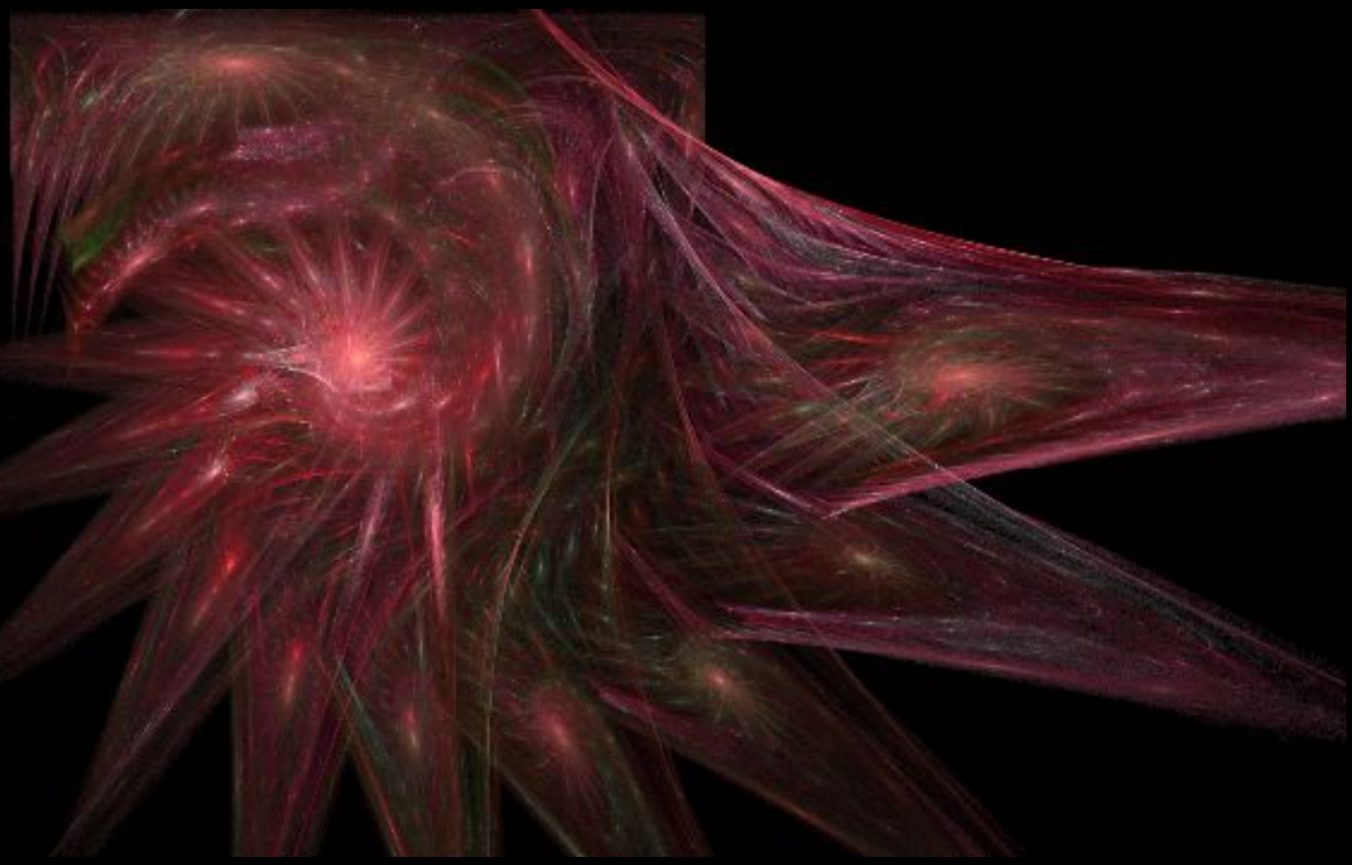
CHIARA TONINI, Cozumel 2016

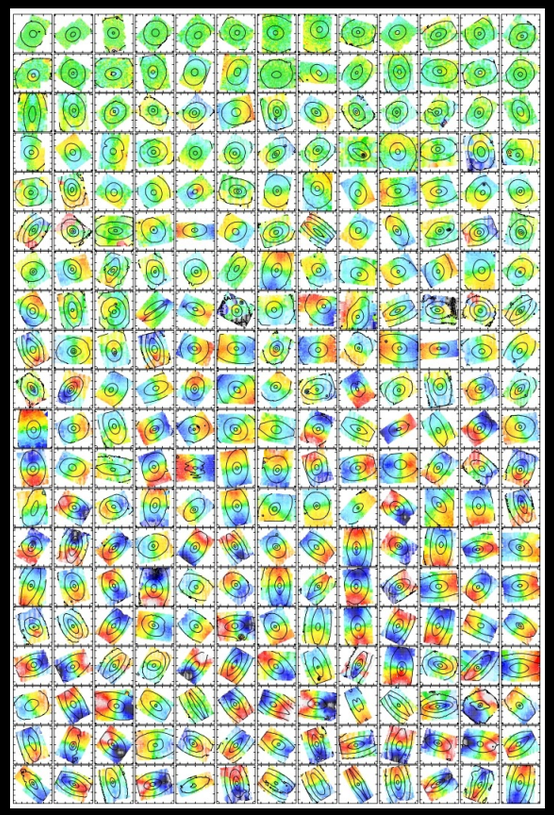
THE IMPRINT OF HIERARCHICAL ASSEMBLY ON THE GALAXY POPULATION: SECULAR vs VIOLENT PROCESSES



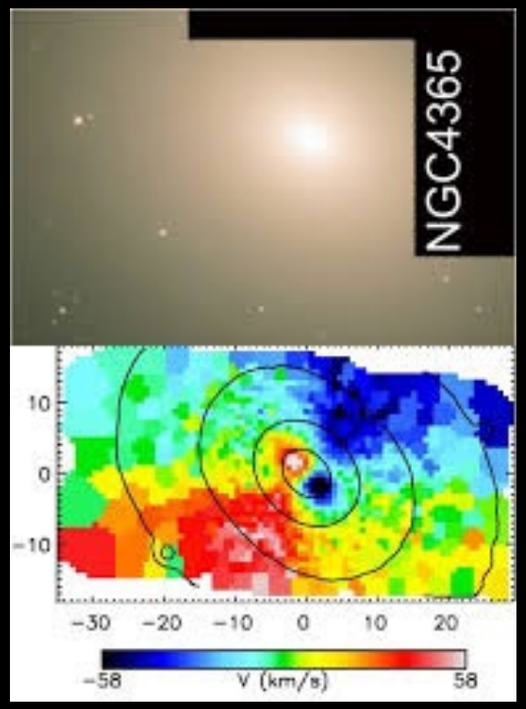
In collaboration with Simon Mutch, Darren Croton, Stuart Wyithe

