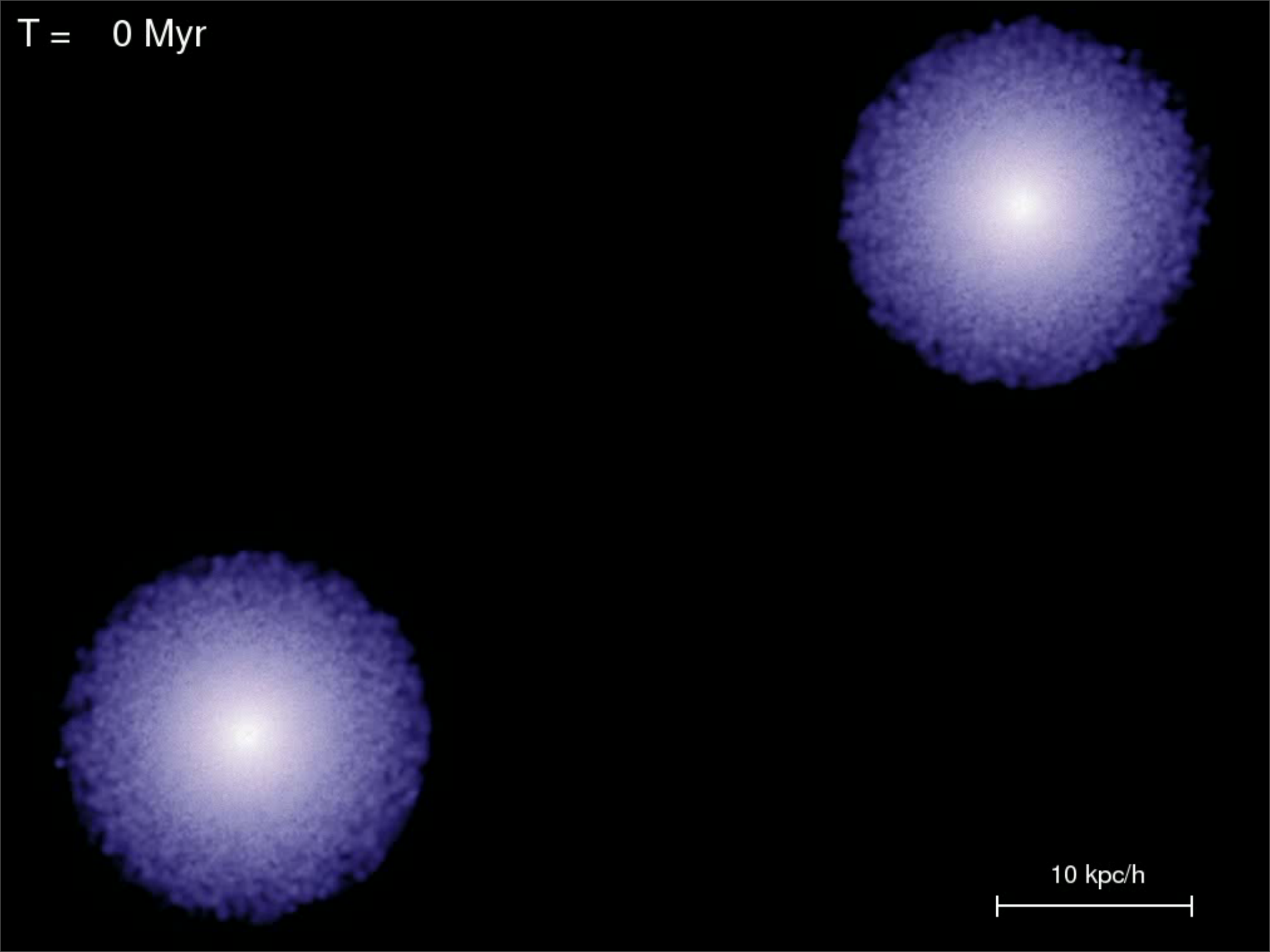
Dealing with large ensembles of simulations

Dealing with large ensembles of simulations: why?

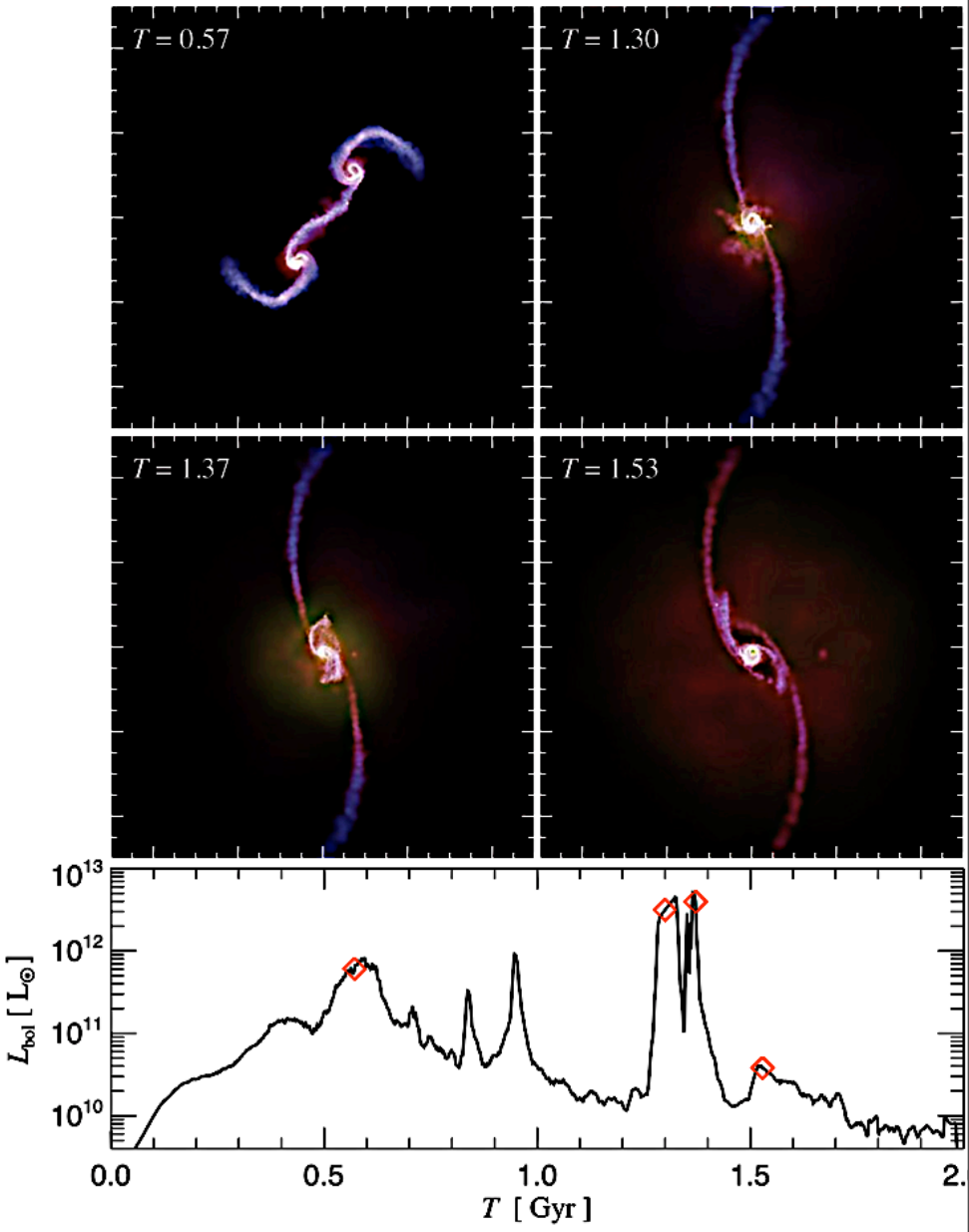
- Beat down randomness/noise


SFR ($M_\odot$ yr^{-1})
10^2
10^1
10^0
10^{-1}
10^{-2}
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Time (Gyr)
1
2
3
4
5
6
Active Phase
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} - σ & FP
Gas
Stars


T = 0 Myr
10 kpc/h

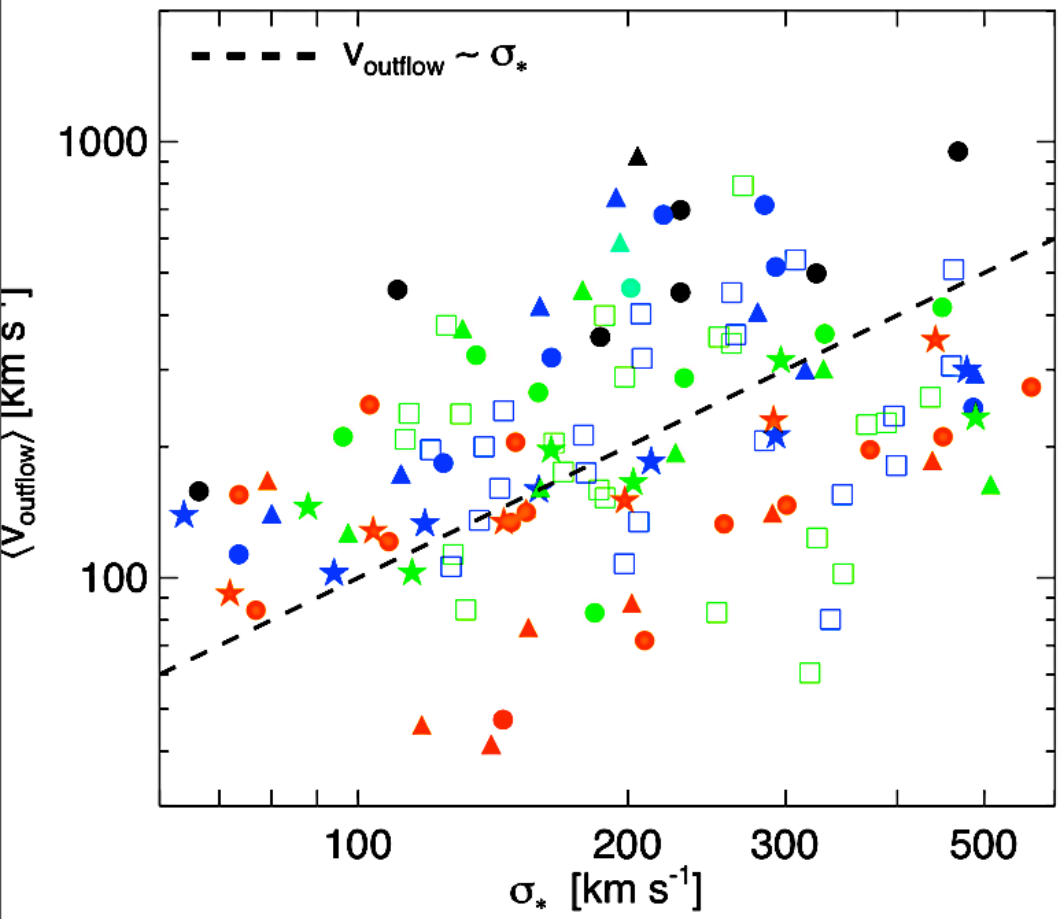
Dealing with large ensembles of simulations: why?

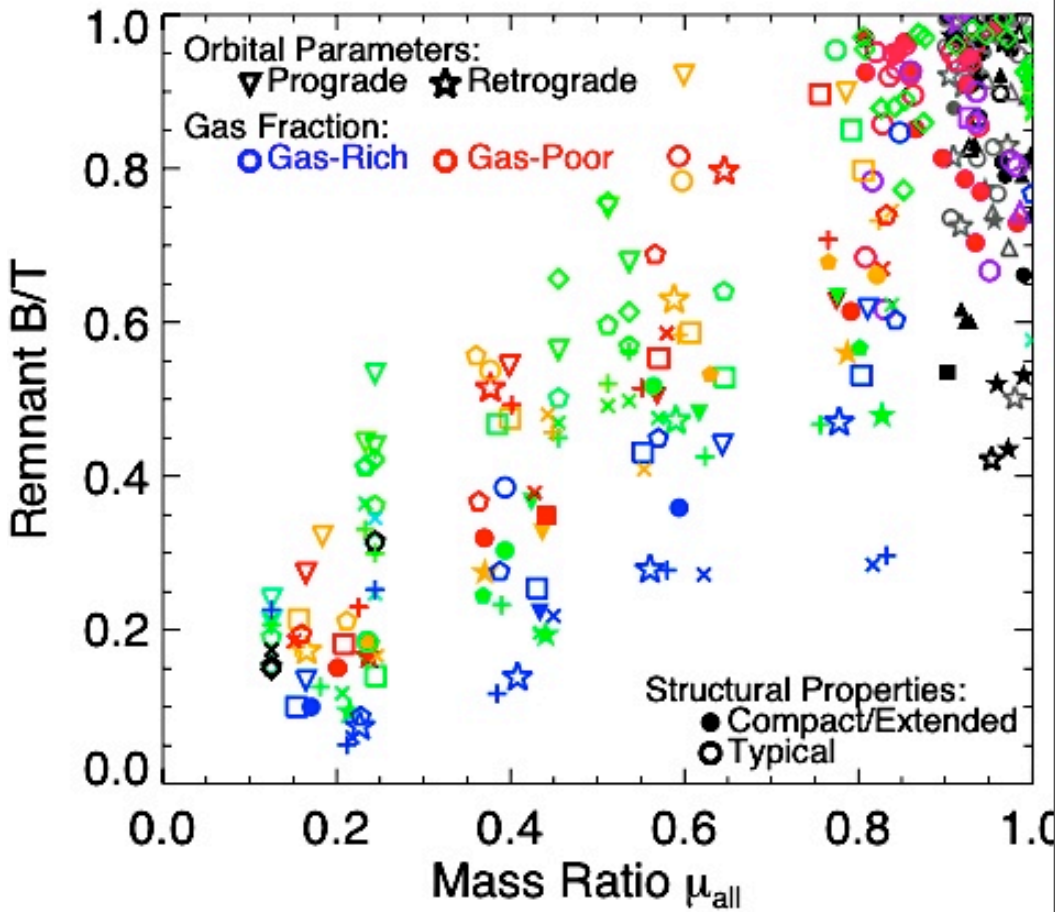
- Beat down randomness/noise



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:


Biggest Galaxy ~ 1/20 SDSS Quasar
Smallest dwarfs ~ 10^{10} Msun

Dealing with large ensembles of simulations: why?

