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Reignition of Star Formation in Dwarf Galaxies

The Simulations

Name	Type	Code	Resolution	Dark Matter Particle Mass	Gas Particle Mass
g14 suite	Zoom-in	Gasoline	65-173 pc	$\sim 10^4$-10^5 $M_\odot$	$\sim 10^3$-10^4 $M_\odot$

Hot gas explodes out of young dwarf galaxies

Simulation by **Andrew Pontzen**, **Fabio Governato** and **Alyson Brooks** on the **Darwin Supercomputer**, Cambridge UK.

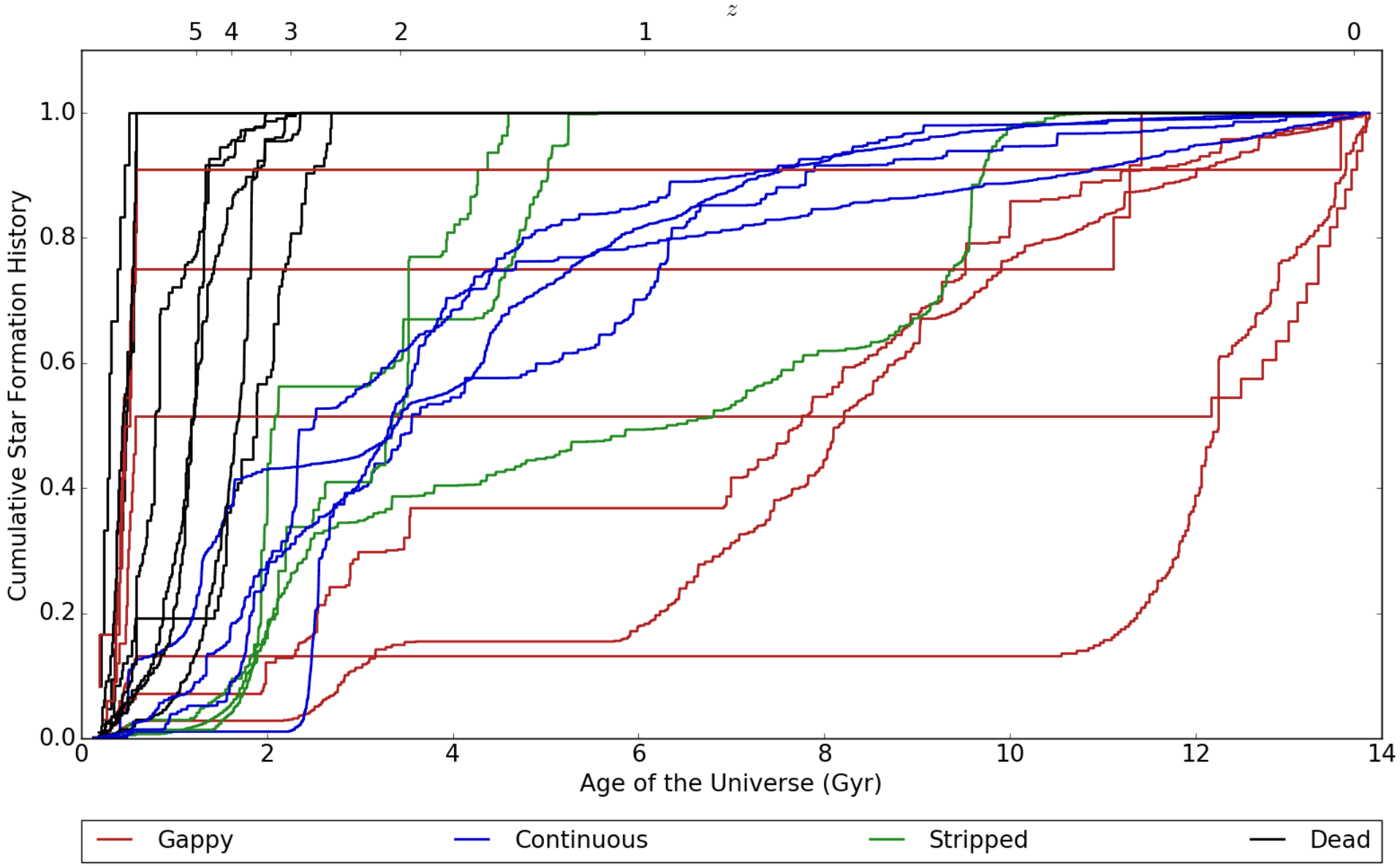
Simulation code **Gasoline** by **James Wadsley** and **Tom Quinn** with metal cooling by **Sijing Sheng**.

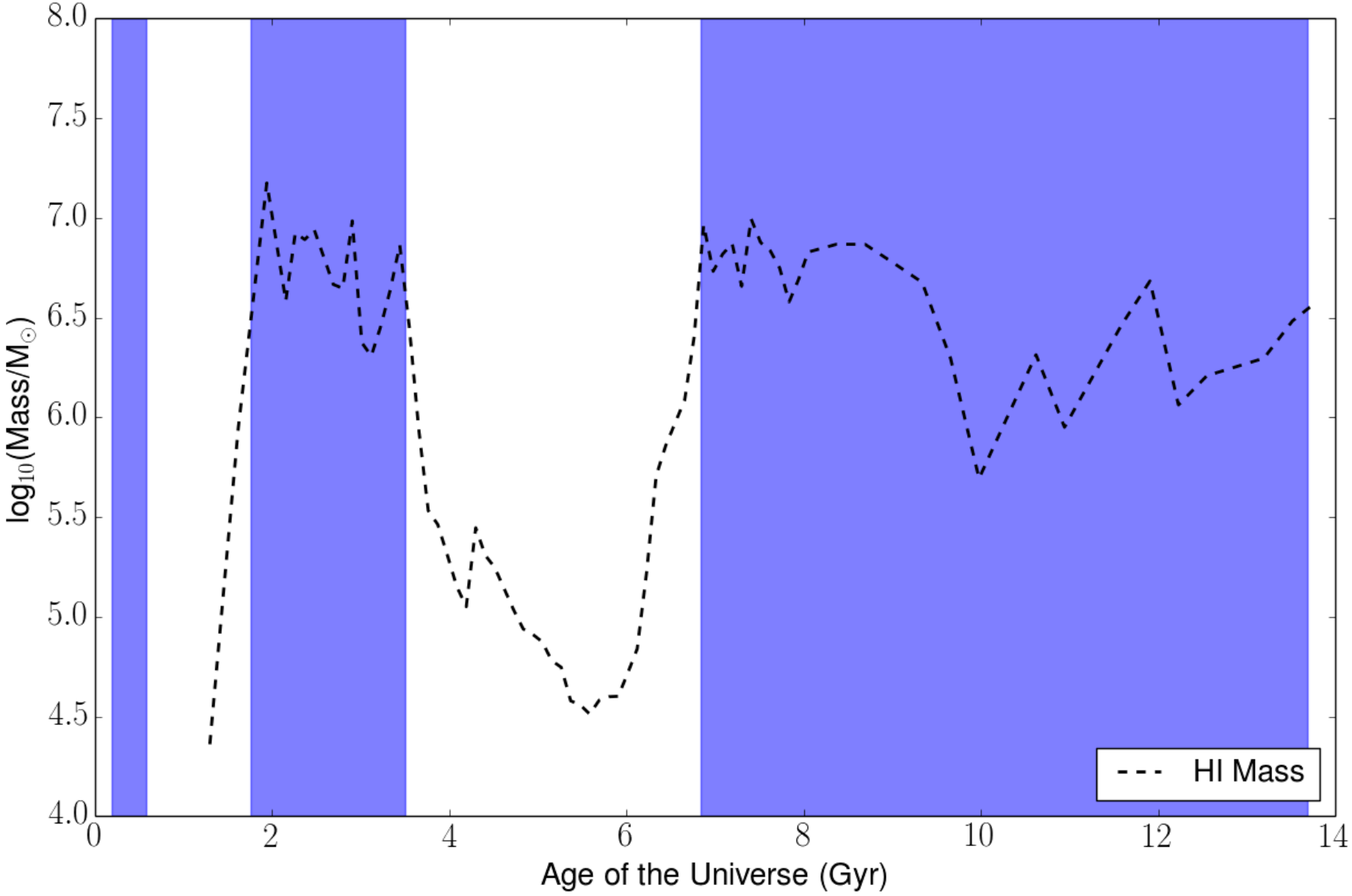
Visualization by **Andrew Pontzen**.