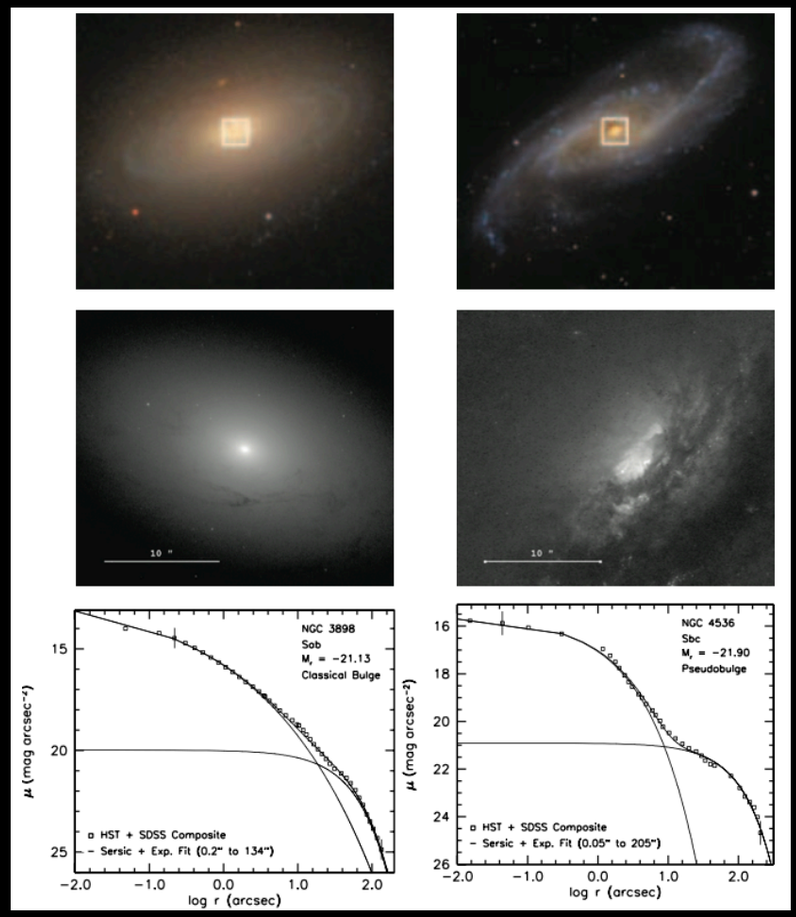
CT et al. 2016; arXiv 1604.02192

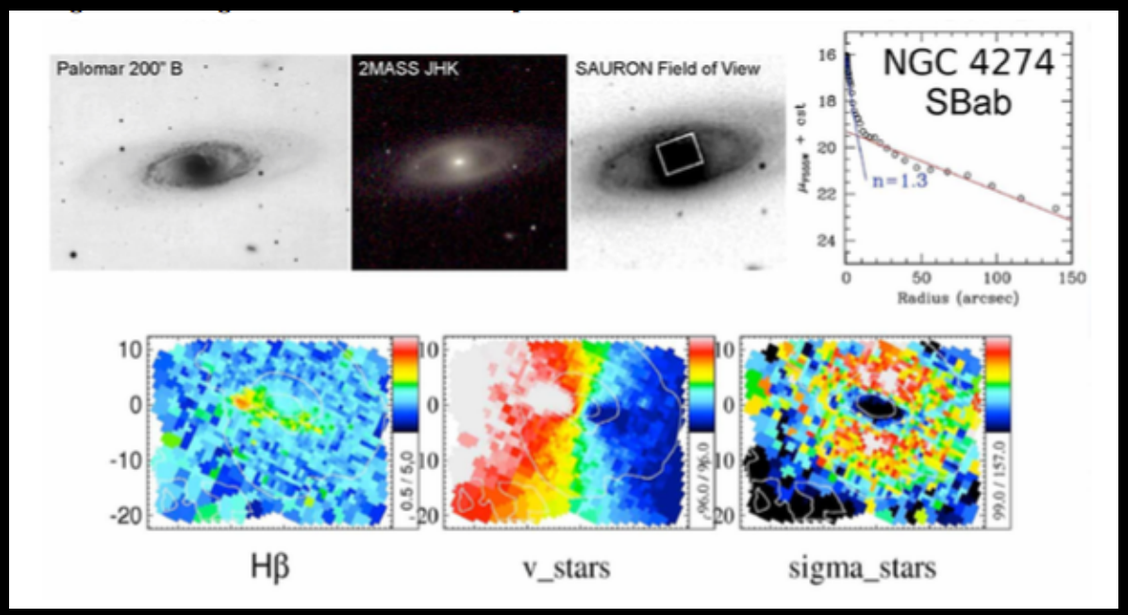
IS “EARLY-TYPE” OBSOLETE?