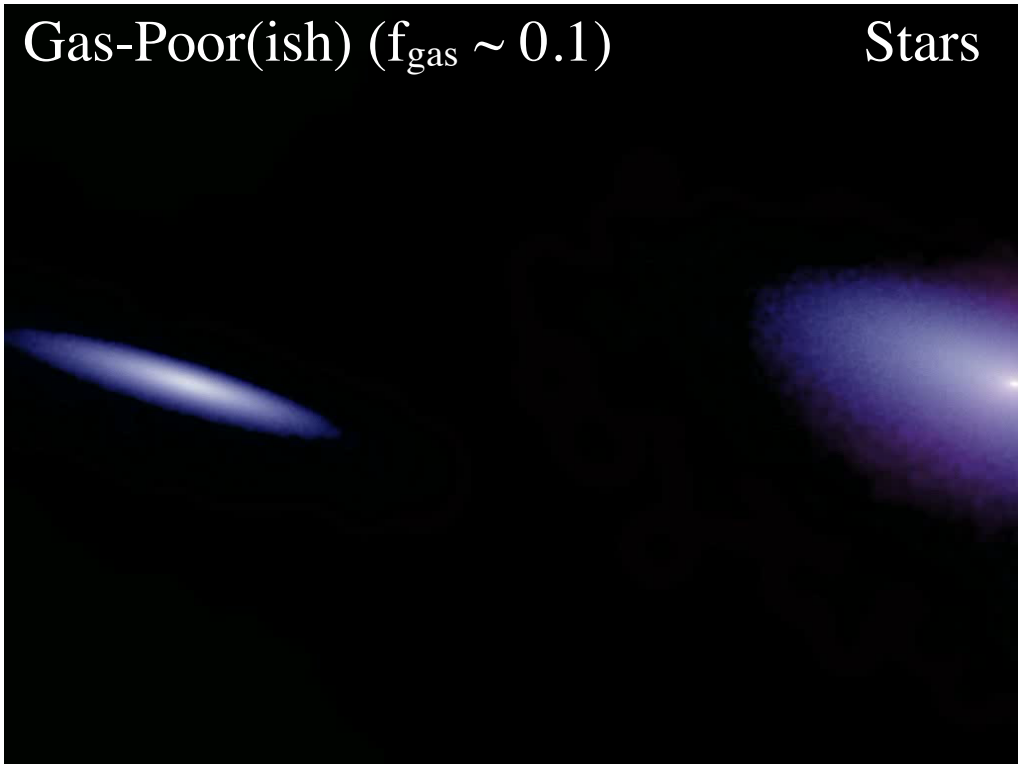
- Beat down randomness/noise
- Dynamic range
  - Cosmological:
  - ‘Re-simulation’ Techniques:

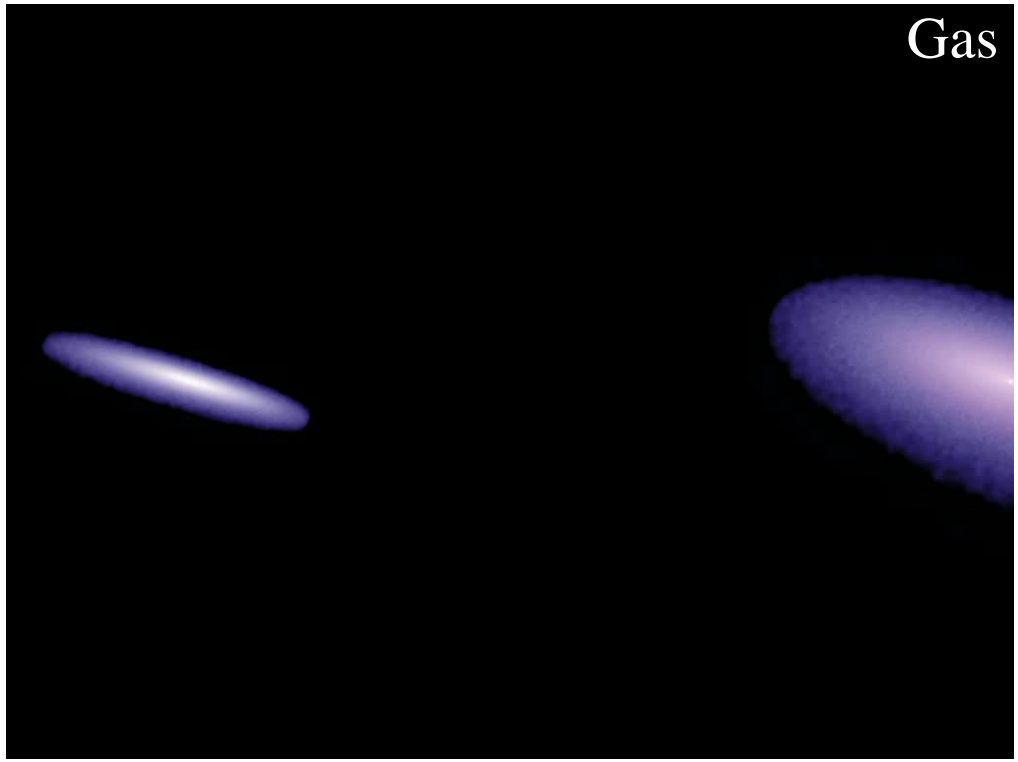

T = 0 Myr
Gas

Dealing with large ensembles of simulations: why?

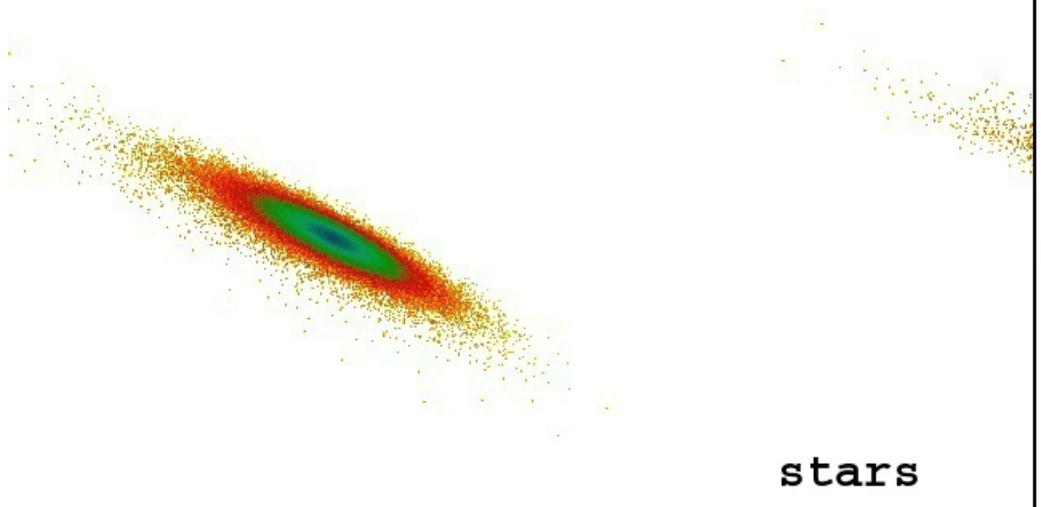
- Beat down randomness/noise
- Dynamic range
- Parameter Studies

Gas-Poor vs Gas-Rich Merger





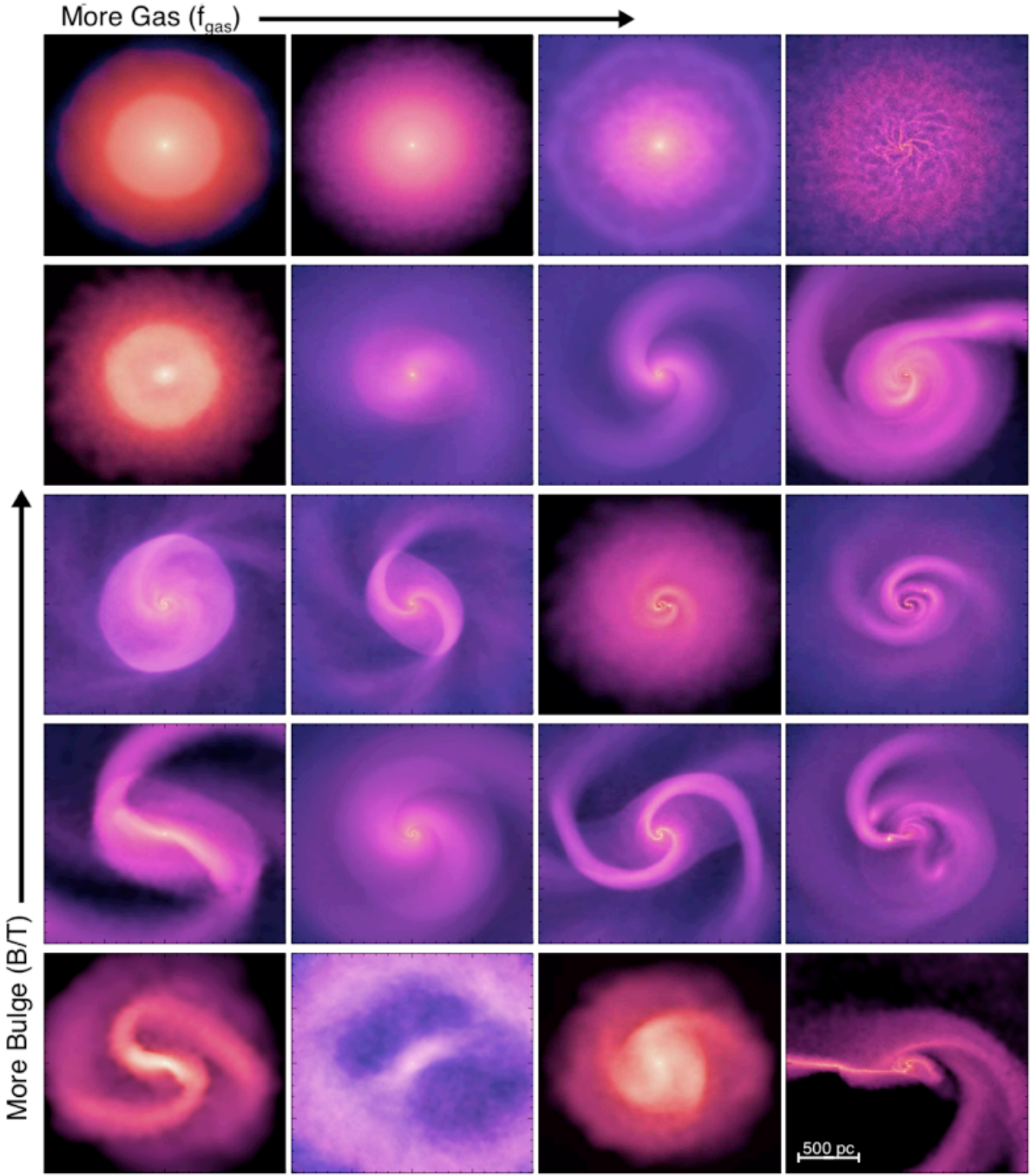
Gas-Rich(er) (f_{gas} ~ 0.4)



Dealing with large ensembles of simulations: why?

- Beat down randomness/noise
- Dynamic range
- Parameter Studies
  - "Known Unknowns" (e.g. dynamics)

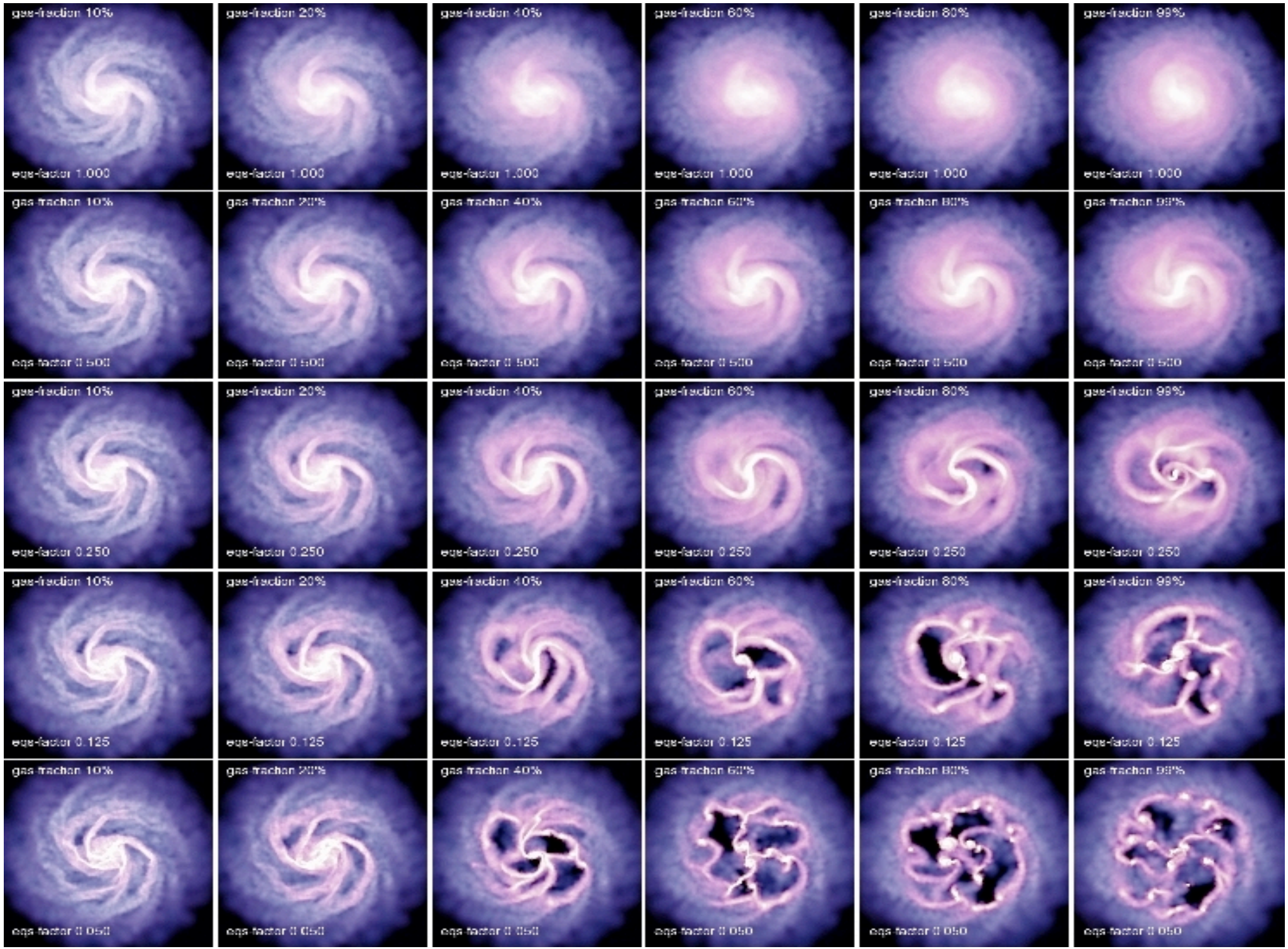
“known unknowns”



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’

Sampling: How to Do It?

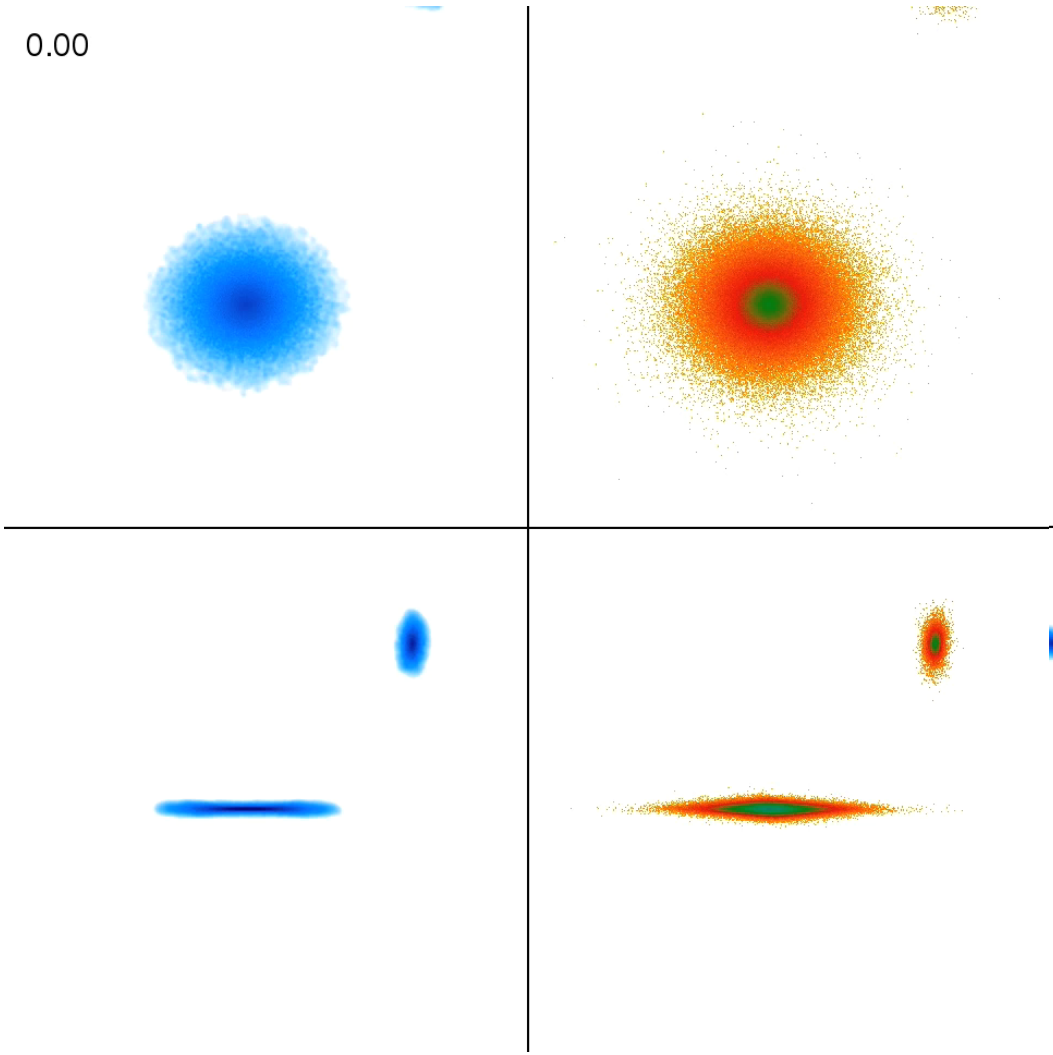
- Cosmological Simulations
  - Enough dynamic range?
  - What if it's wrong?
  - Skew weighting in fits?
  - How do you define quantities?
    - Galaxy mass?
    - Merger mass ratio?
    - Gas fraction?