“Gappy” Dwarf Galaxies

- 10^9-10^{10} $M_\odot$
- Field galaxies
- Gap of at least 2 Gyr in star formation

Image Credit: M. Irwin/SDSS-II


z
5
4
3
2
1
0
1.0
0.8
0.6
0.4
0.2
0.0
Cumulative Star Formation History
0
2
4
6
8
10
12
14
Age of the Universe (Gyr)
Gappy
Continuous
Stripped
Dead


8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
log10(Mass/M⊙)
0
2
4
6
8
10
12
14
Age of the Universe (Gyr)
HI Mass

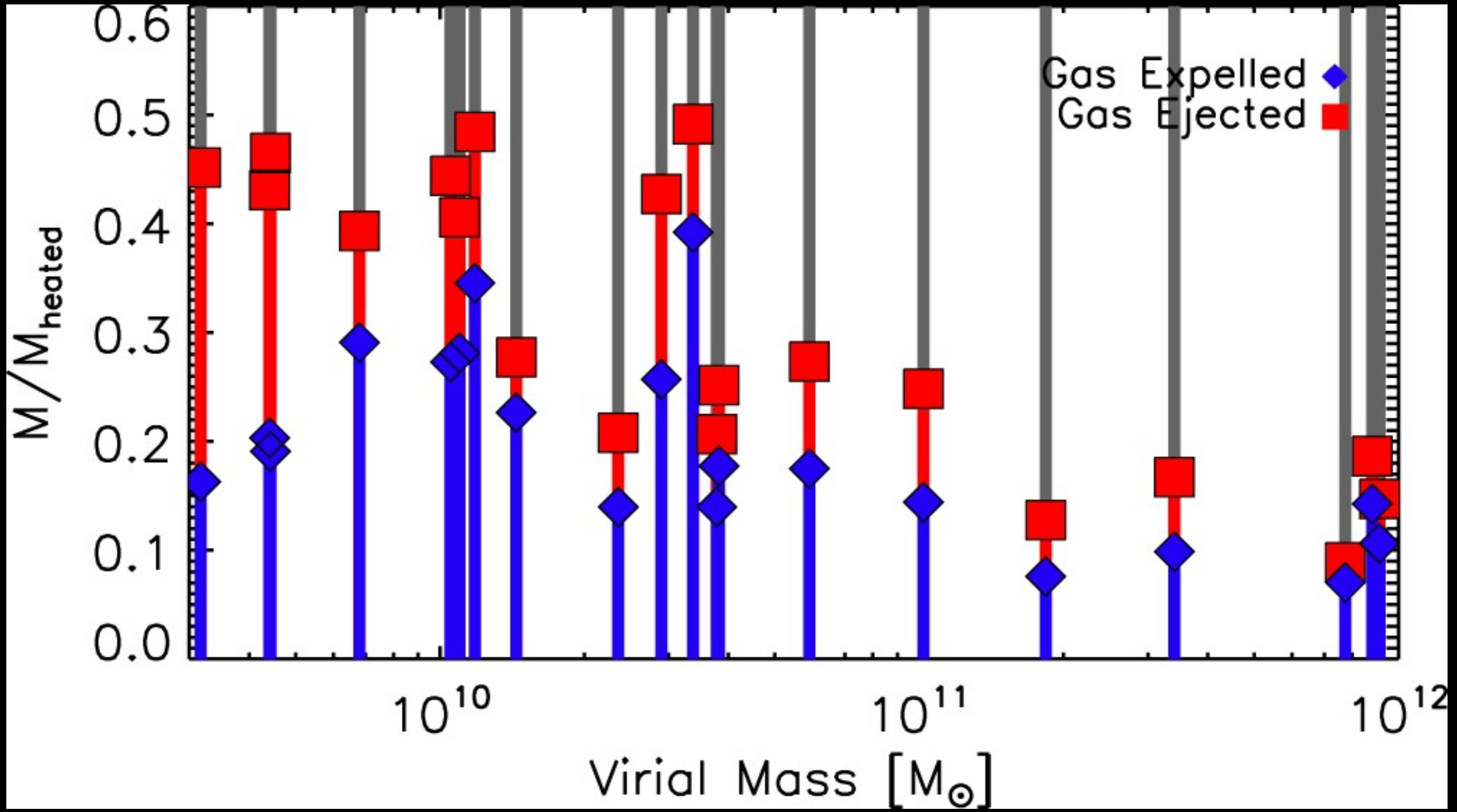
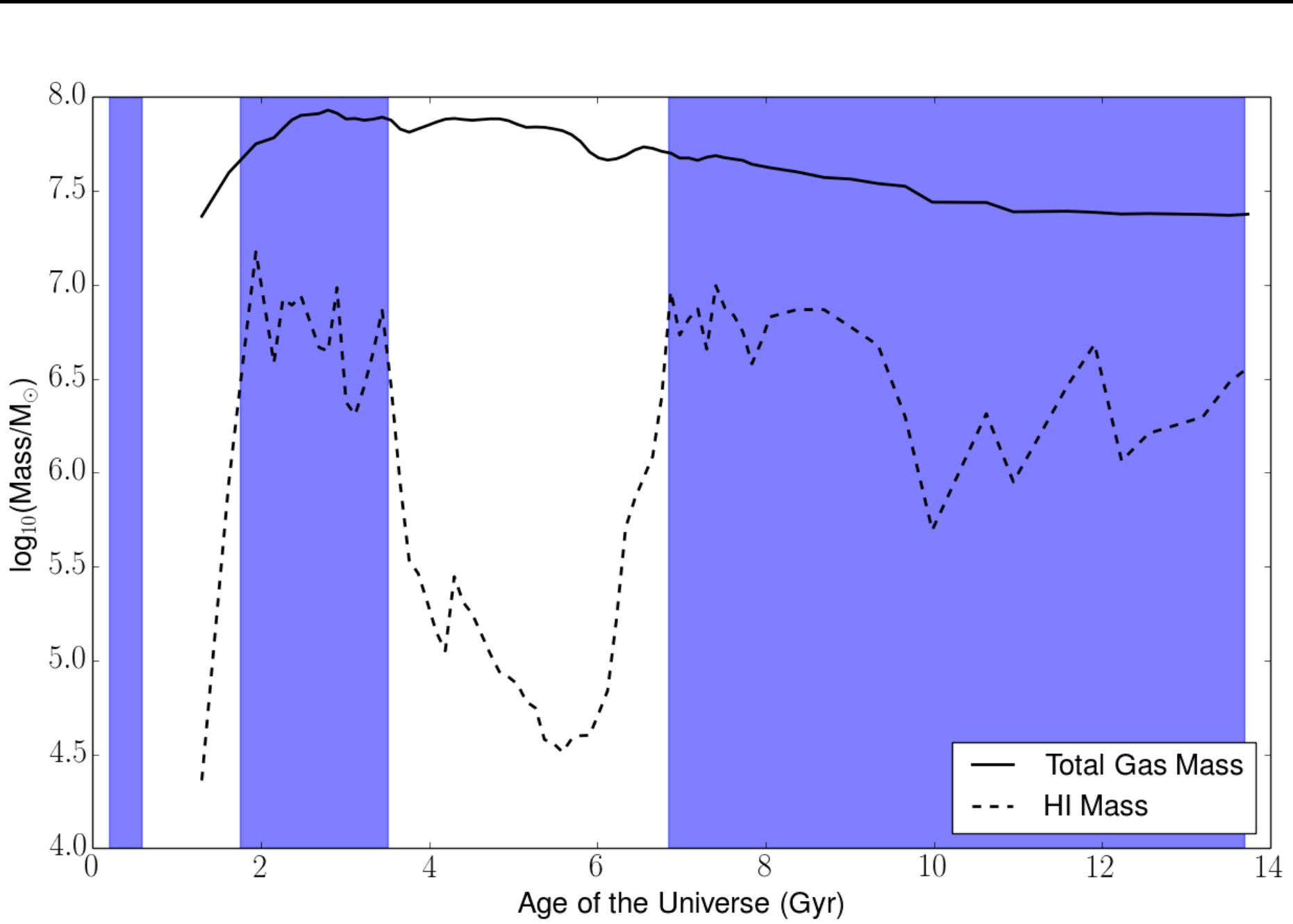
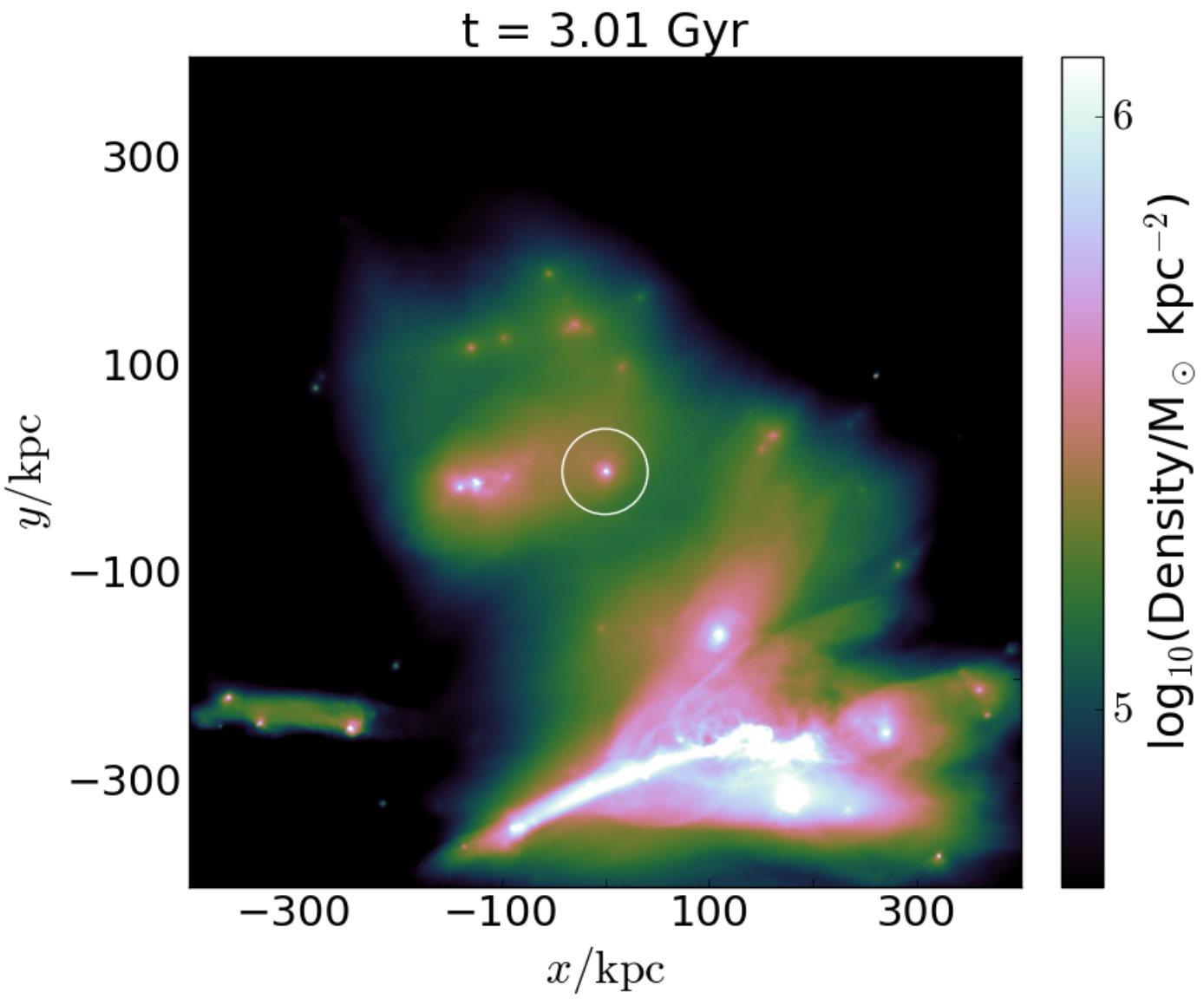
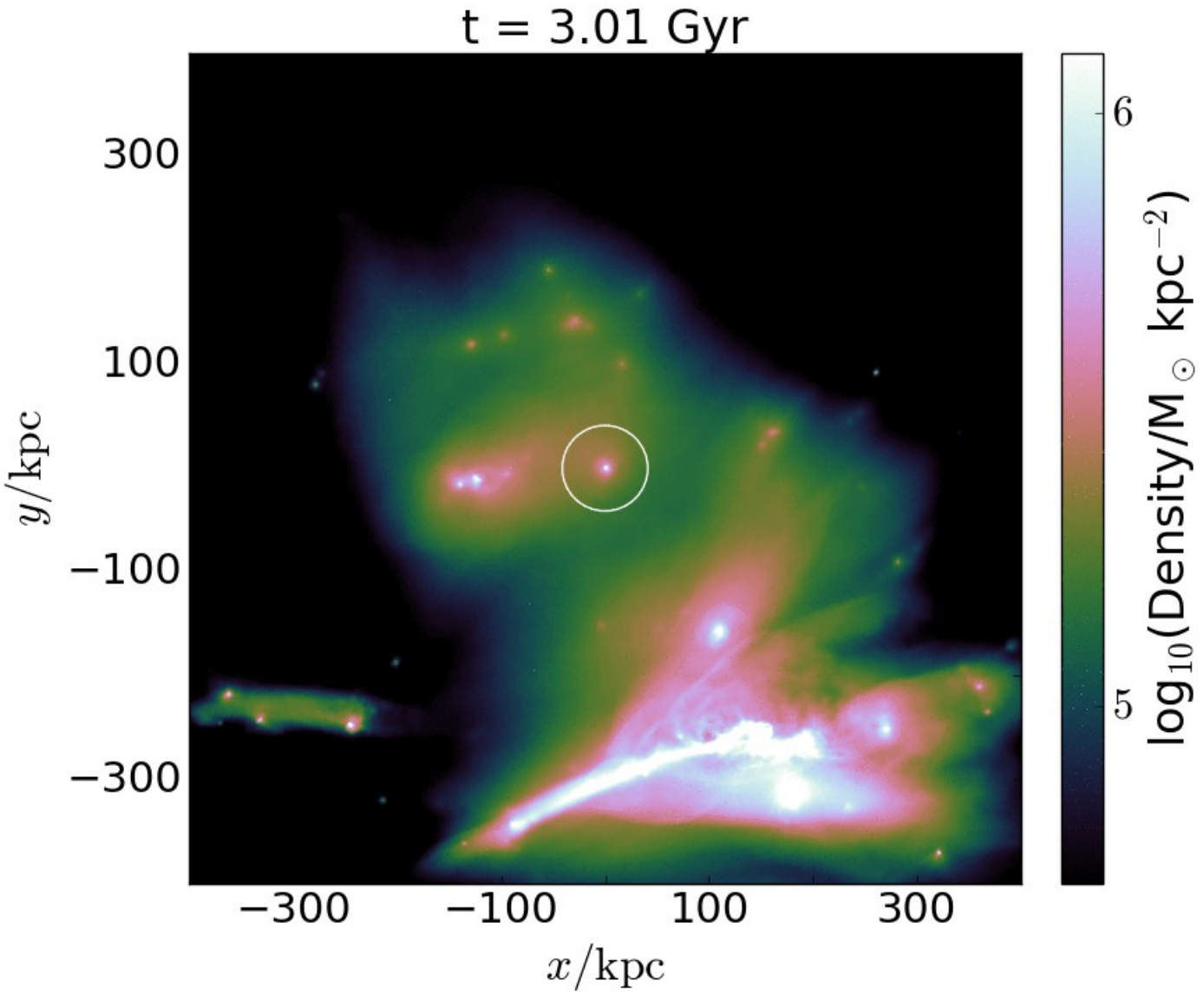
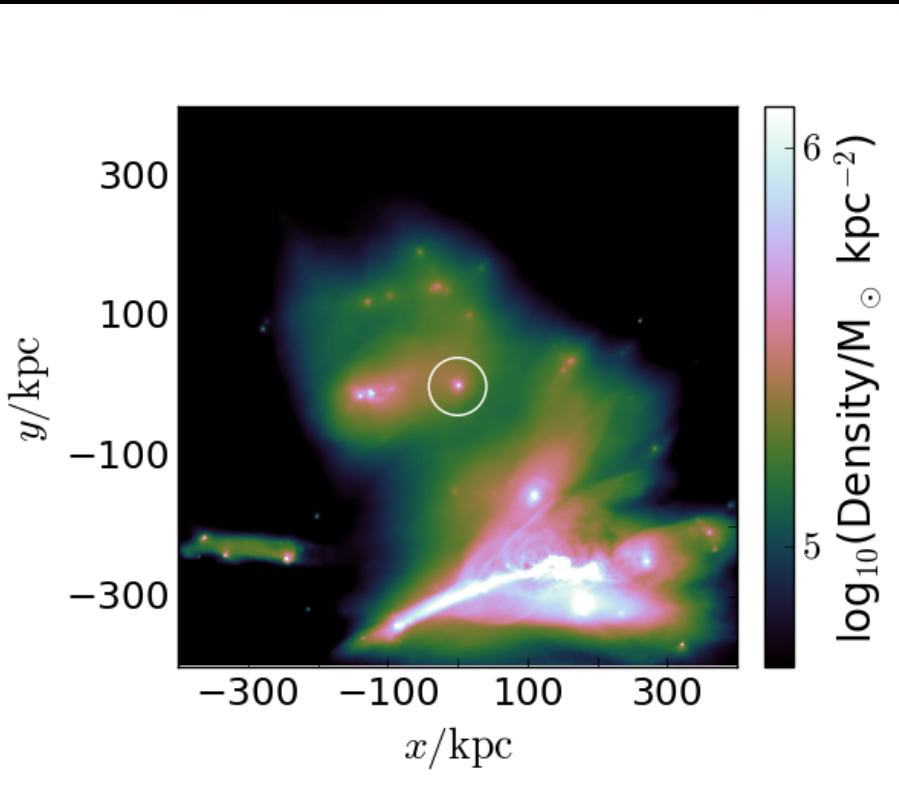