ATLAS 3D
Cappellari et al. 2011

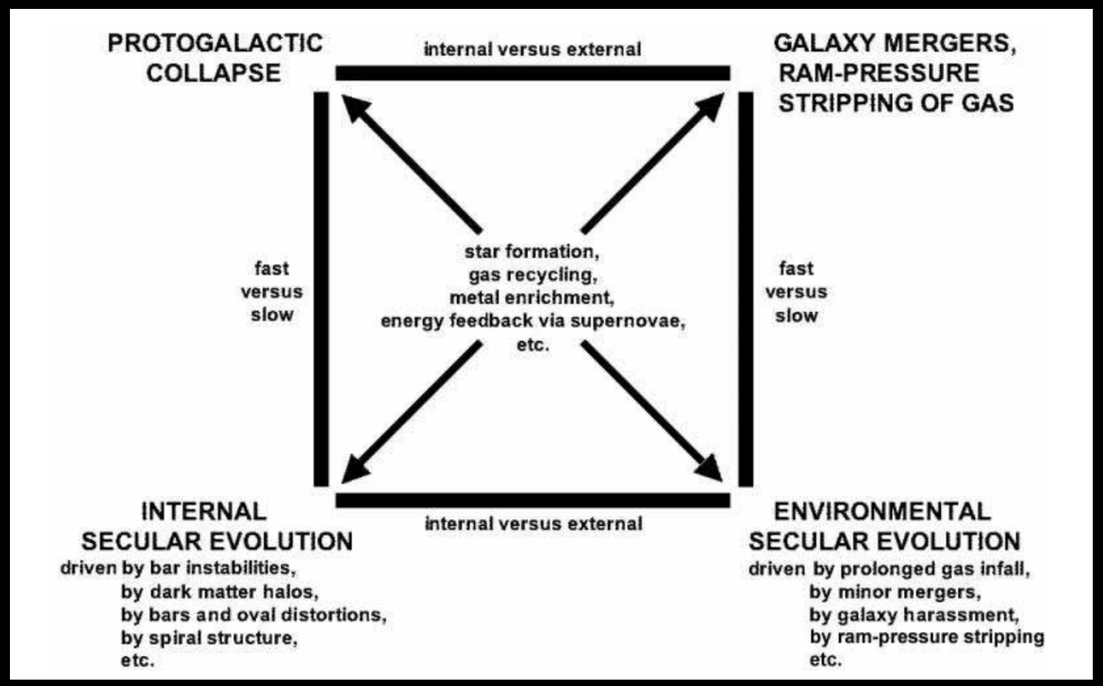




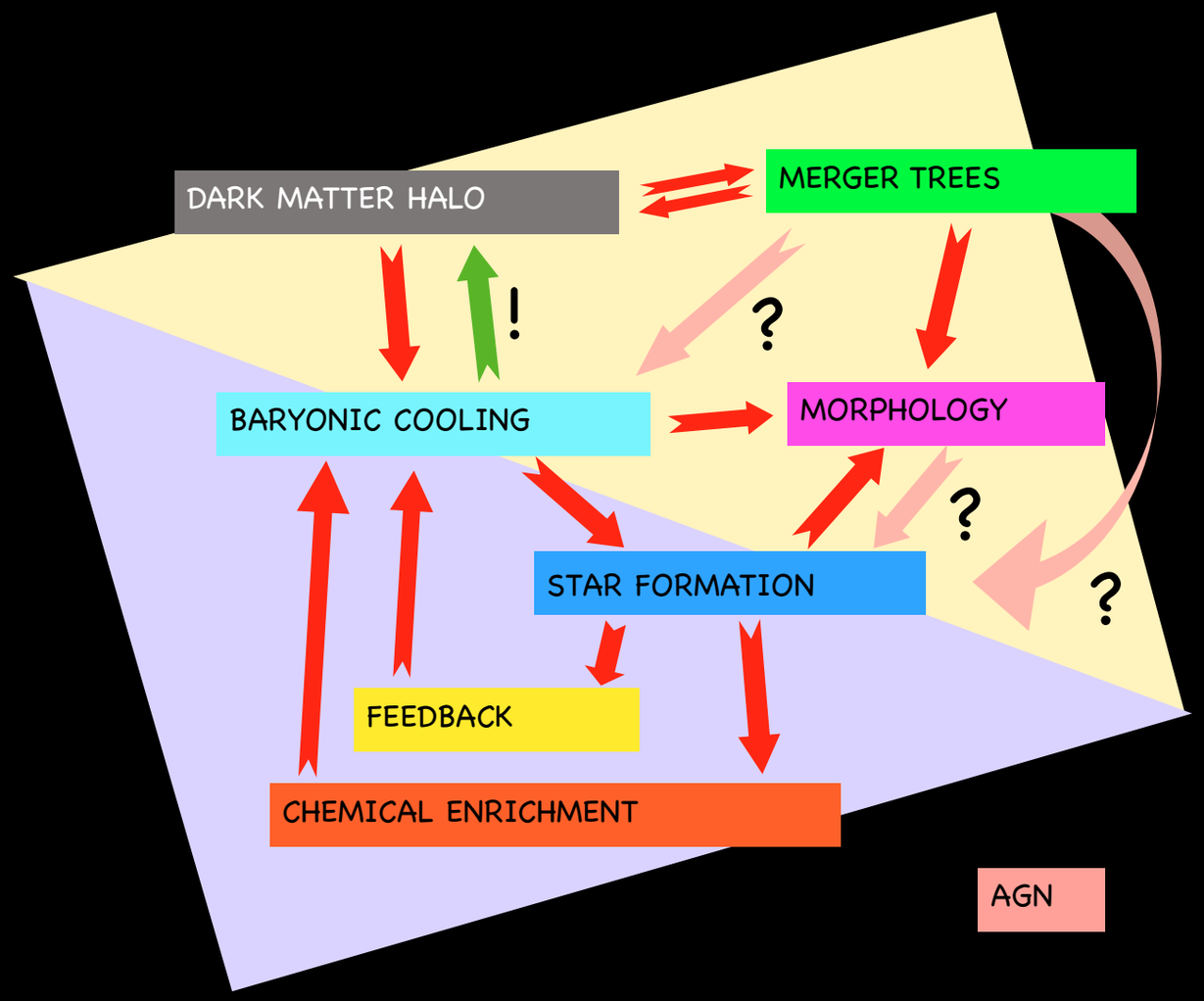


Peletier et al. 2007
Drory & Fisher 2007
Kormendy & Fisher 2008

THE FIGHT FOR DYNAMICAL DOMINANCE



Kormendy & Fisher 2008



general physical recipes

*

hierarchical clustering merger trees

→ galaxy population

2 ASSUMPTIONS

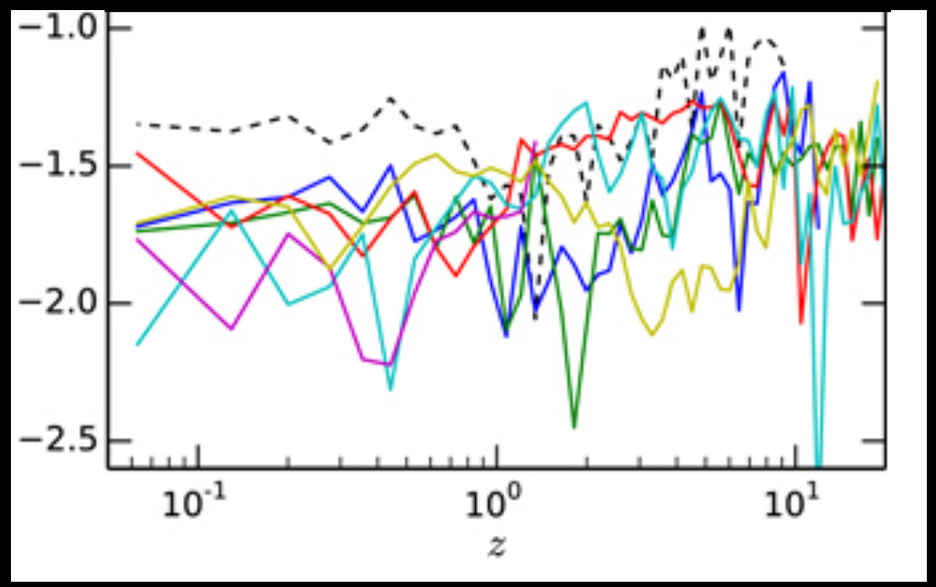
1. any event induces a perturbation in the galaxy proportional to the variation in mass

2. the dominant mass component regulates the encounter : “memory” of the assembly history

BACK TO THE BEGINNING

Galaxies start their lives as disks…
… and remain coupled to their dark matter halos (Mo et al. 1998)

$$R_D \propto \lambda R_{halo}$$



$$SFR \propto M_D/R_D^2$$

$$feedback$$

$$metallicity$$

$$luminosity\ and\ colours$$

This galaxy has no dynamical memory, its structure is recalculated at every timestep.

The dynamical memory of the galaxy is carried by the angular mometum distribution.

EVOLUTION OF DISK ANGULAR MOMENTUM

$$\delta\vec{J}_{gas} = \delta\vec{J}_{gas,cooling} + \delta\vec{J}_{gas,sat} + \delta\vec{J}_{gas,SF}$$

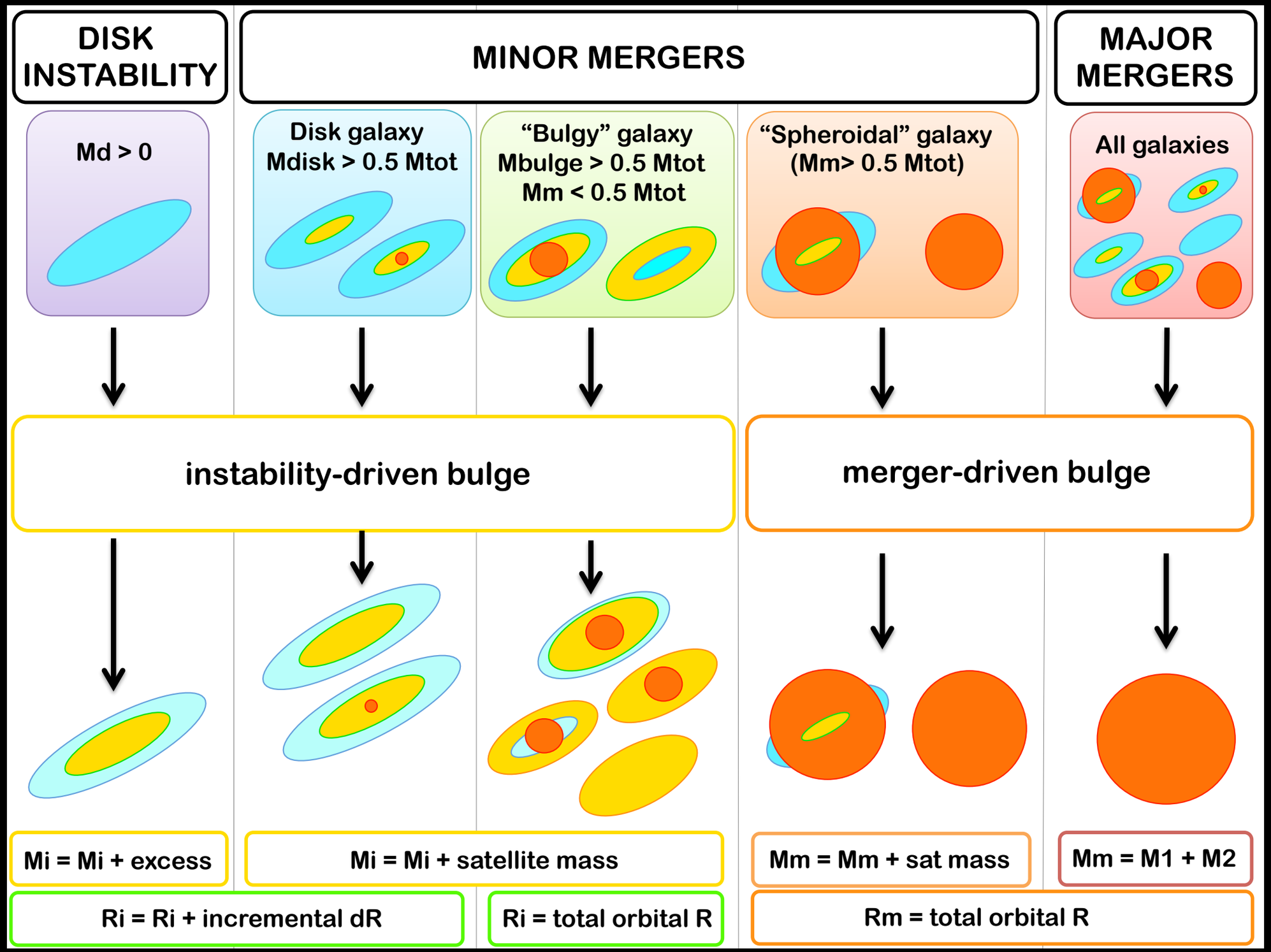
$$\delta\vec{J}_{gas,cooling} = \dot{M}_{cool}\frac{\vec{J_{DM}}}{M_{DM}}\delta t$$