z=99.00
2 kpc
Agertz et al. (2009)

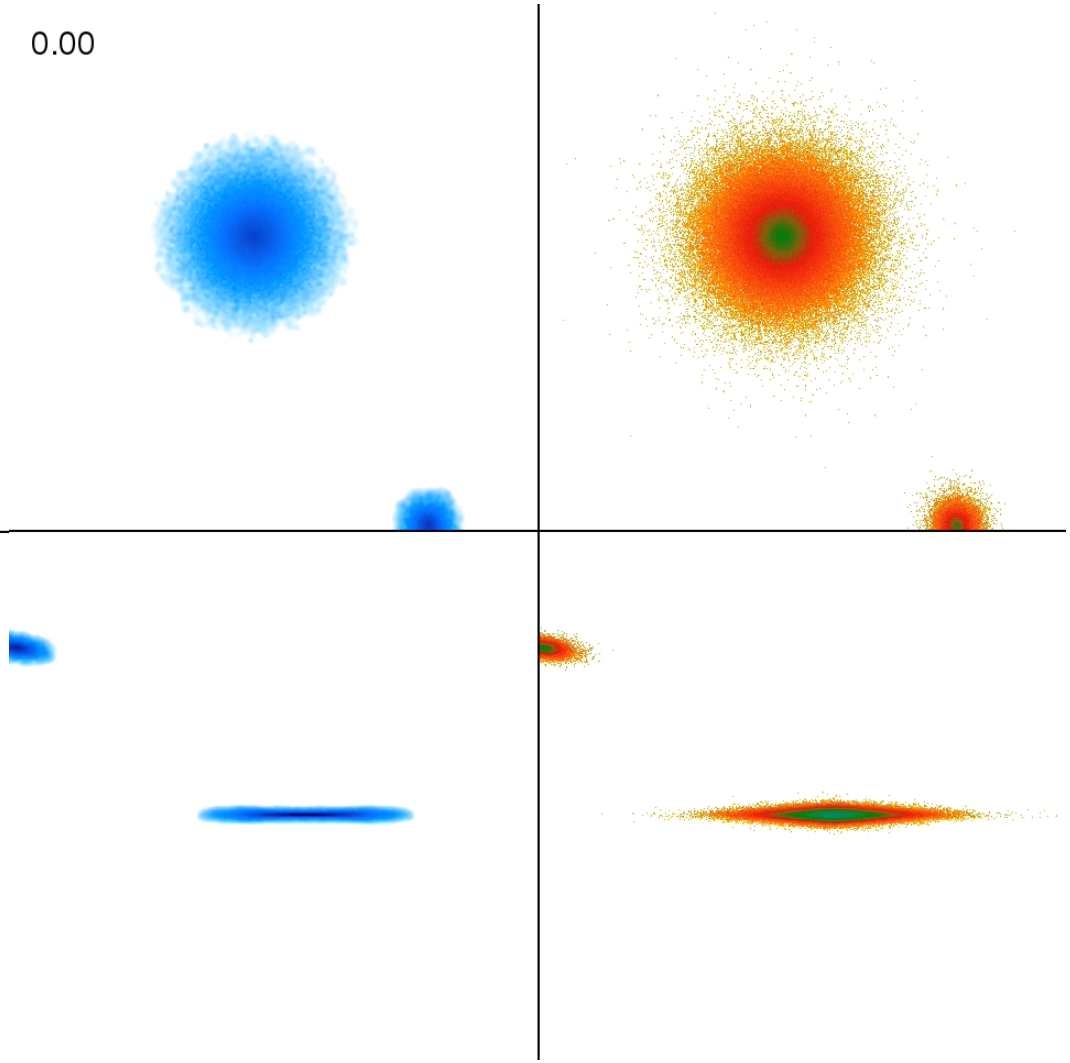
Sampling: How to Do It?

- ‘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

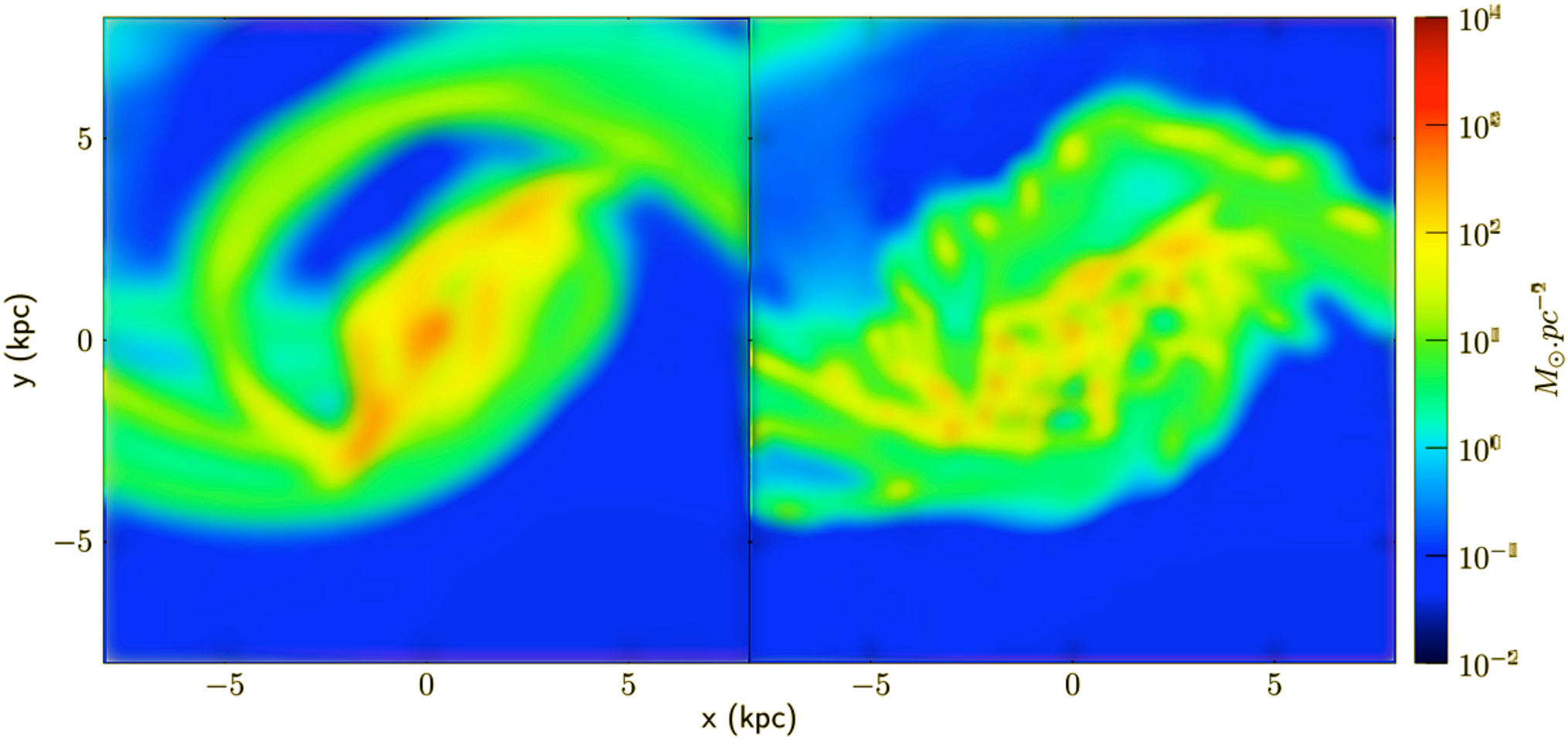


minor merger: retrograde



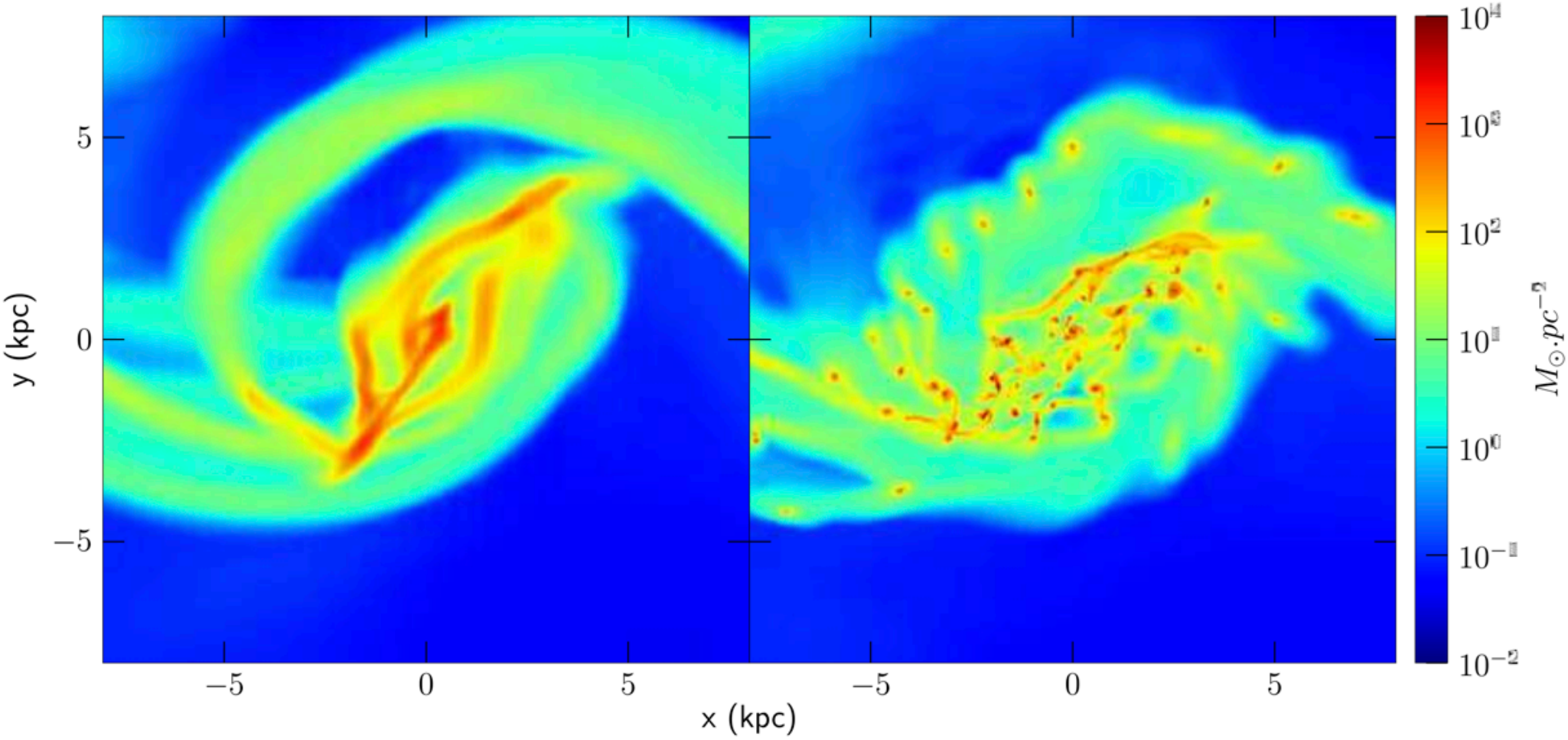
Sampling: How to Do It?

- Low-Res to High?

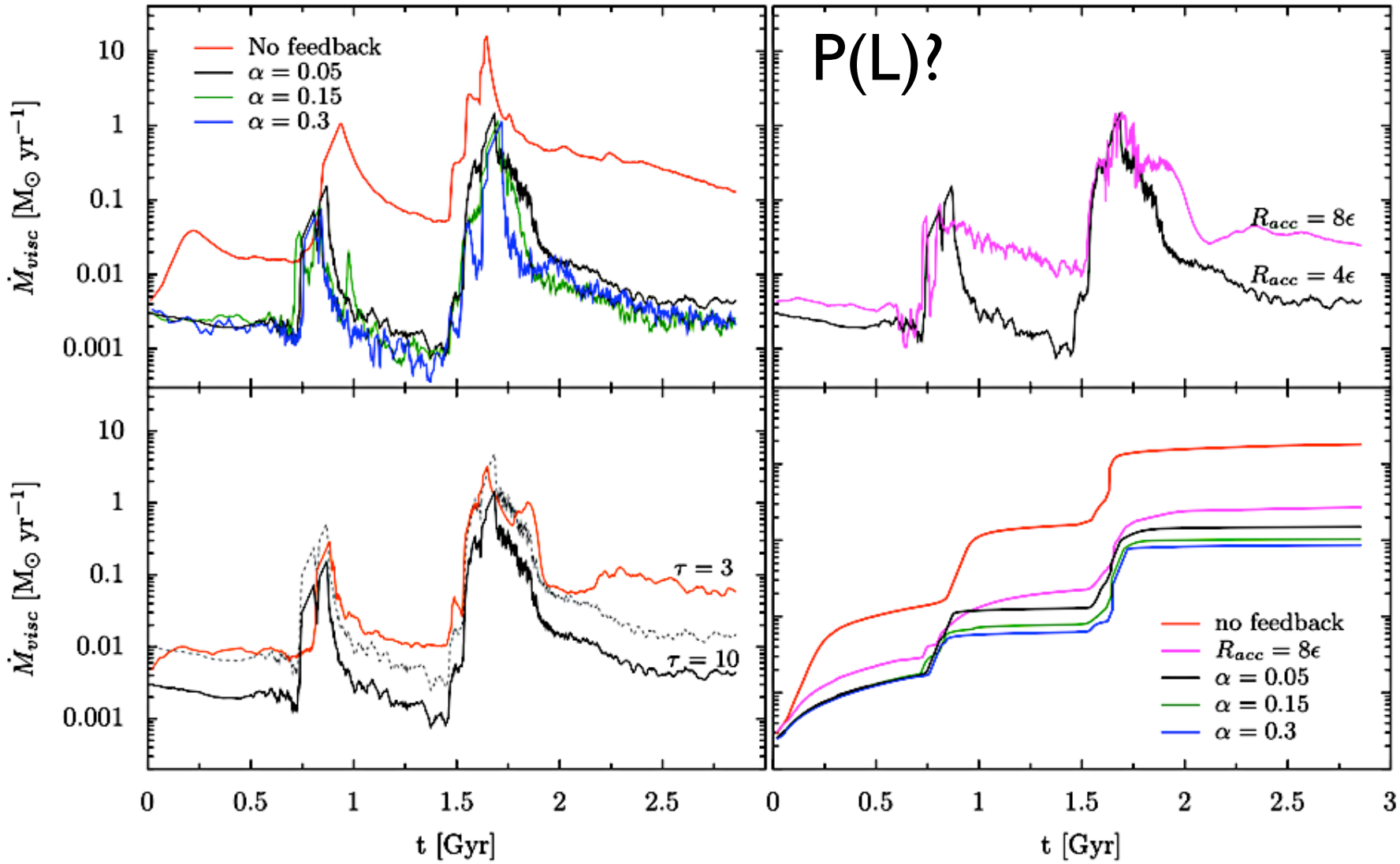


Sampling: How to Do It?