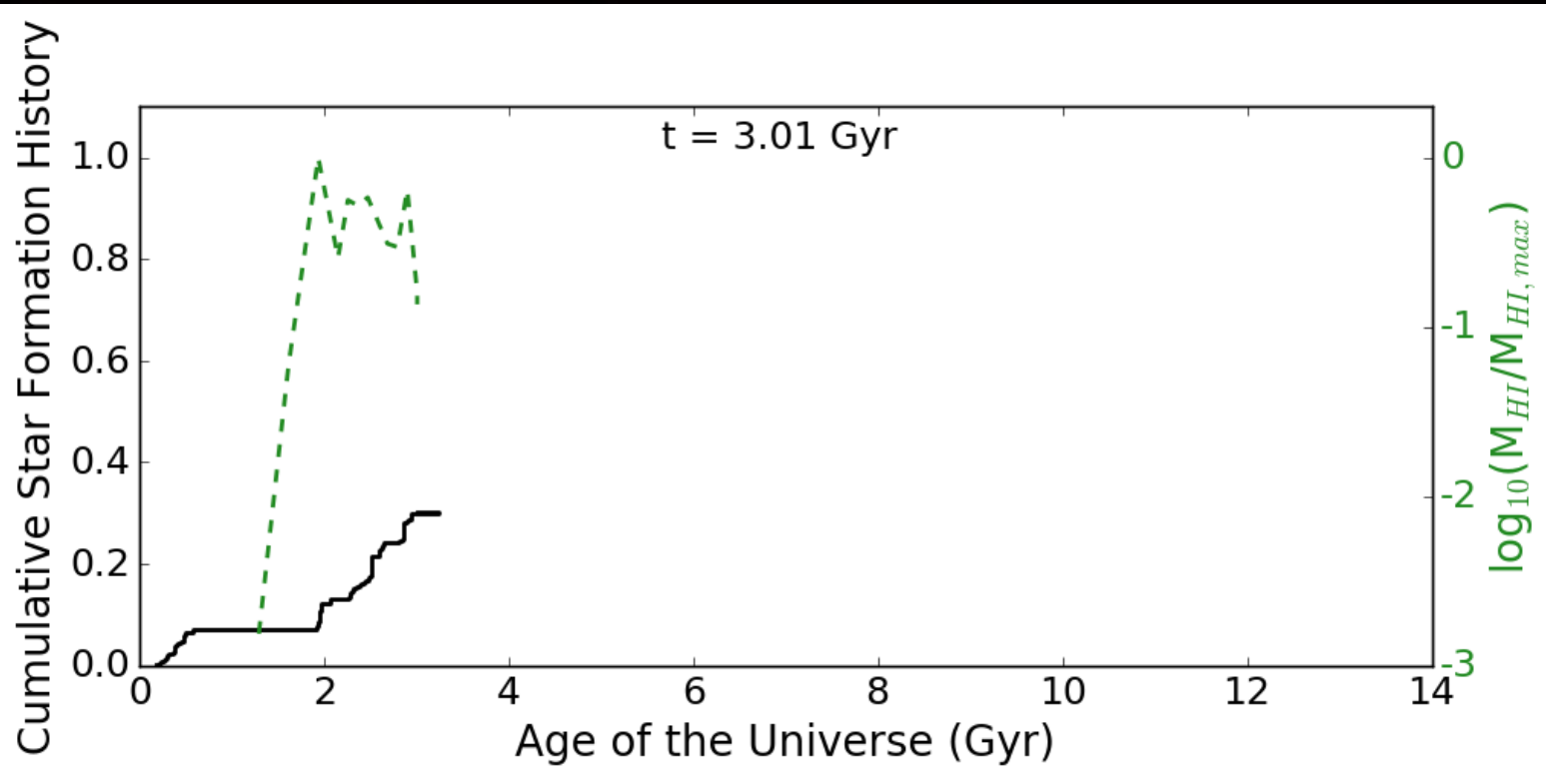
Figure 10 from Christensen et al., 2016

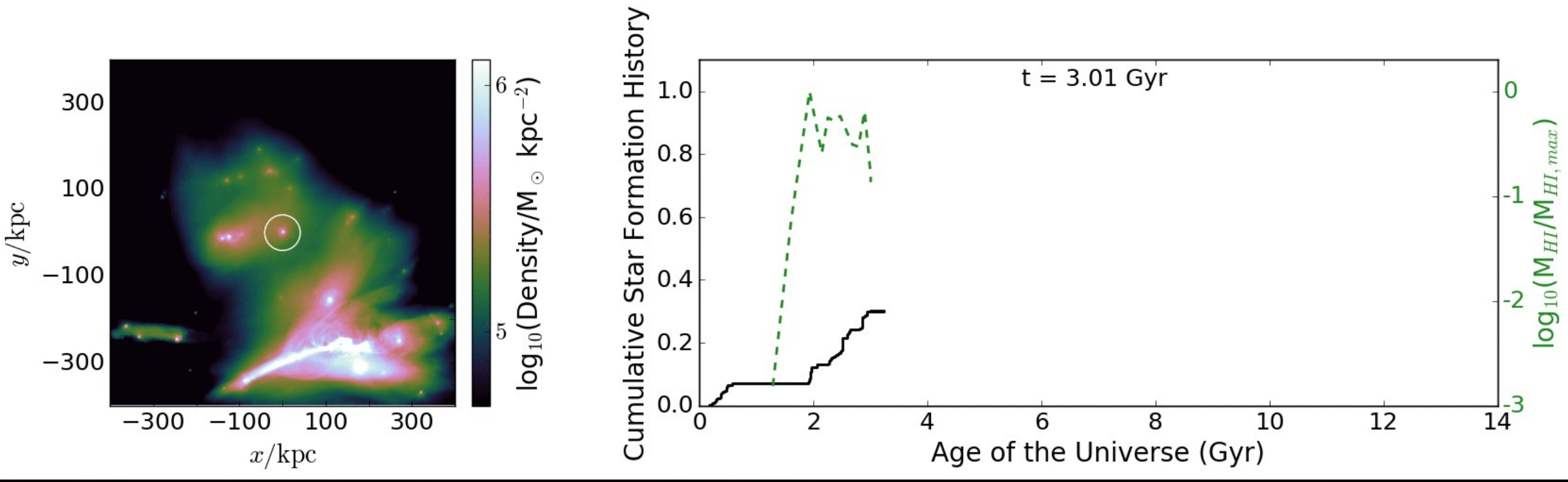

8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
log10(Mass/M⊙)
0
2
4
6
8
10
12
14
Age of the Universe (Gyr)
Total Gas Mass
HI Mass

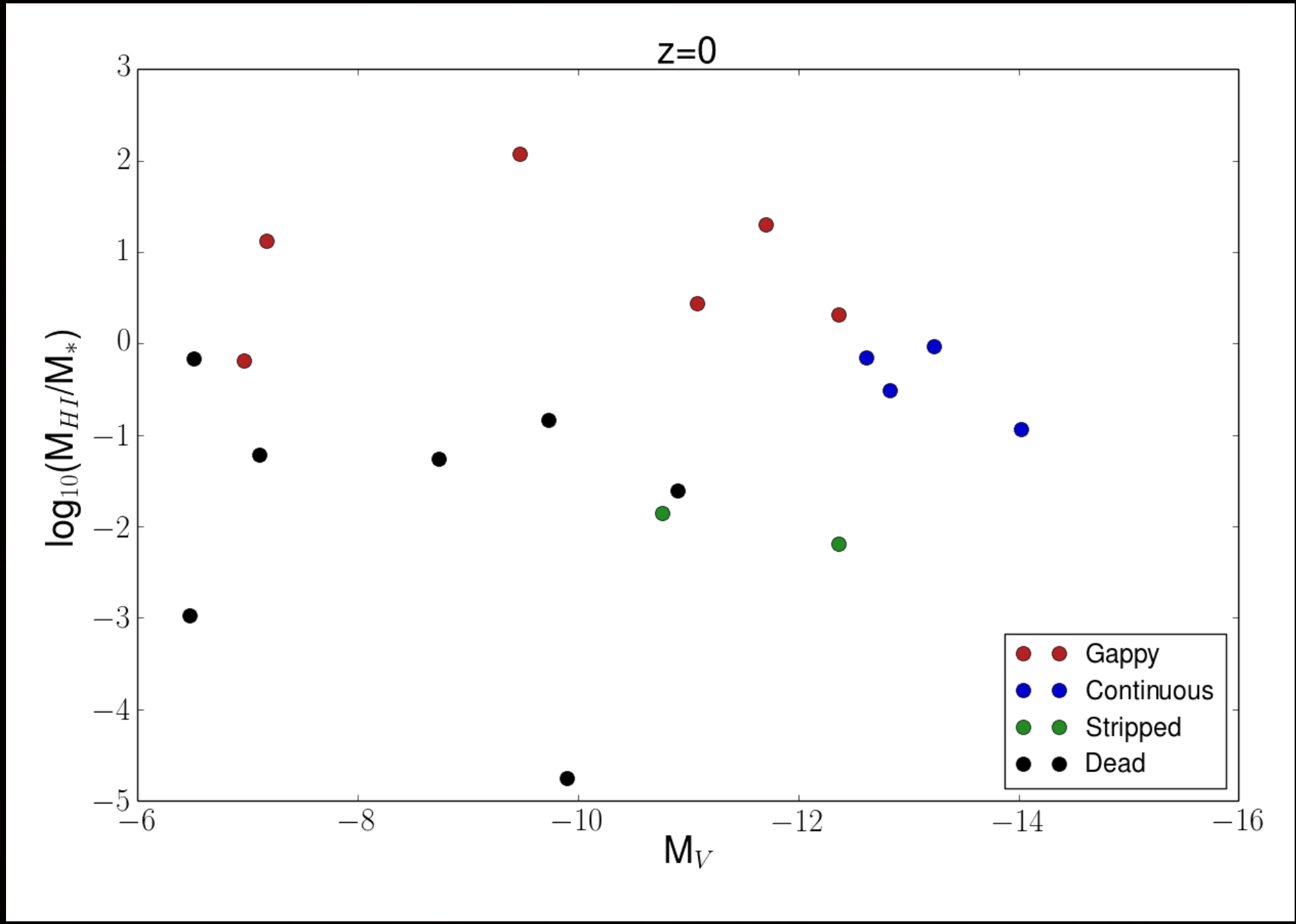

t = 3.01 Gyr
300
100
−100
−300
y/kpc
−300
−100
100
300
x/kpc
6
5
$\log_{10}(\mathrm{Density/M}_\odot\ \mathrm{kpc}^{-2})$