$$\delta\vec{J}_{gas,sat} = M_{sat,gas}\frac{\vec{J_{DM}}}{M_{DM}}\delta t$$

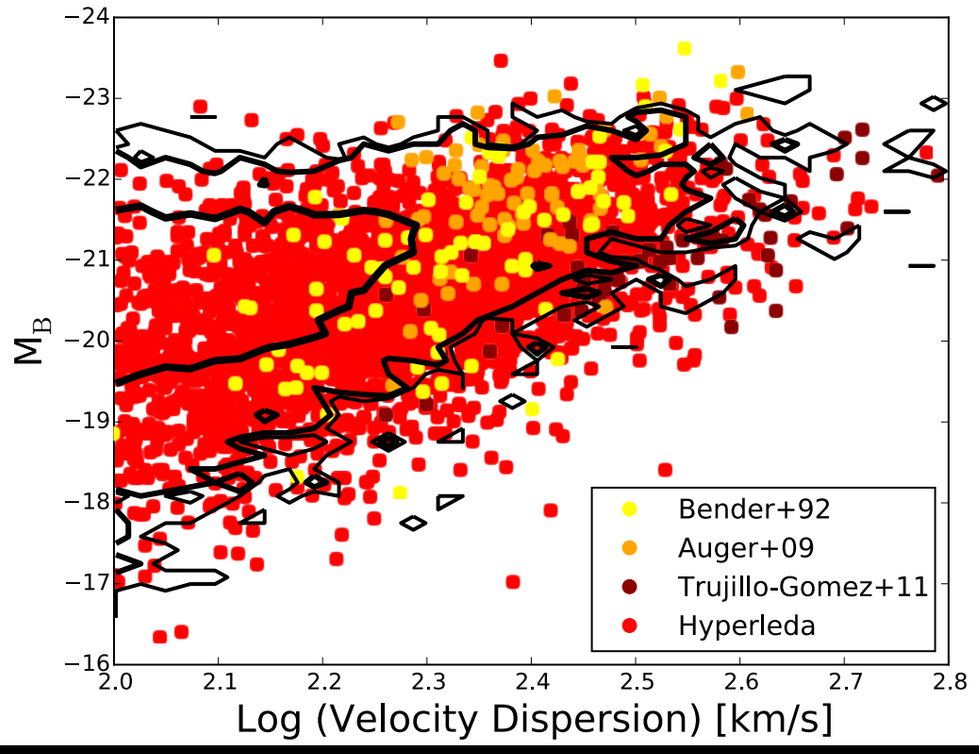
$$\delta\vec{J}_{gas,SF} = -\dot{M}_{*}\frac{\vec{J_{gas}}}{M_{gas}}\delta t = -\delta\vec{J}_{*,SF}$$

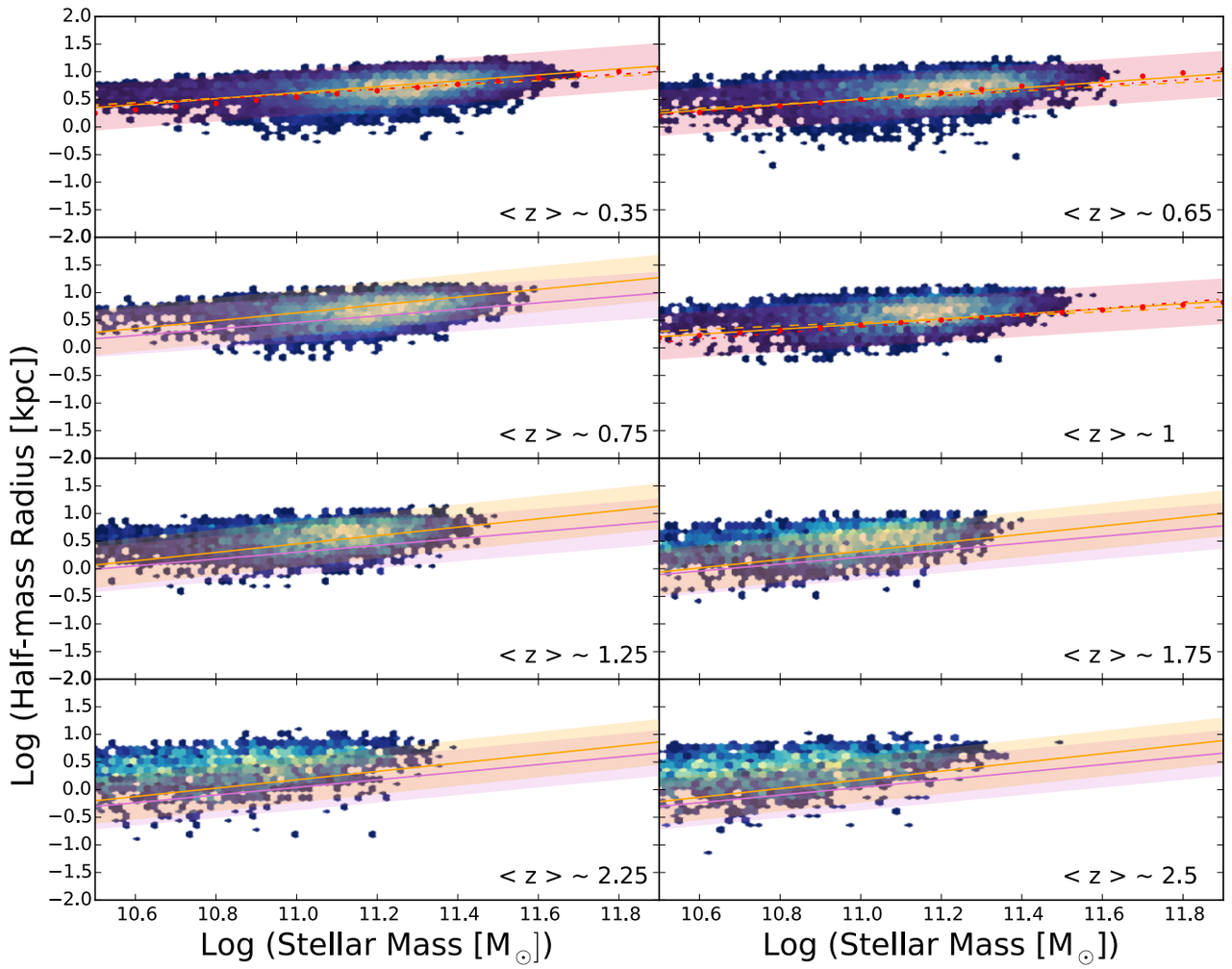
$$R_{D,gas} = \frac{J_{gas}/M_{gas}}{2V_{max}}$$