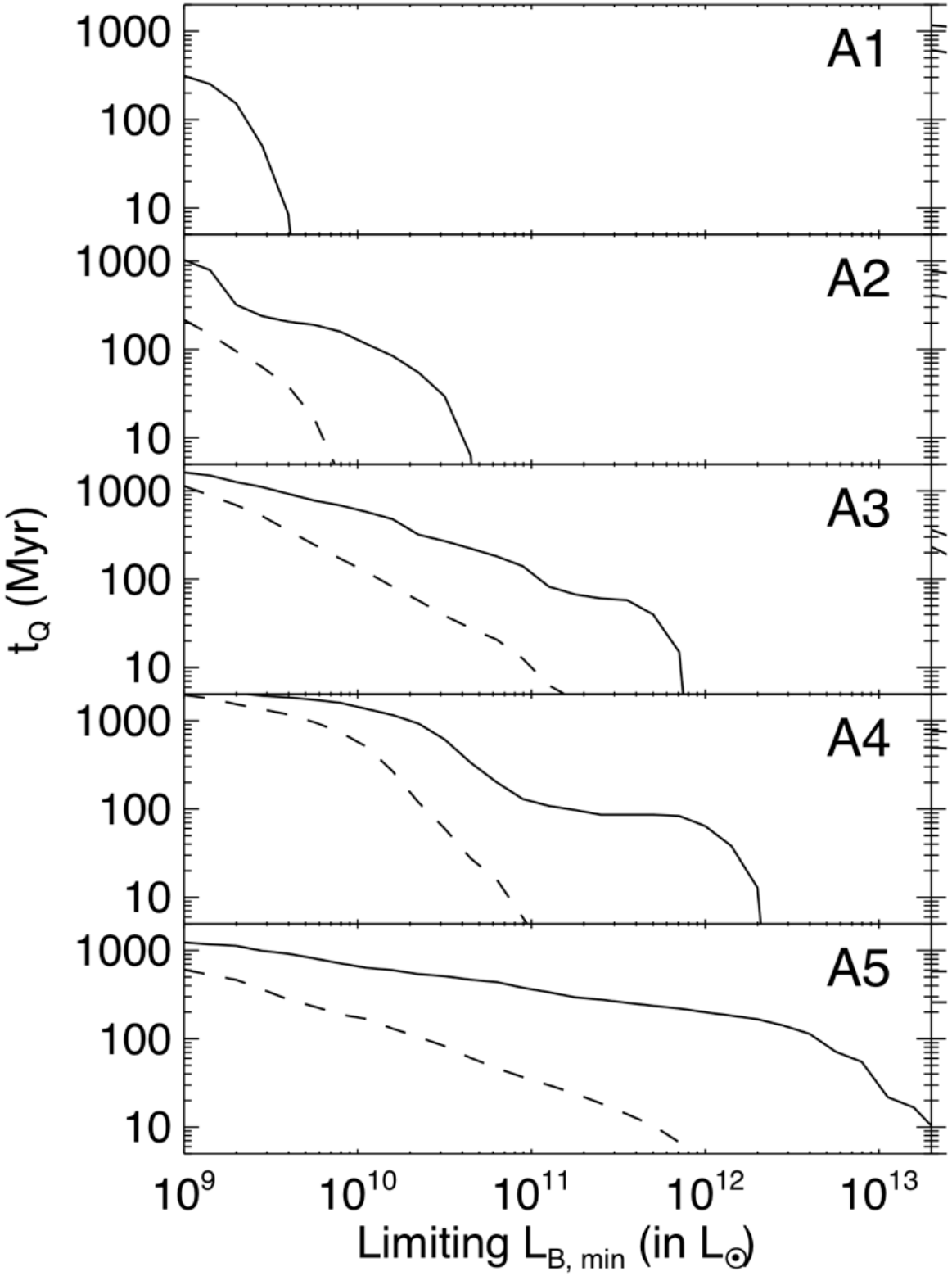
- Low-Res to High?

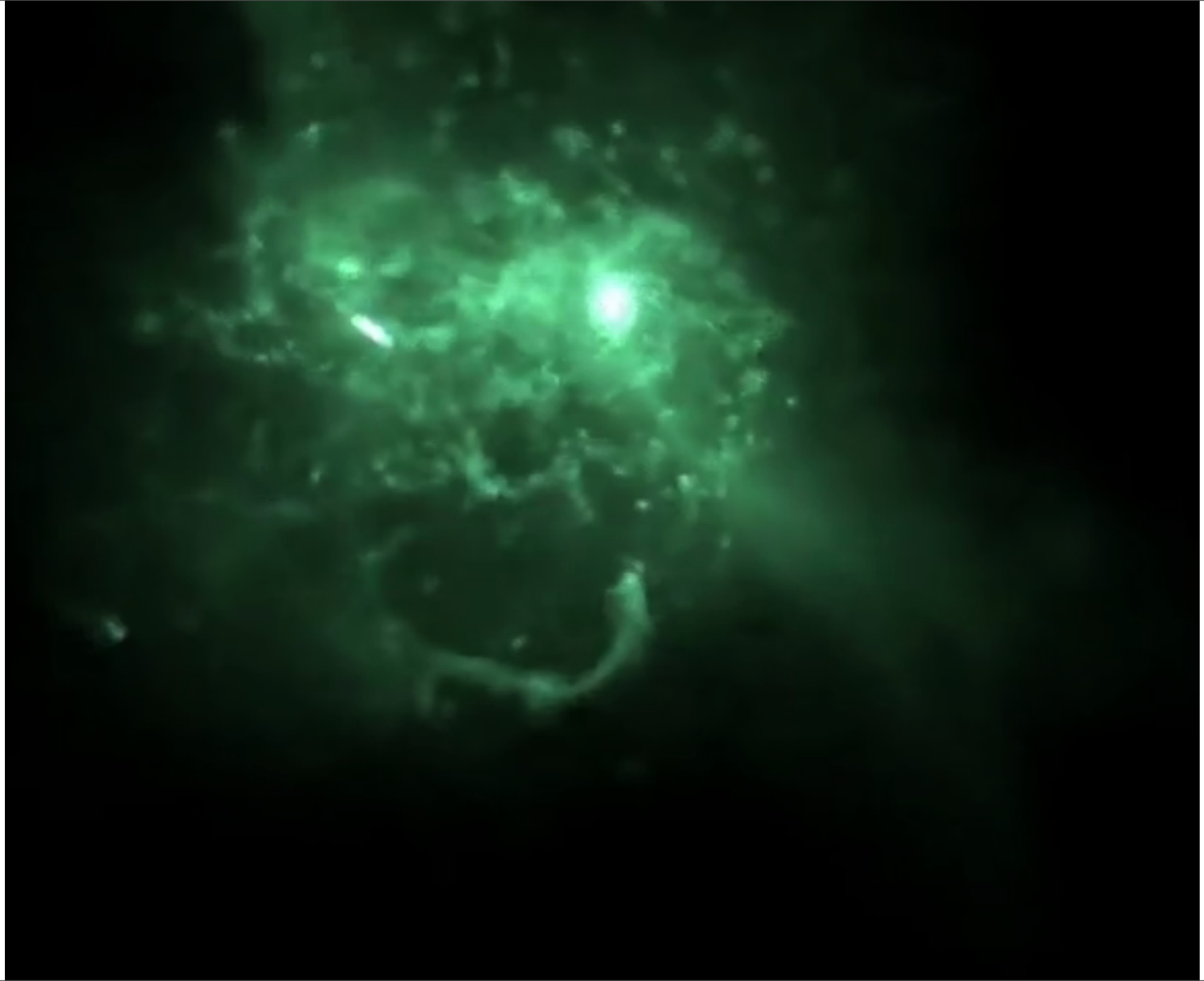


Ok, so you have your simulations... now what?



Define robust quantities:



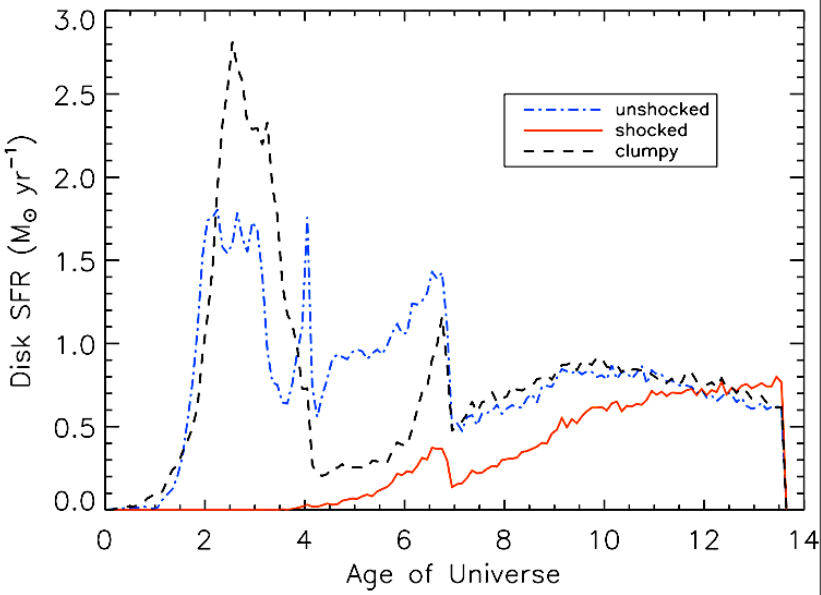


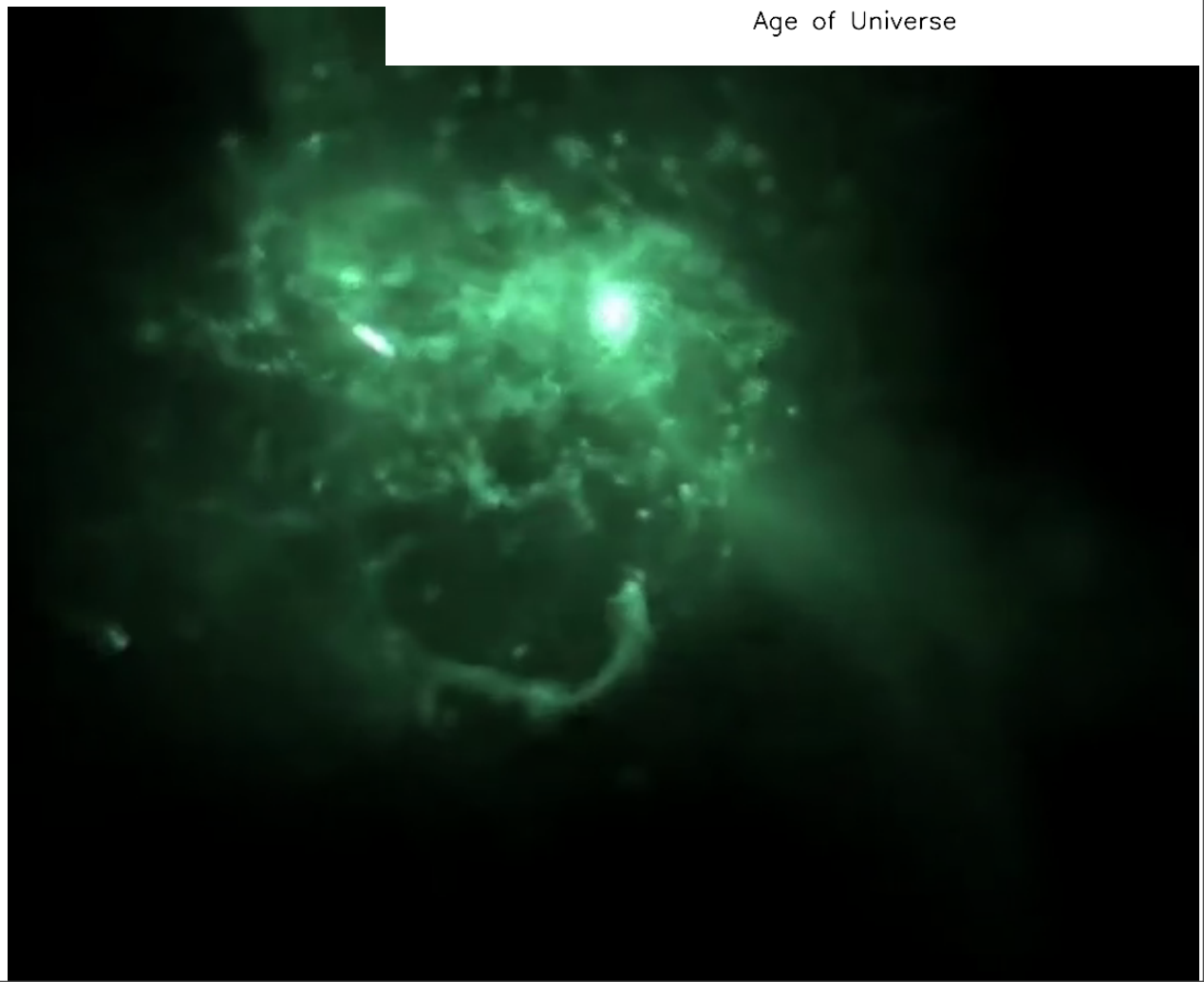
- When is the merger?

- What are the gas fractions?

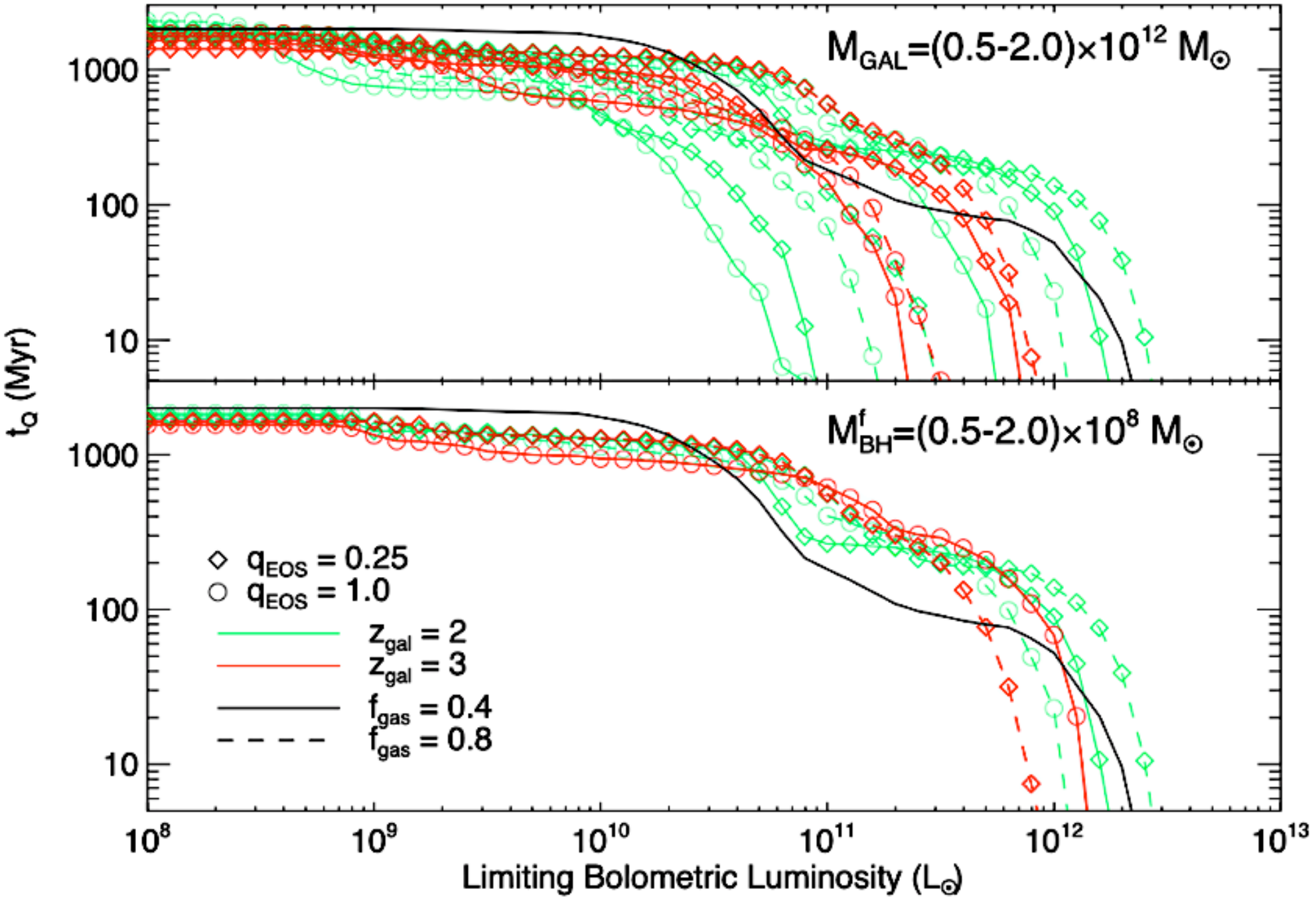
- Mass ratio: when? what? how?

- What do you define
  a ‘starburst’ relative to?