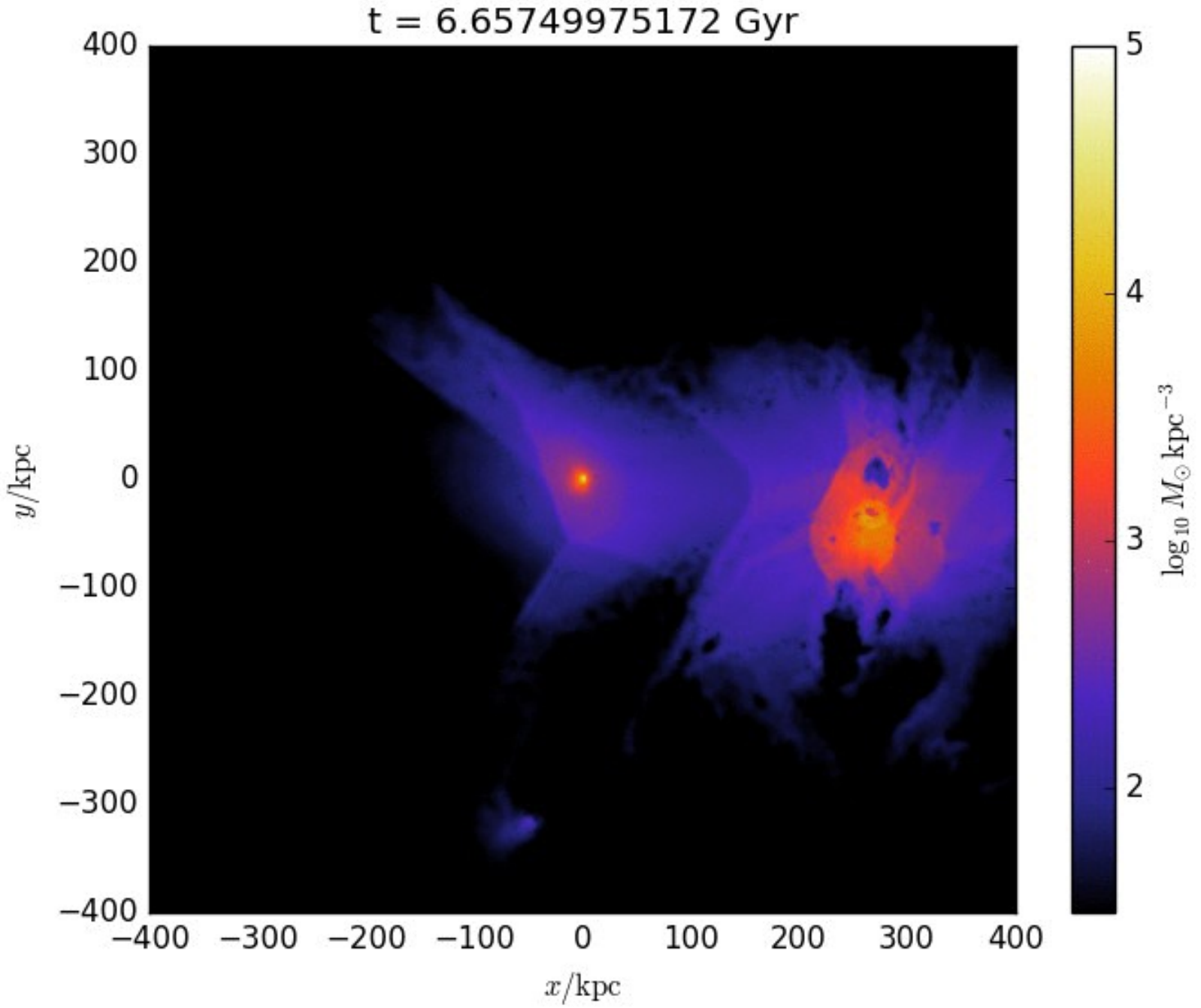

t = 3.01 Gyr
300
100
−100
−300
y/kpc
−300
−100
100
300
x/kpc
6
5
log10(Density/M⊙ kpc−2)