BULGES: DYNAMICAL BUILD-UP

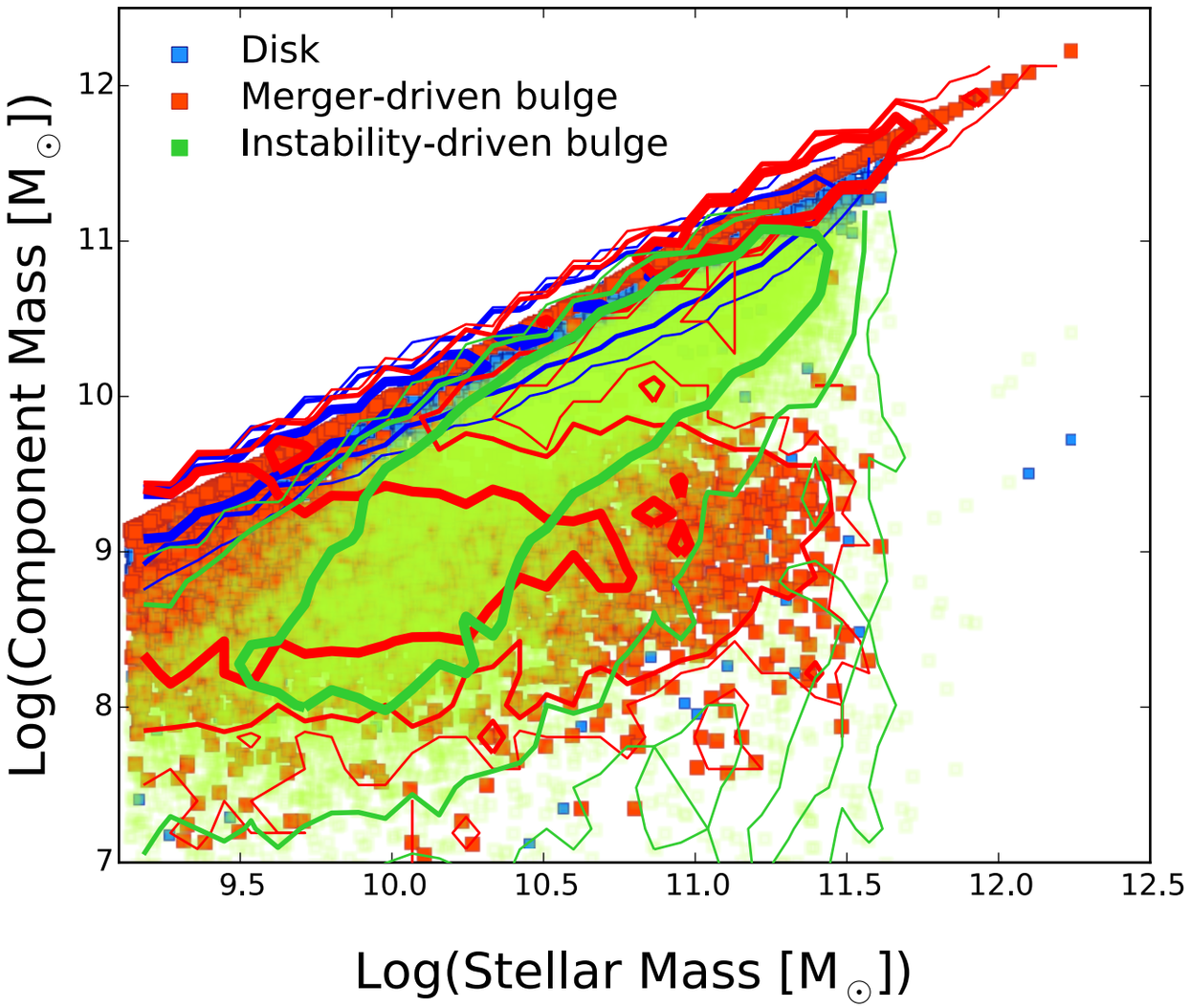


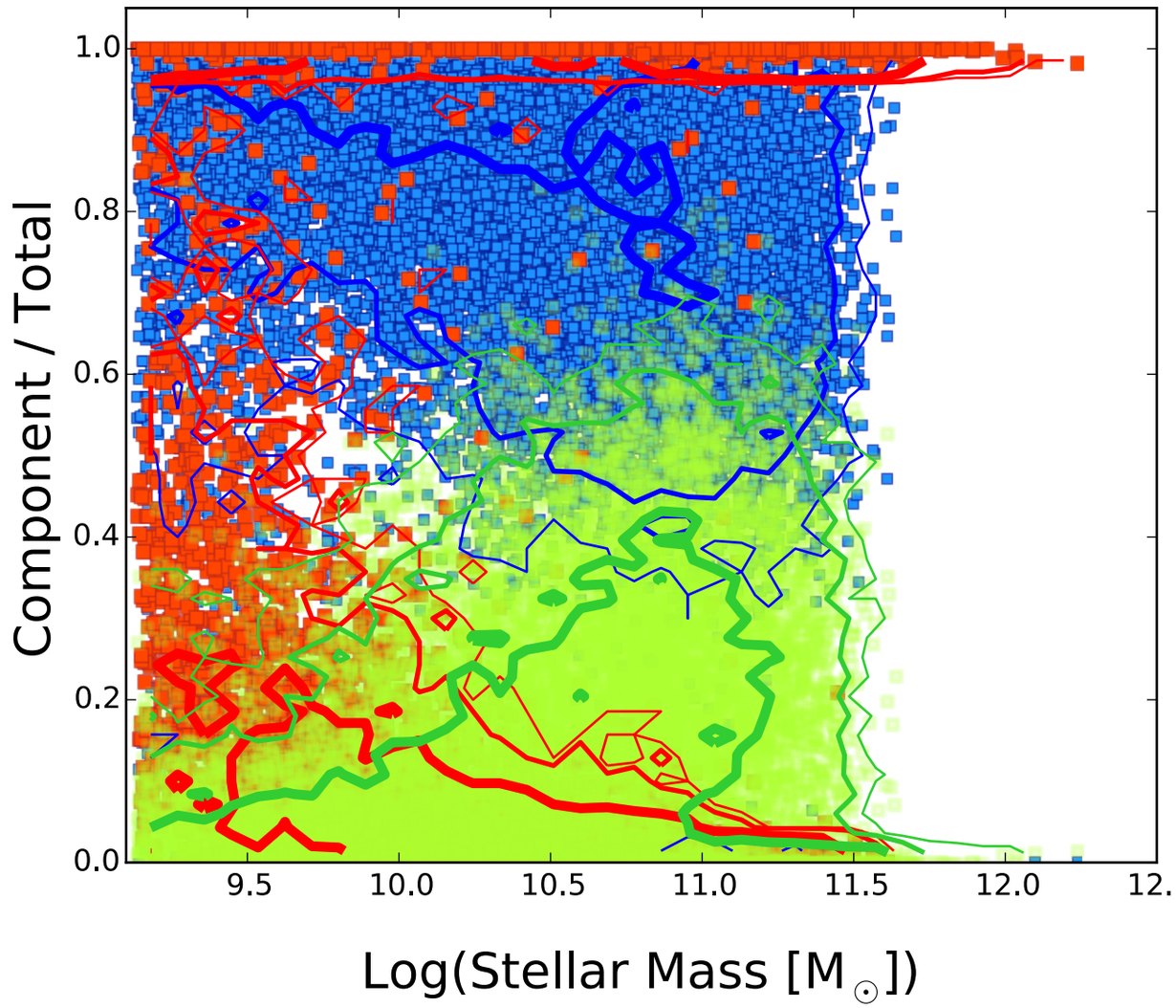
SCALING RELATIONS OF ELLIPTICALS





INSTABILITIES vs MERGERS



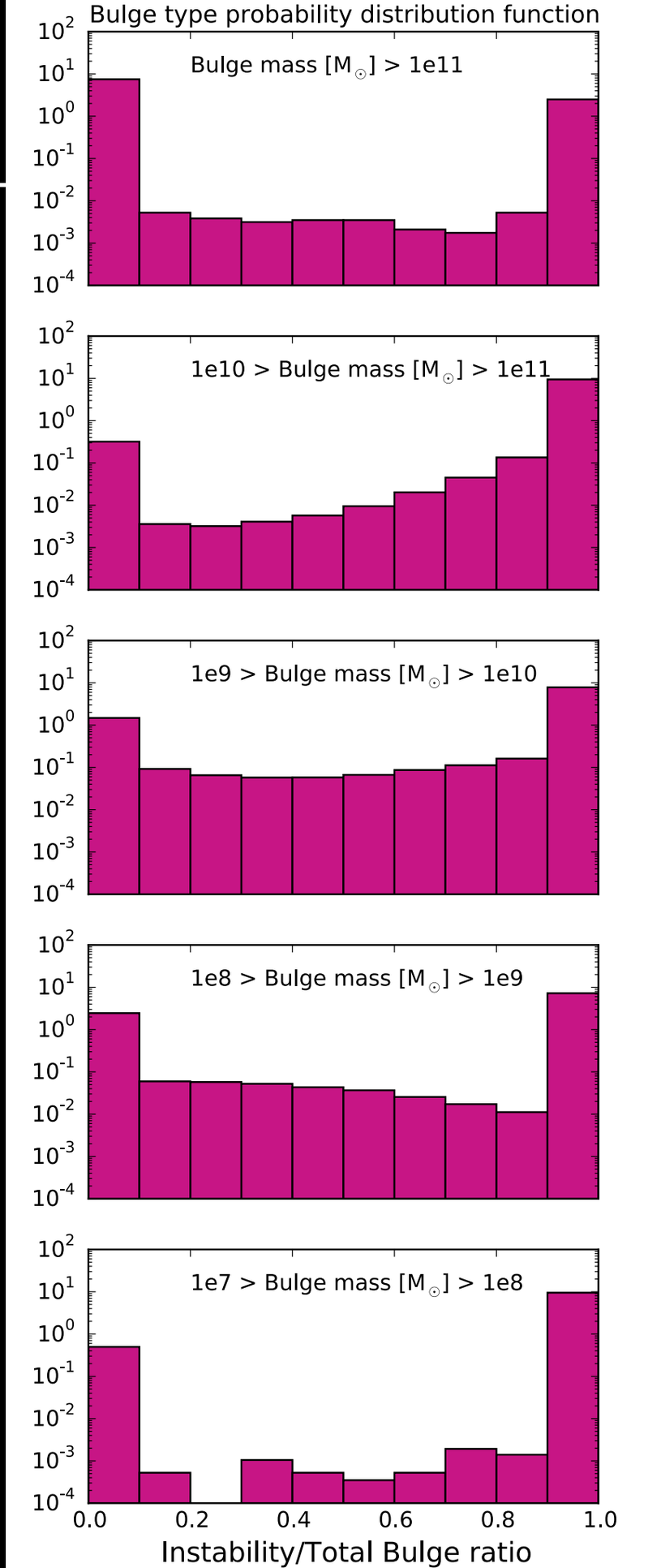


INSTABILITIES vs MERGERS