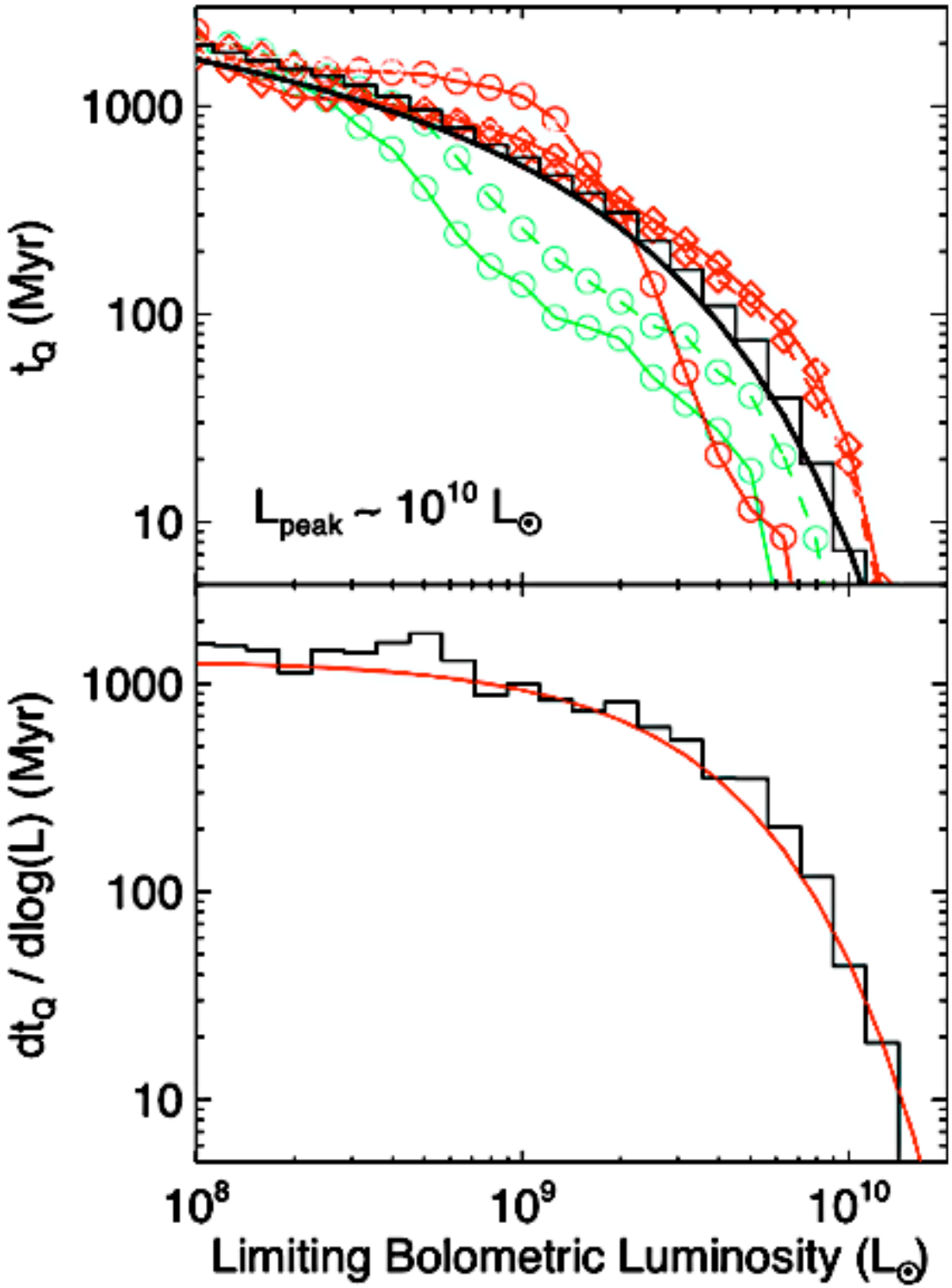




Look for what controls the outcomes:



Defining ‘typical’:



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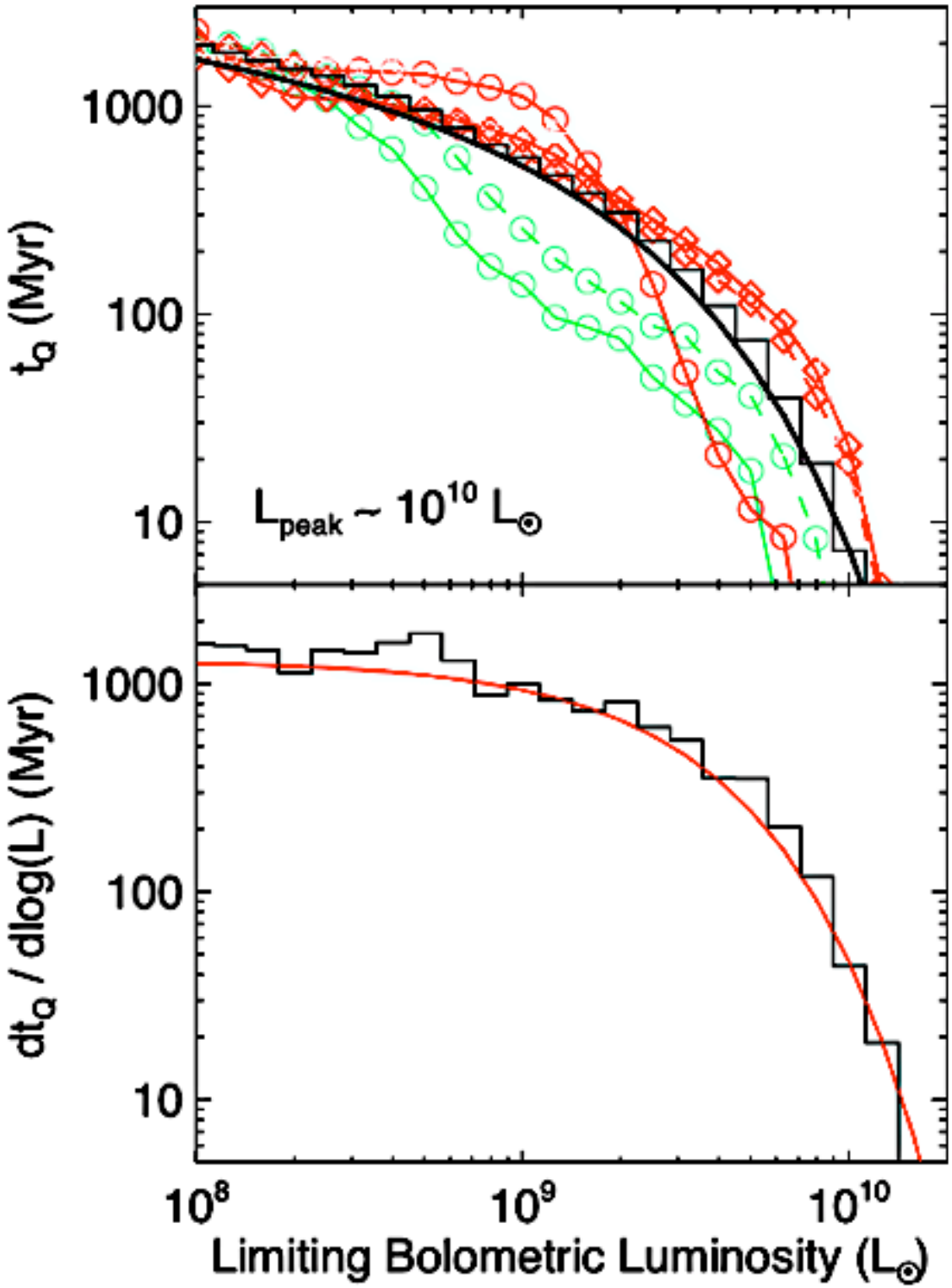

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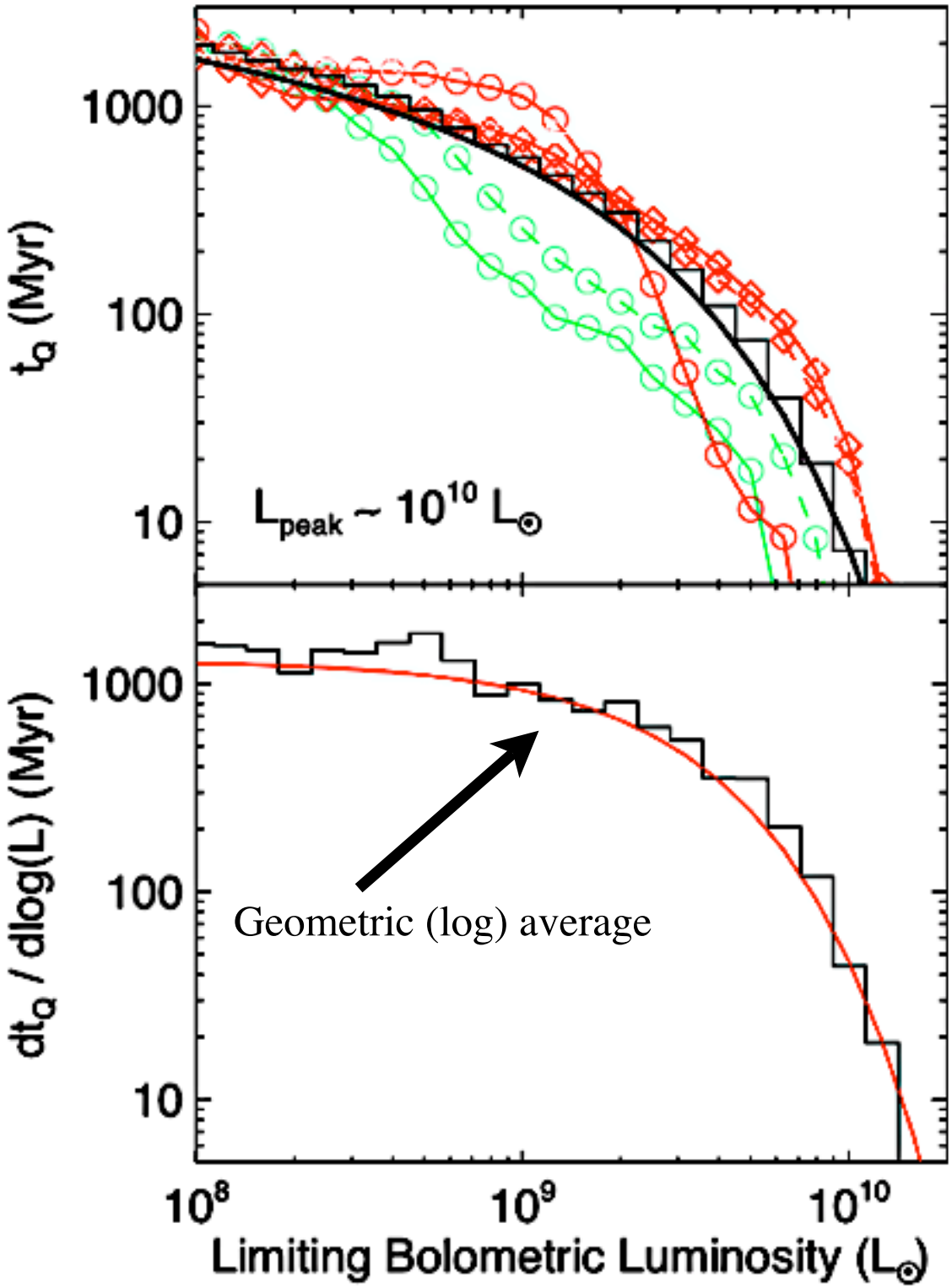

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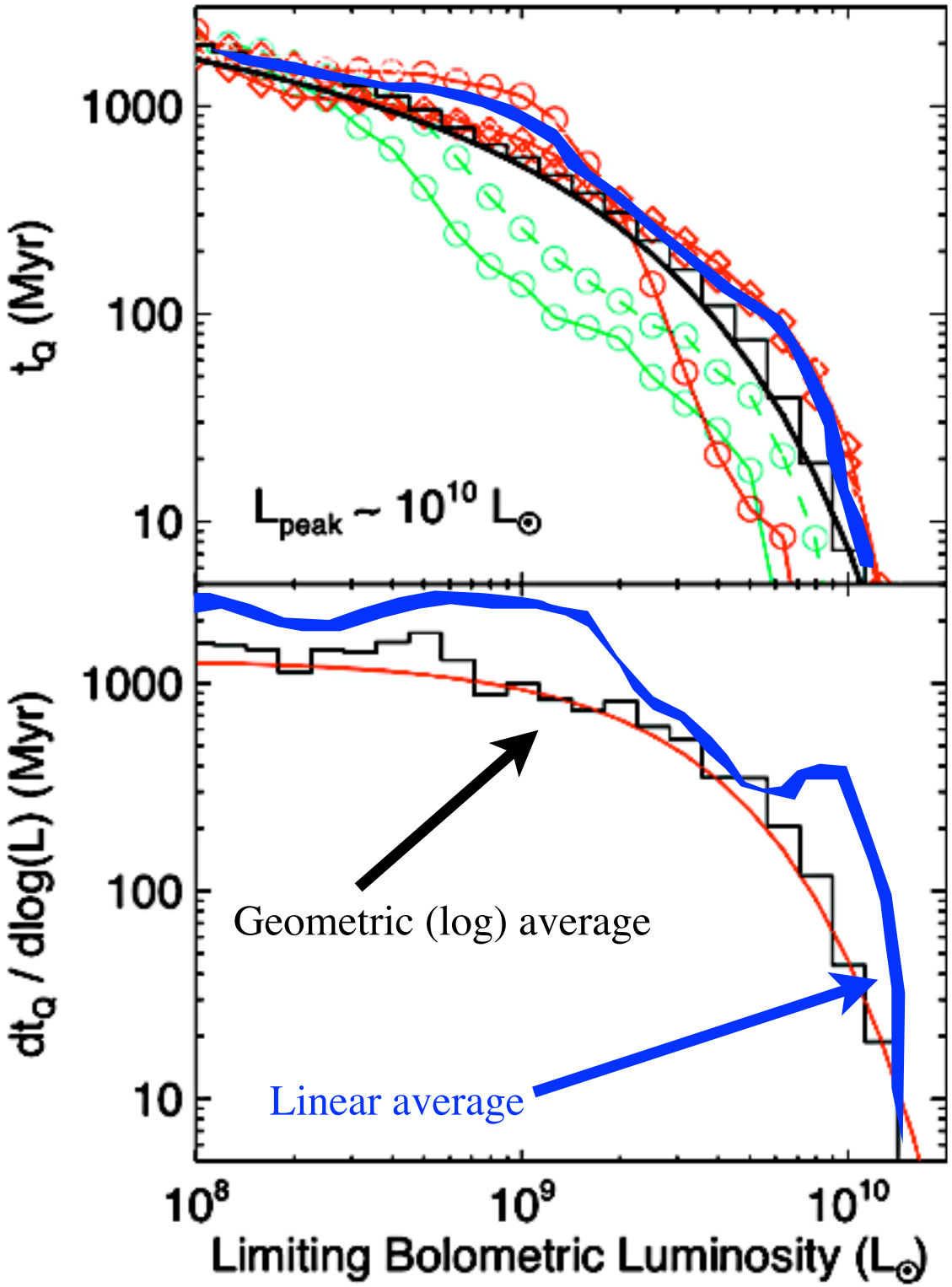
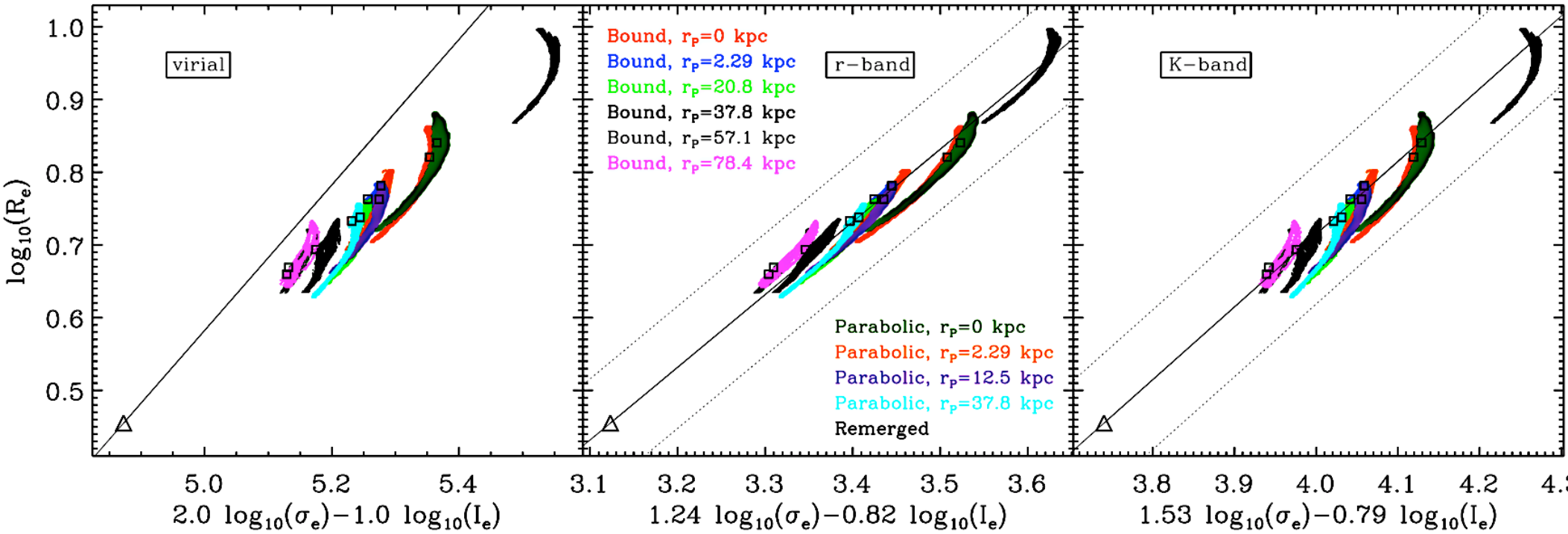


So we define something... How do you 'fit' it?