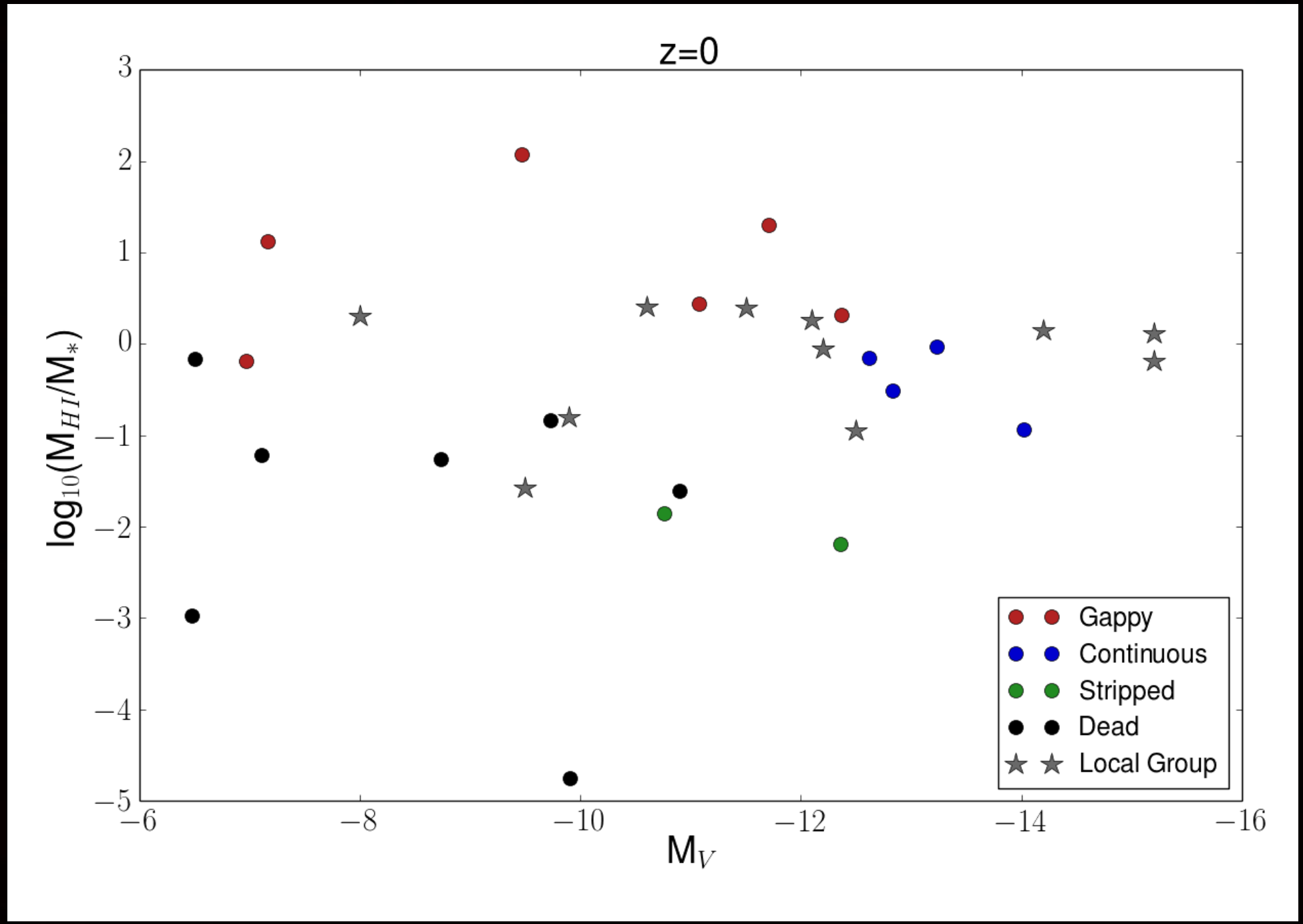

300
100
−100
−300
y/kpc
−300
−100
100
300
x/kpc
6
5
log10(Density/M⊙ kpc−2)

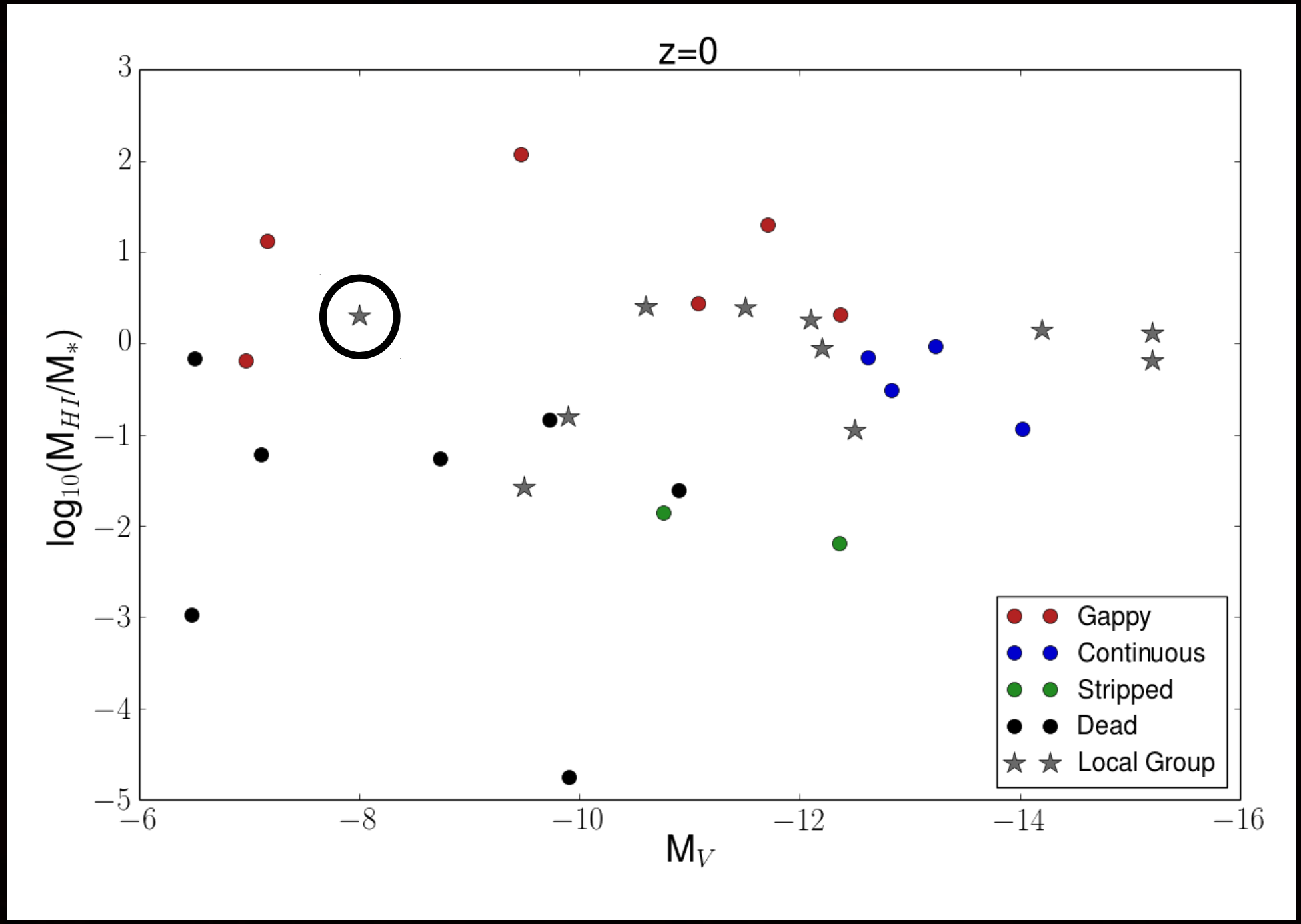

t = 3.01 Gyr
Cumulative Star Formation History
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
Age of the Universe (Gyr)
0
-1
-2
-3
log10(MHI/MHI, max)