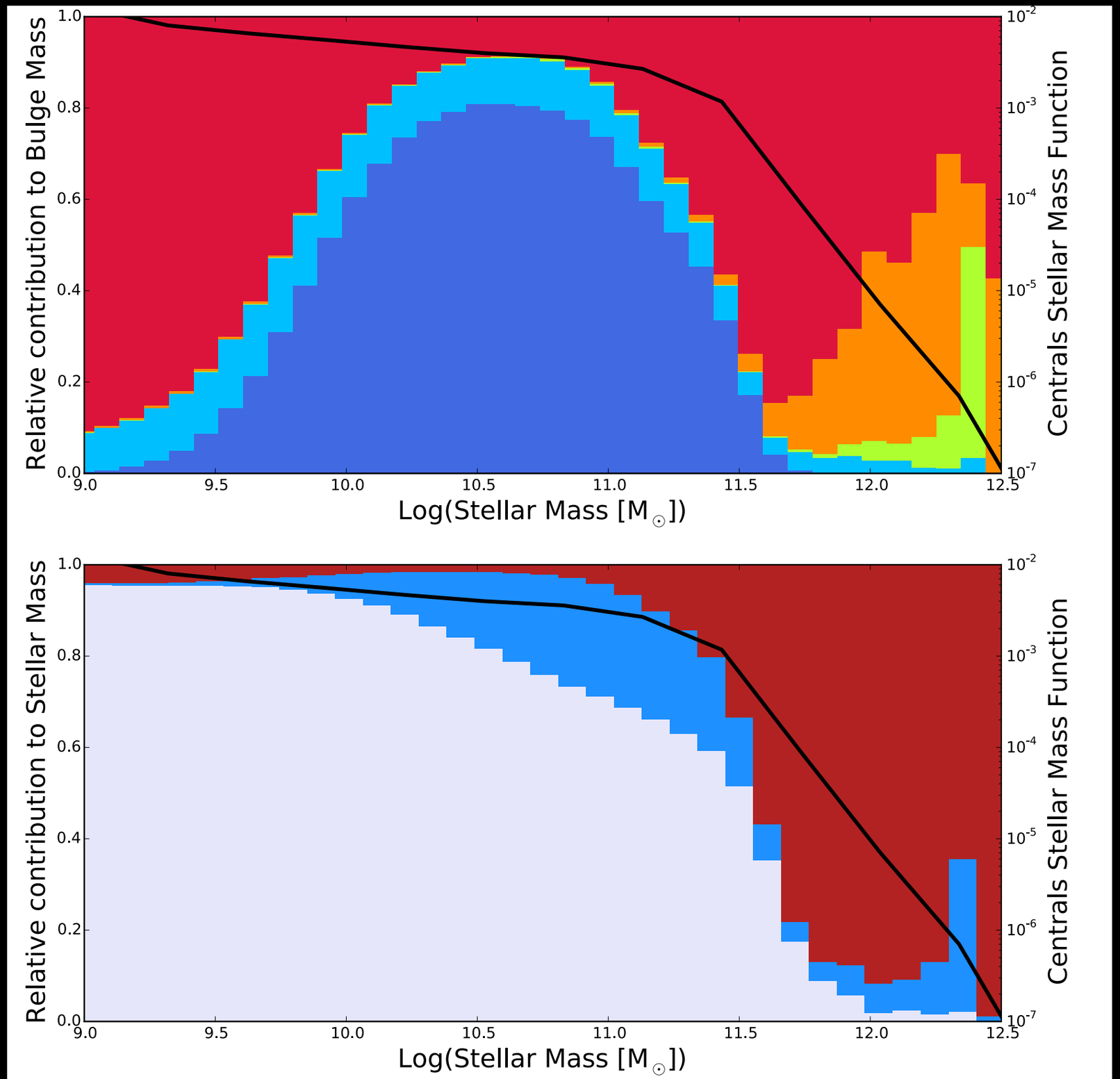
“BULGE”: stellar component (mostly) not originating from direct cooling of gas, that turns into starts

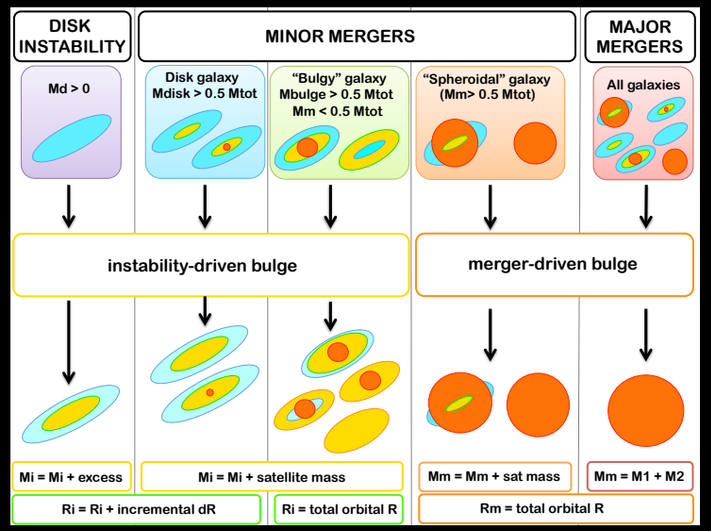
Bulge stars are formed somewhere else and then assembled