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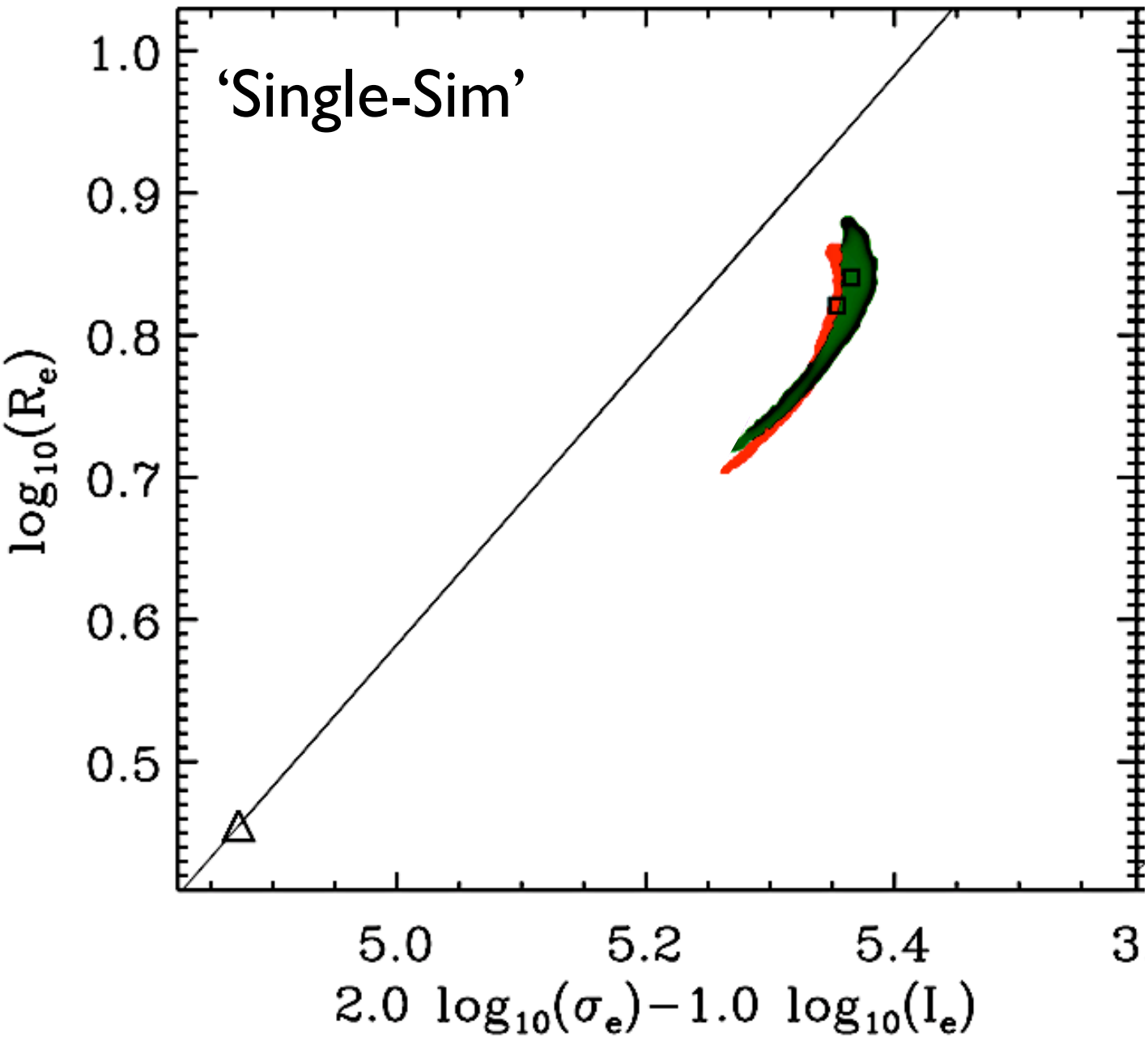

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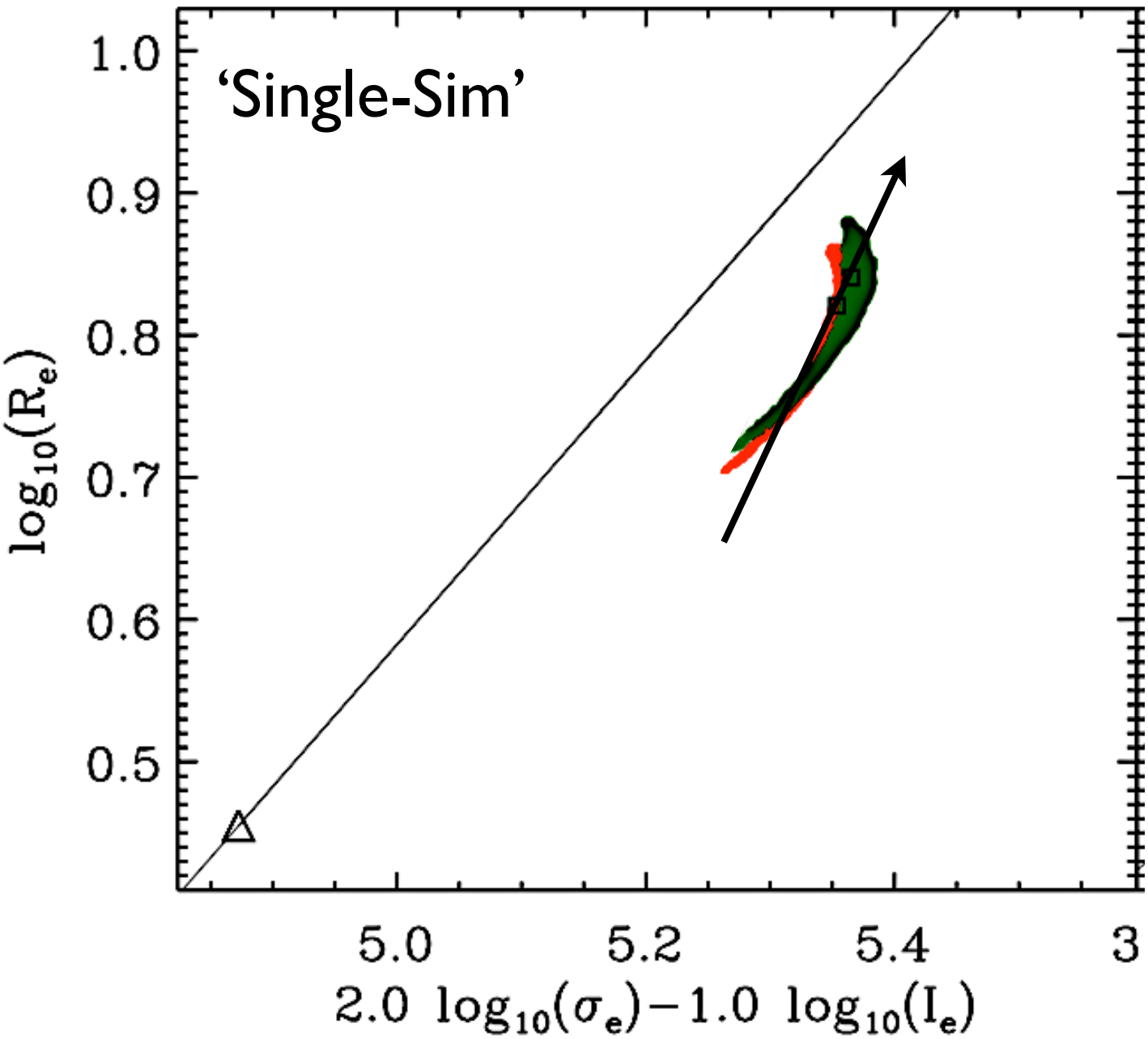

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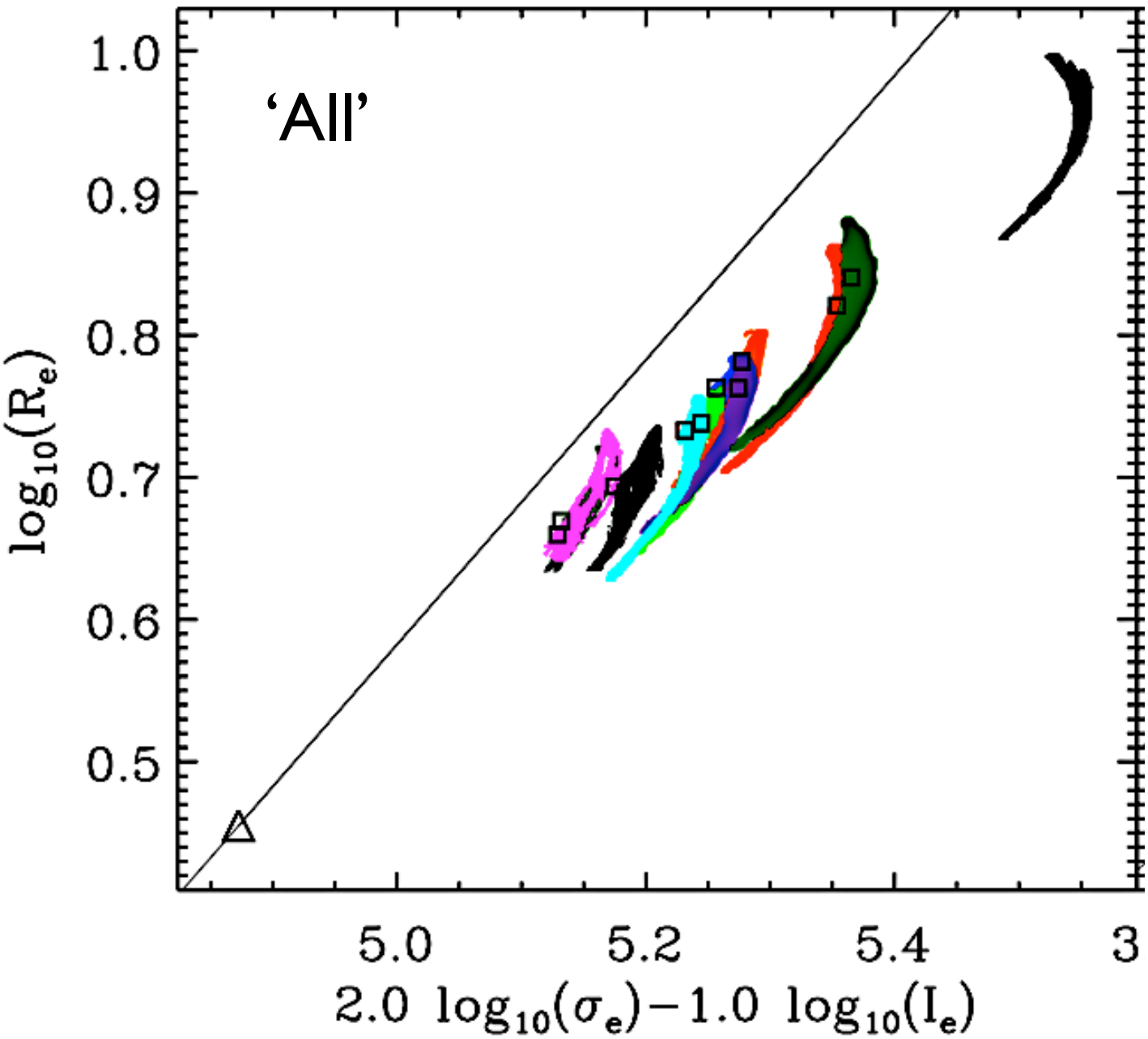

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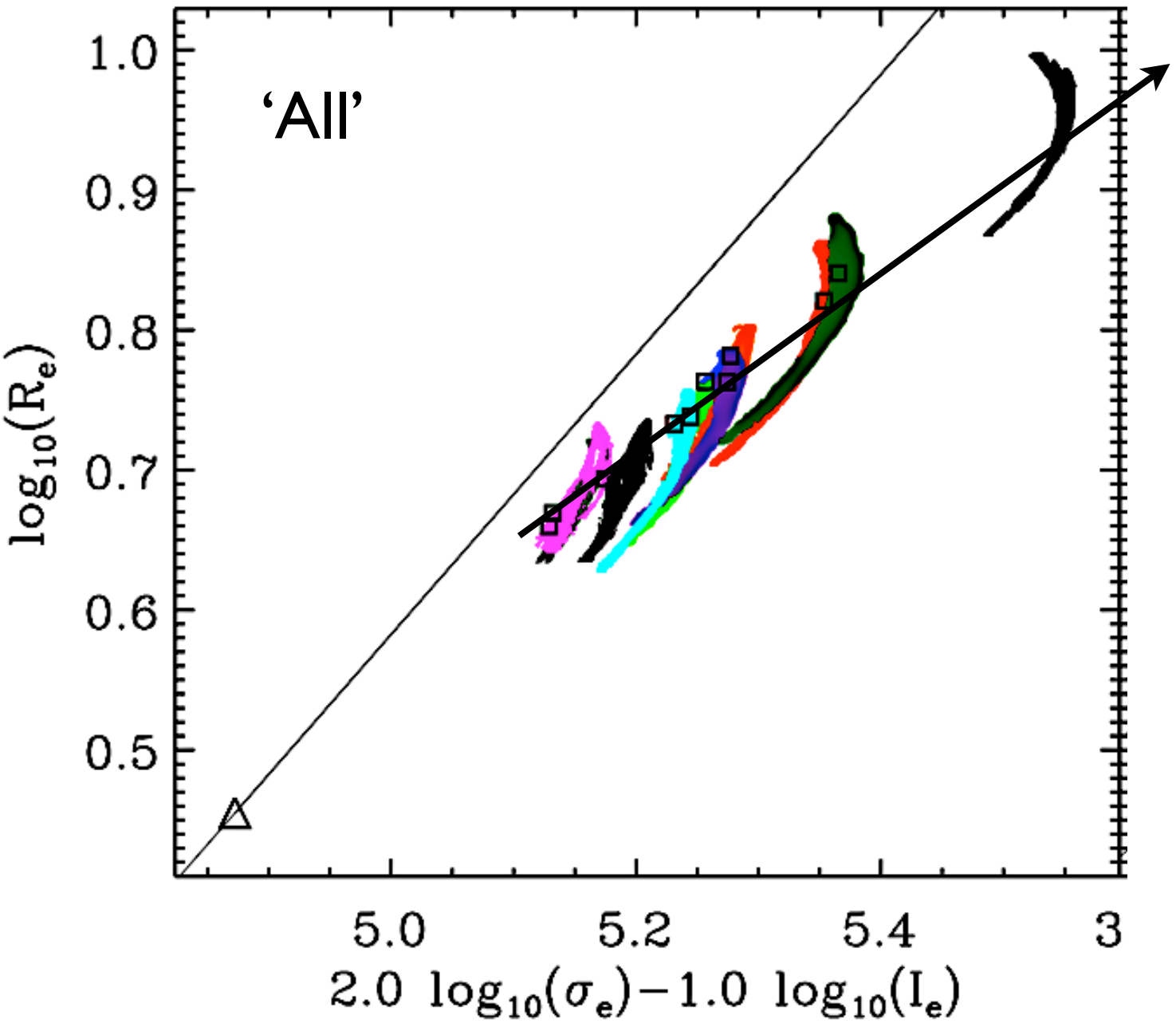

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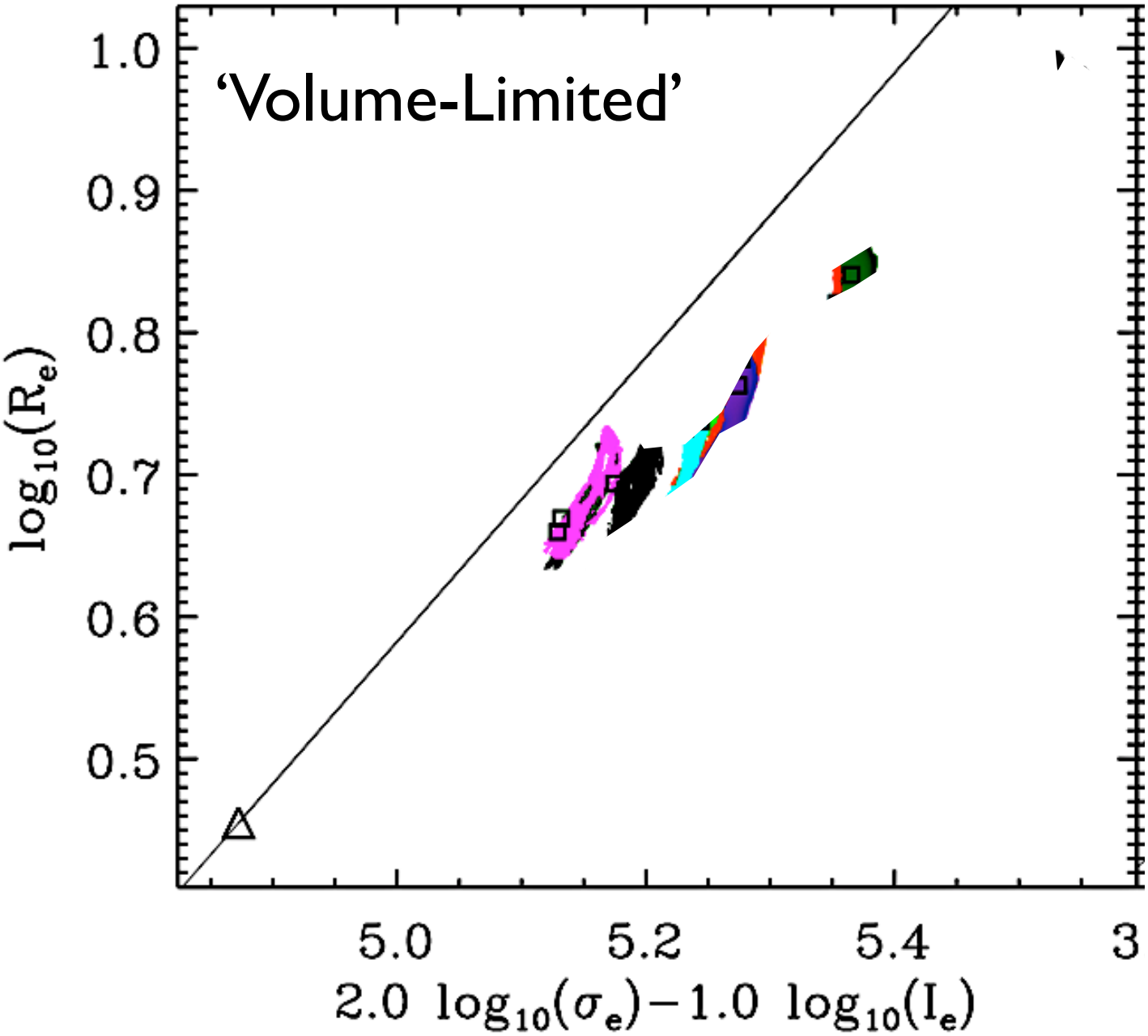

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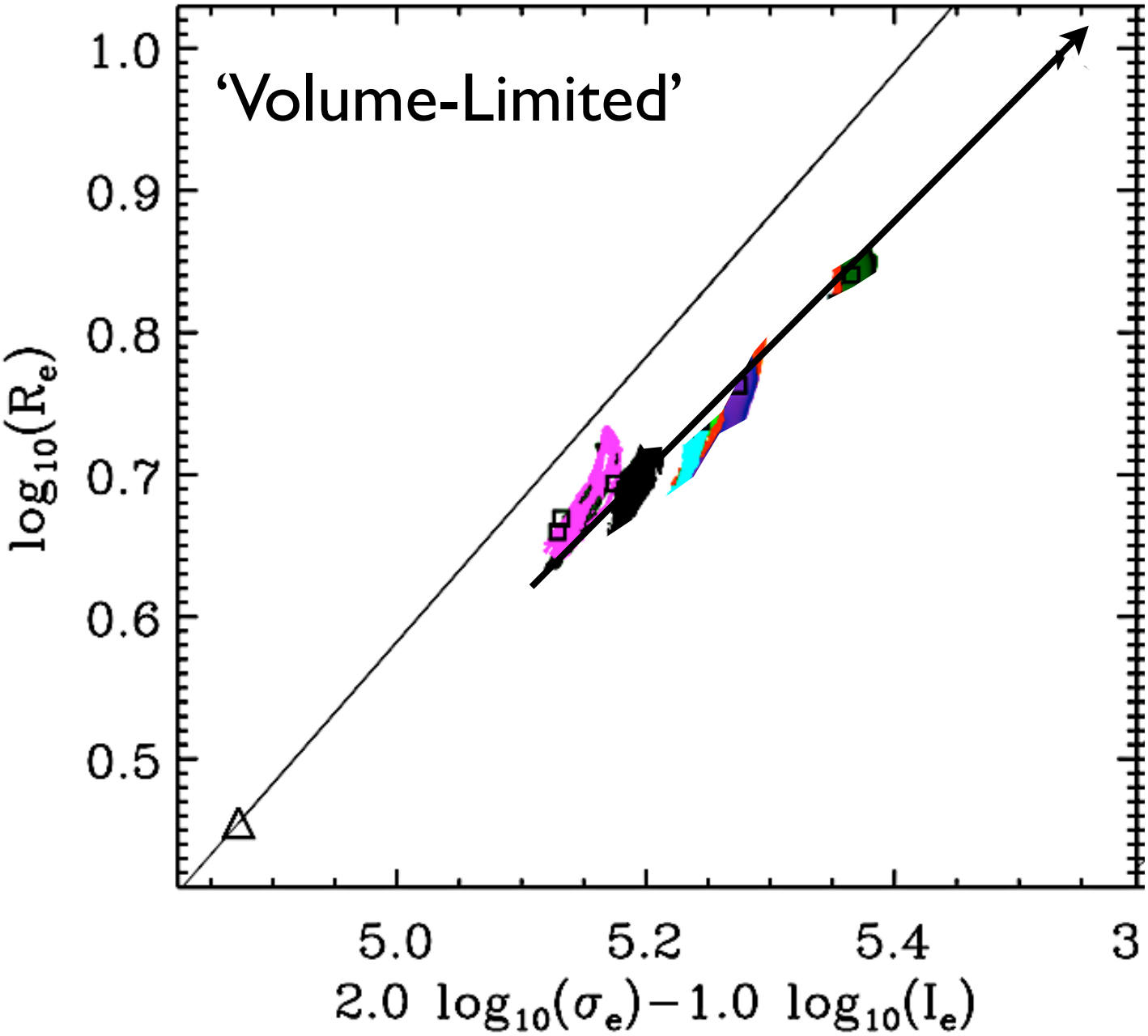
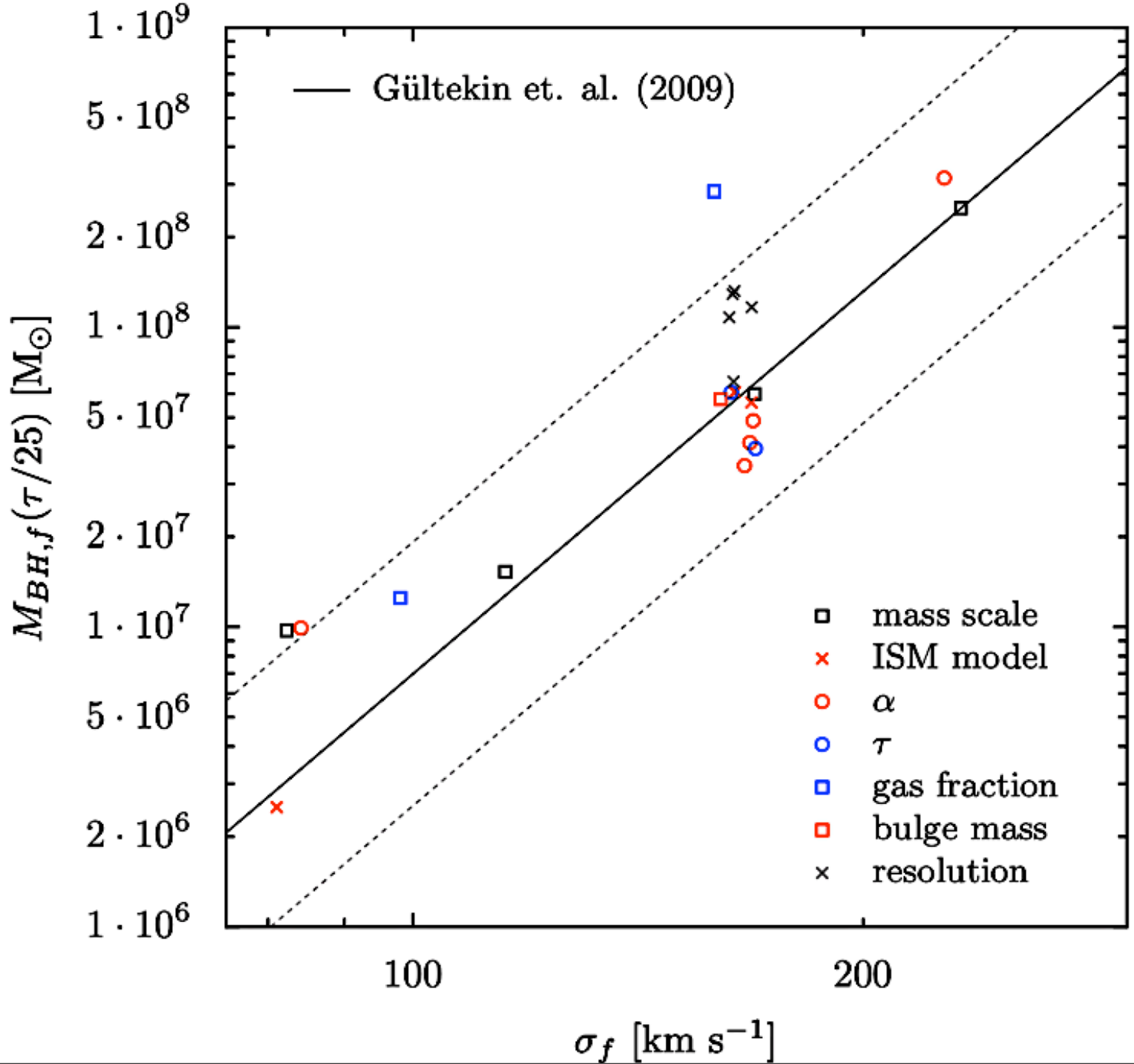


Even reduced to one point per simulation:



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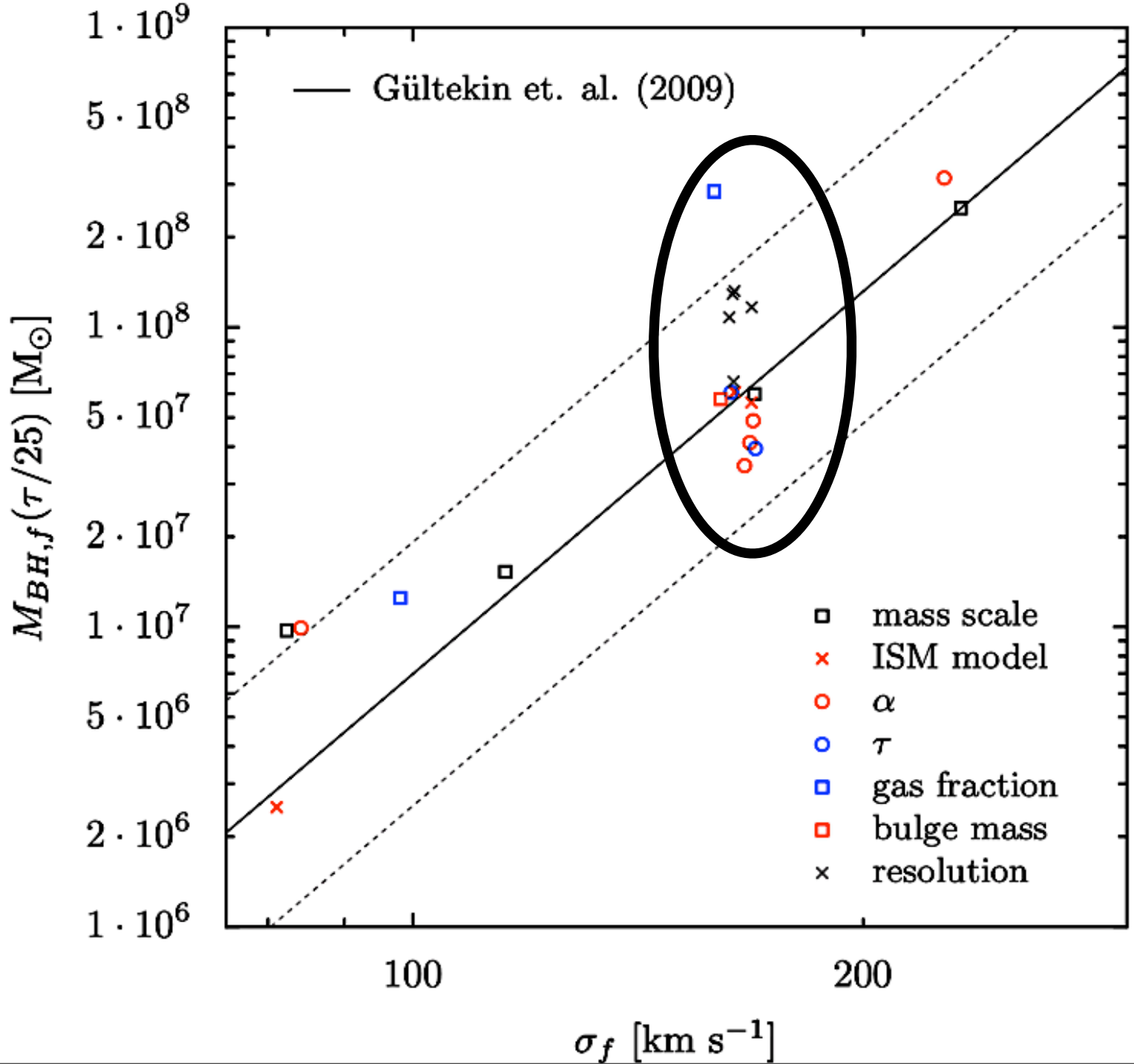
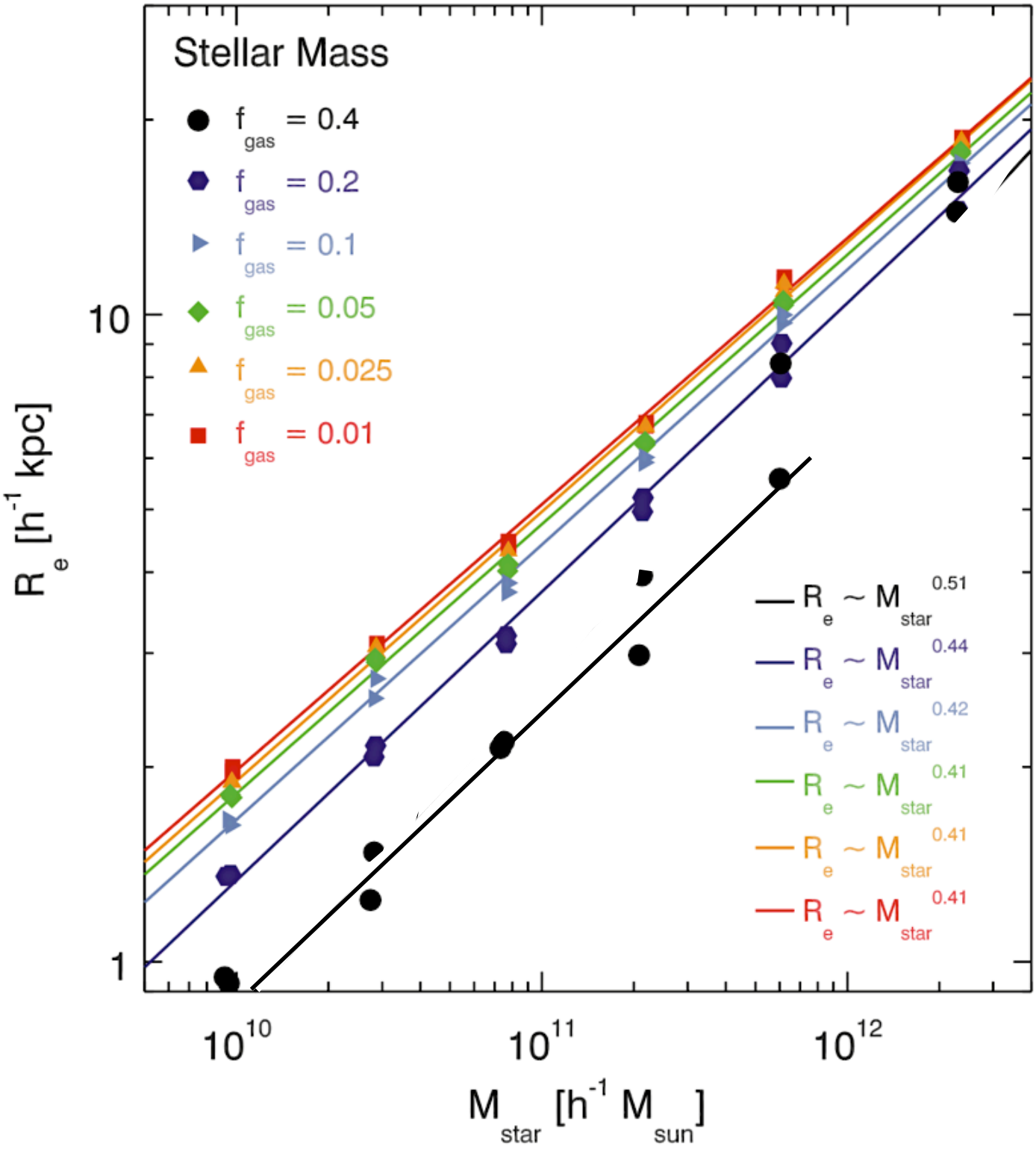