The distribution of bulge types seems to indicate that the instability and merger channels are well separated

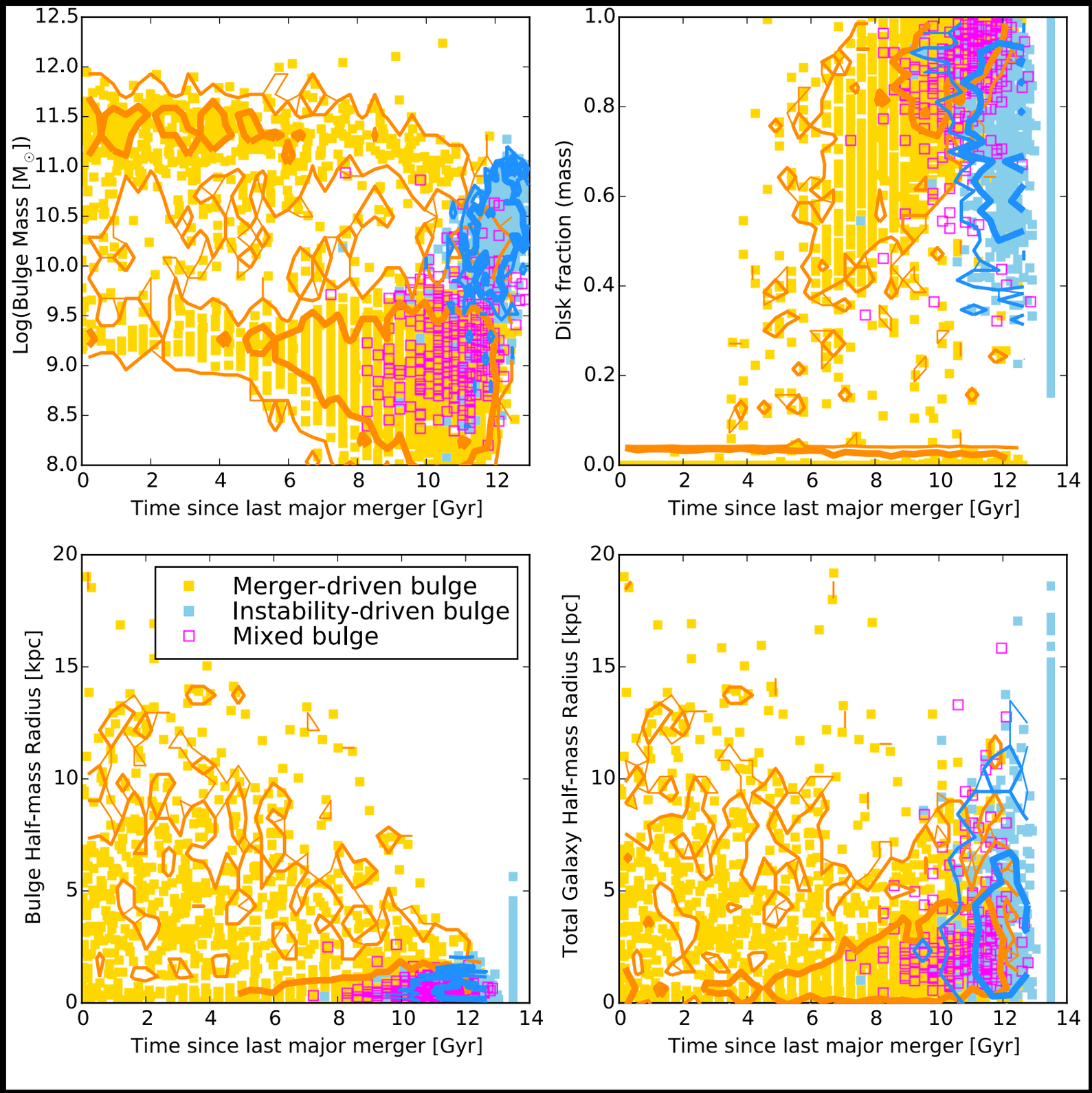


SECULAR vs VIOLENT MASS BUILD-UP

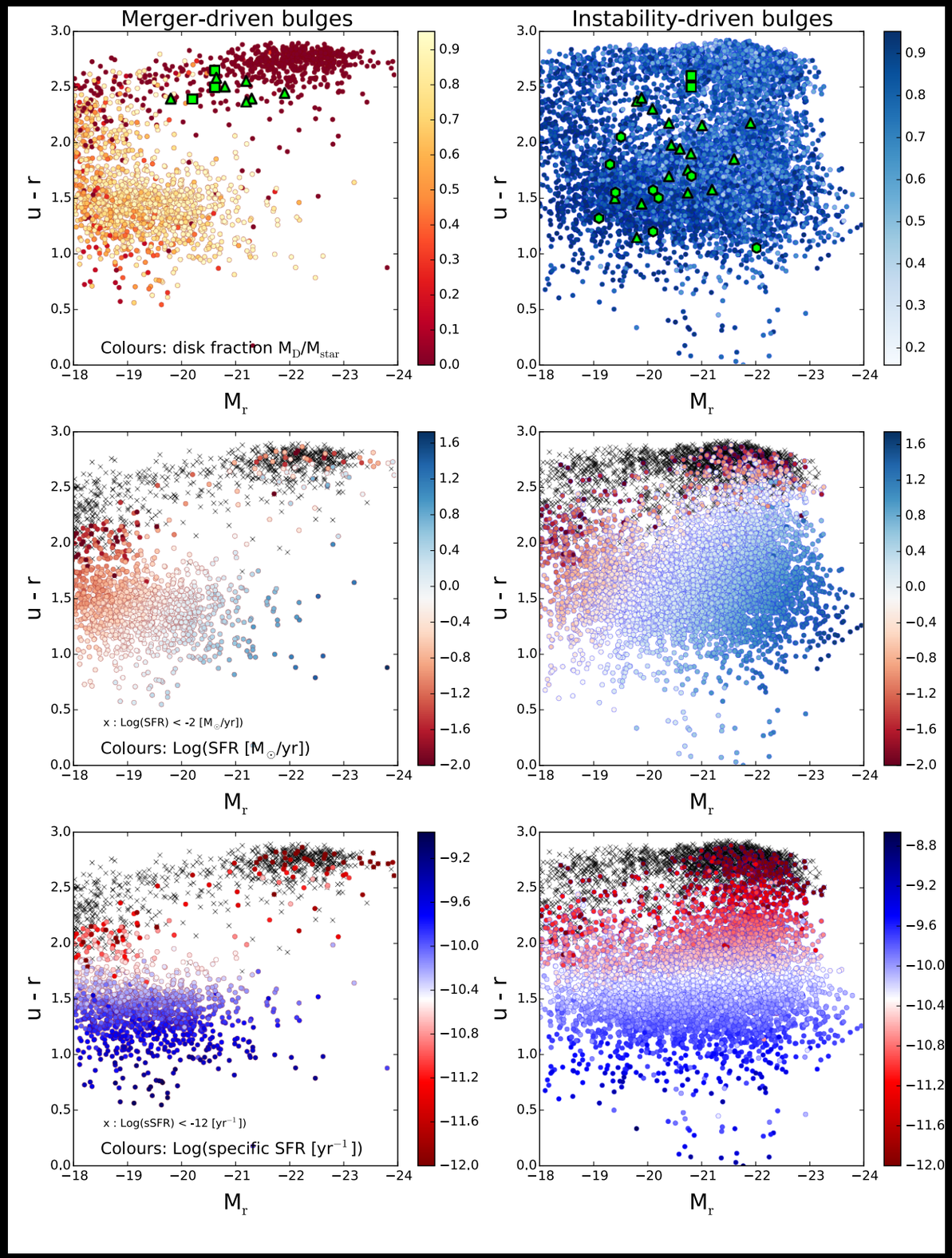




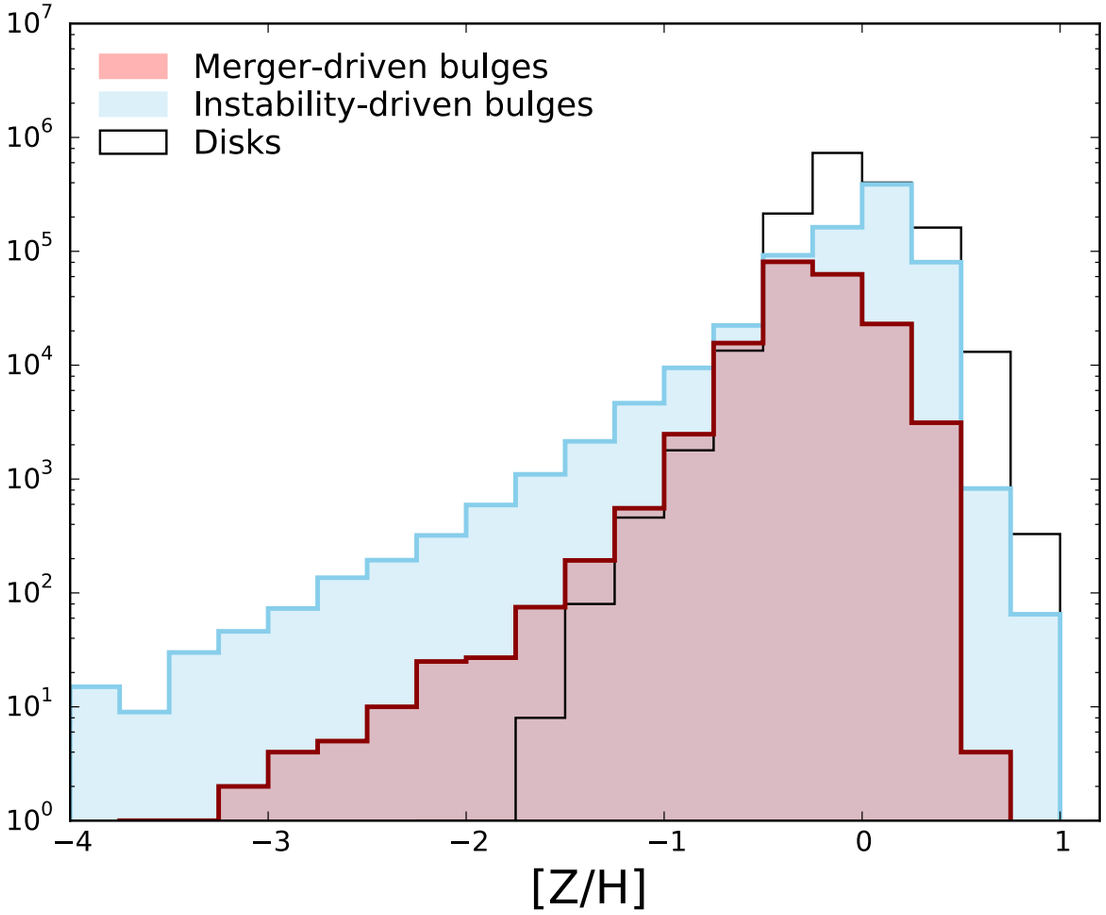
TIMESCALES OF BULGE GROWTH

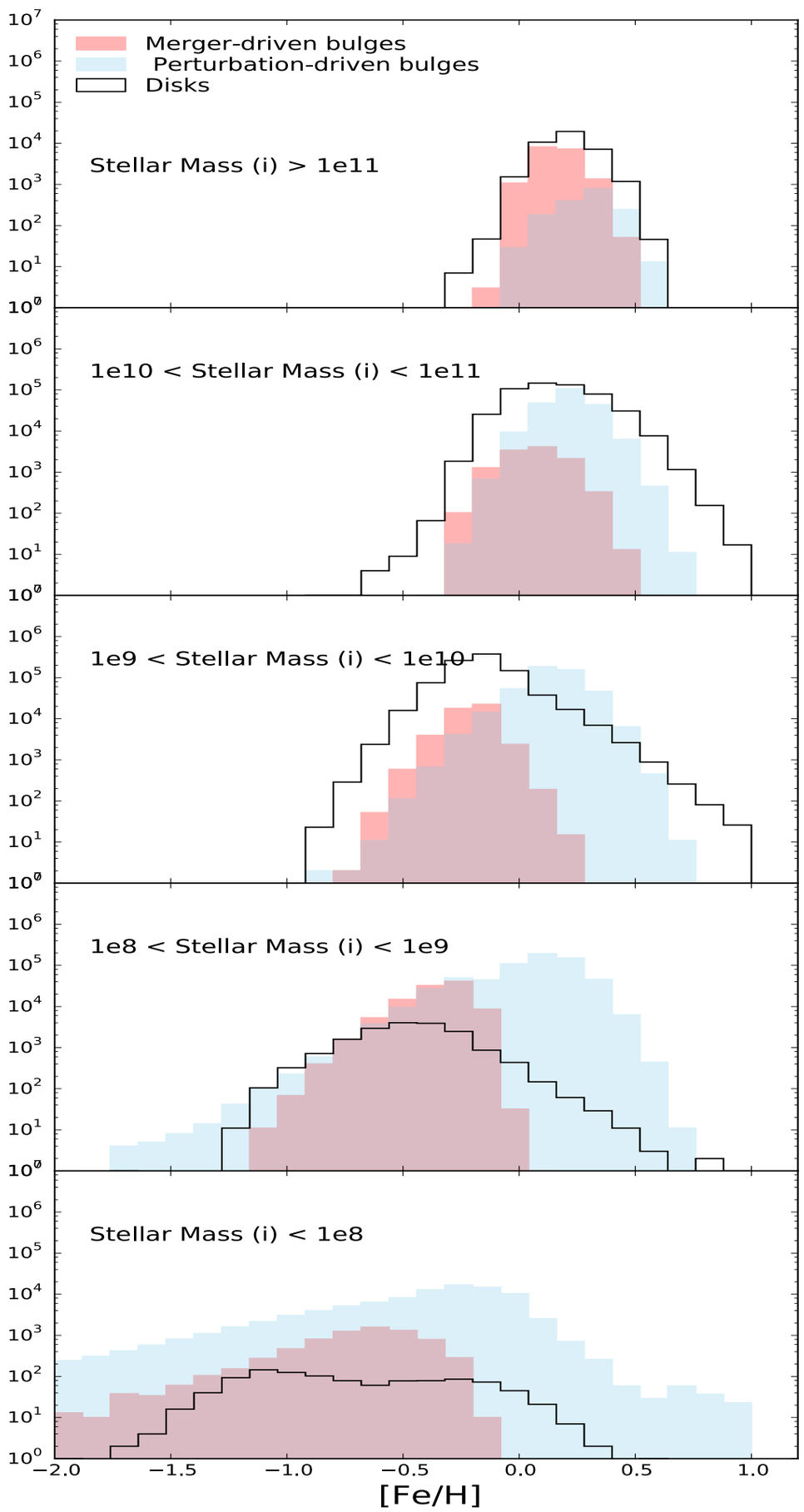


STELLAR POPULATIONS IN BULGES



METALLICITY DISTRIBUTION





SUMMARY

arXiv 1604.02192

Model based on two assumptions:

1. any event induces a perturbation in the galaxy proportional to the variation in mass
2. the dominant mass component regulates the encounter : “memory” of the assembly history

Hierarchical clustering produces a VIOLENT and a SECULAR channel of evolution, with 2 populations of bulges

Secular evolution dominates at intermediate masses, and at the high-mass end of the disk population: “active” galaxies produce instability-driven bulges. Violent evolution dominates at the high mass end.

Instability-driven and merger-driven bulges form on very different timescales (~8-9 Gyr for instability-driven)

Bulge mass AND bulge type determine the galaxy colours. The growth of instability-driven bulges correspond to a colour shift into the green valley.

Metallicity is sensitive to the dynamical history.