- Priors

- What you will compare to



- Priors

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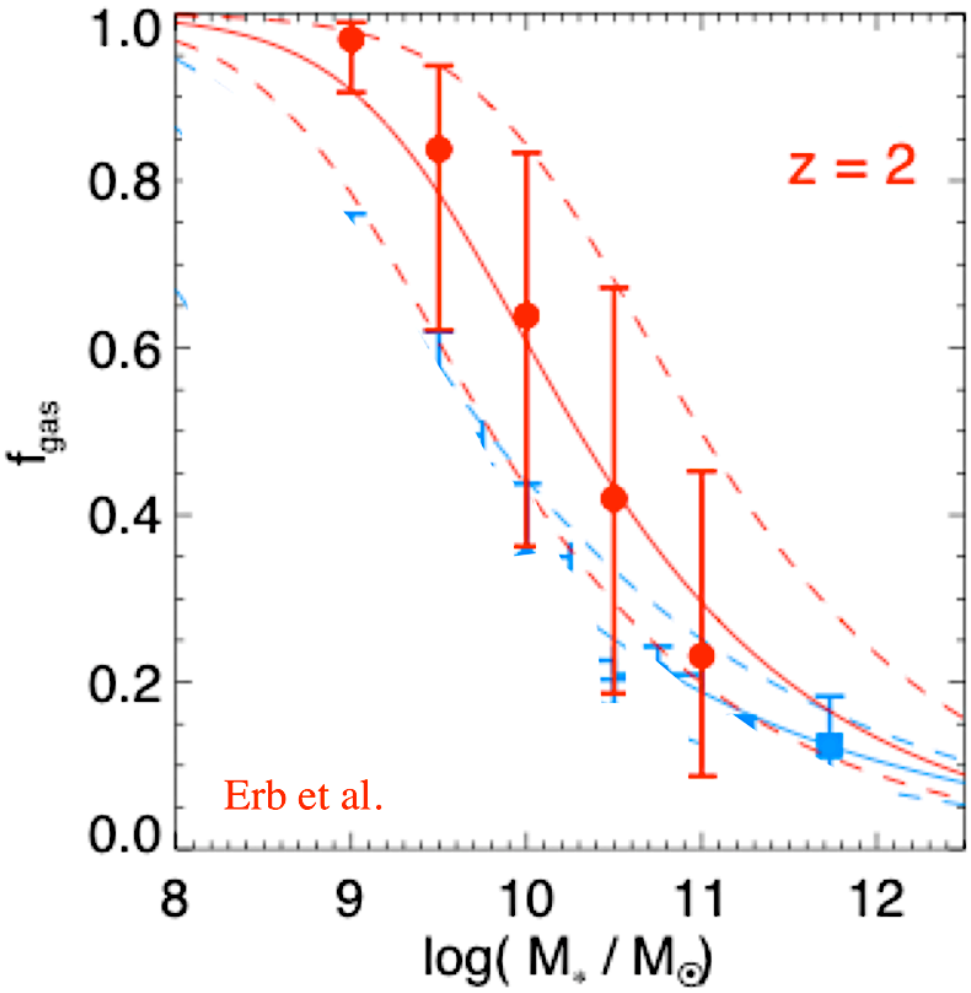

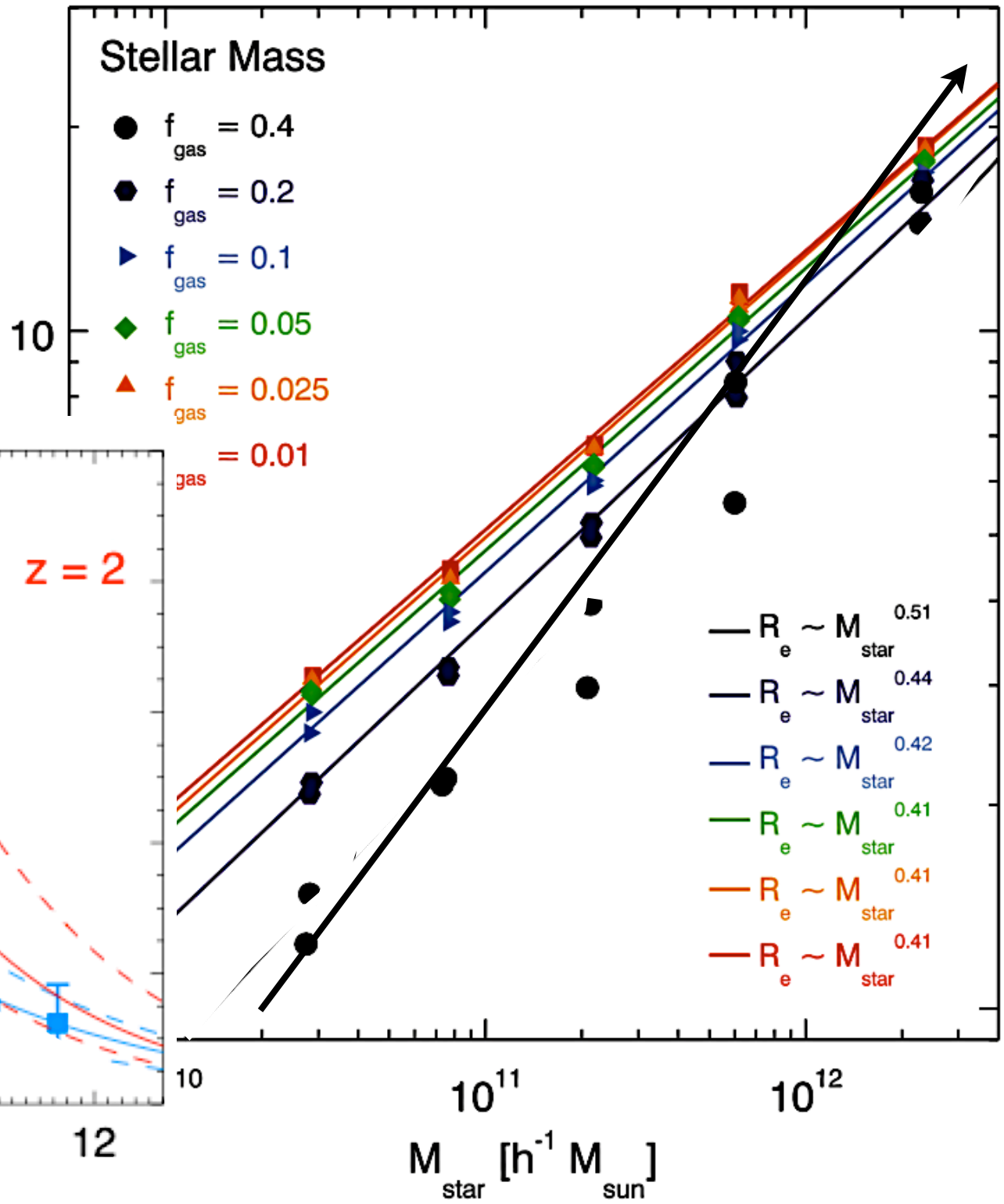

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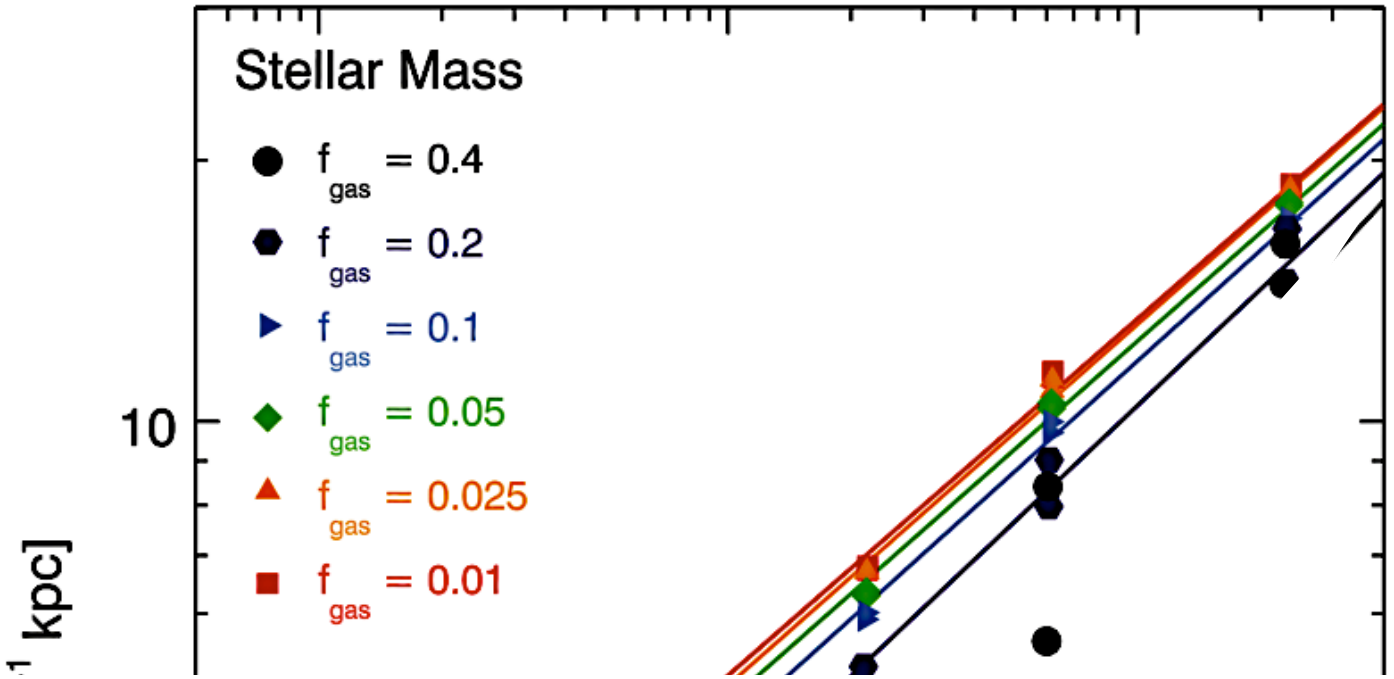

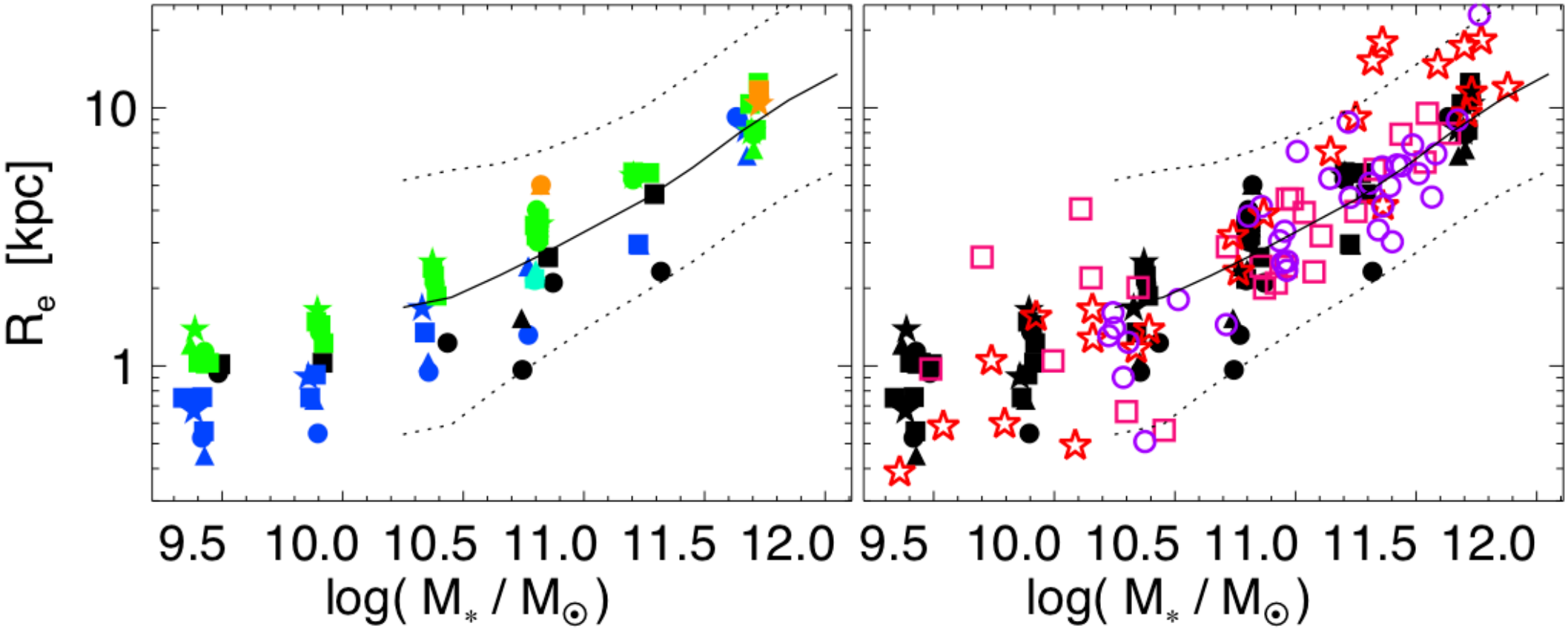

Summary

- 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