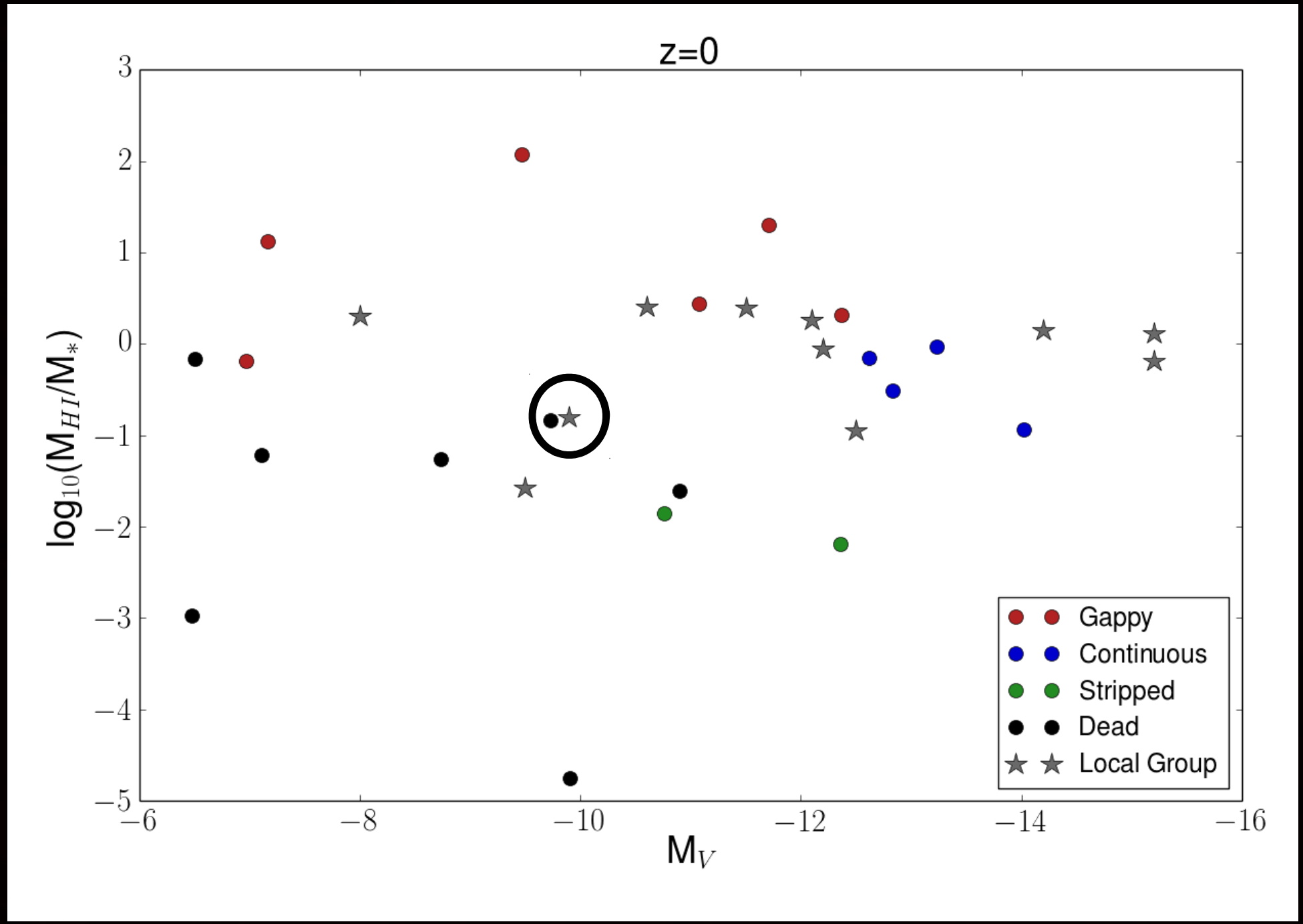

300
100
−100
−300
y/kpc
−300
−100
100
300
x/kpc
6
5
log10(Density/M⊙ kpc−2)
t = 3.01 Gyr
Cumulative Star Formation History
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
Age of the Universe (Gyr)
0
-1
-2
-3
log10(MHI/MHI, max)

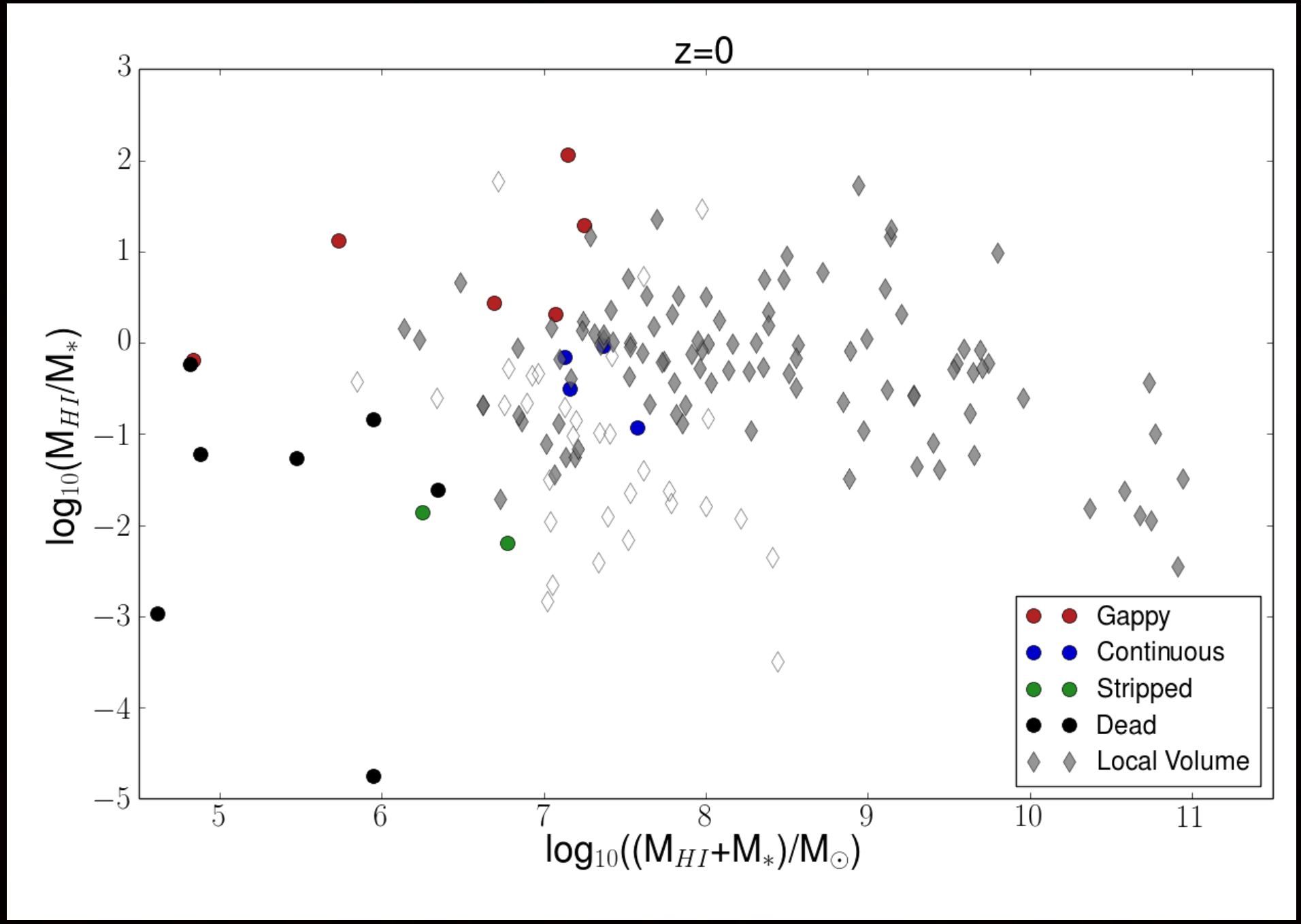

z=0
3
2
1
0
−1
−2
−3
−4
−5
−6
−8
−10
−12
−14
−16
log10(MHI/M*)
MV
Gappy
Continuous
Stripped
Dead


t = 6.65749975172 Gyr
400
300
200
100
0
−100
−200
−300
−400
y/kpc
−400
−300
−200
−100
0
100
200
300
400
x/kpc
5
4
3
2
$\log_{10} M_\odot\,\mathrm{kpc}^{-3}$


z=0
3
2
1
0
−1
−2
−3
−4
−5
−6
−8
−10
−12
−14
−16
log10(MHI/M*)
MV
Gappy
Continuous
Stripped
Dead
Local Group


z=0
3
2
1
0
−1
−2
−3
−4
−5
−6
−8
−10
−12
−14
−16
log10(MHI/M*)
MV
Gappy
Continuous
Stripped
Dead
Local Group

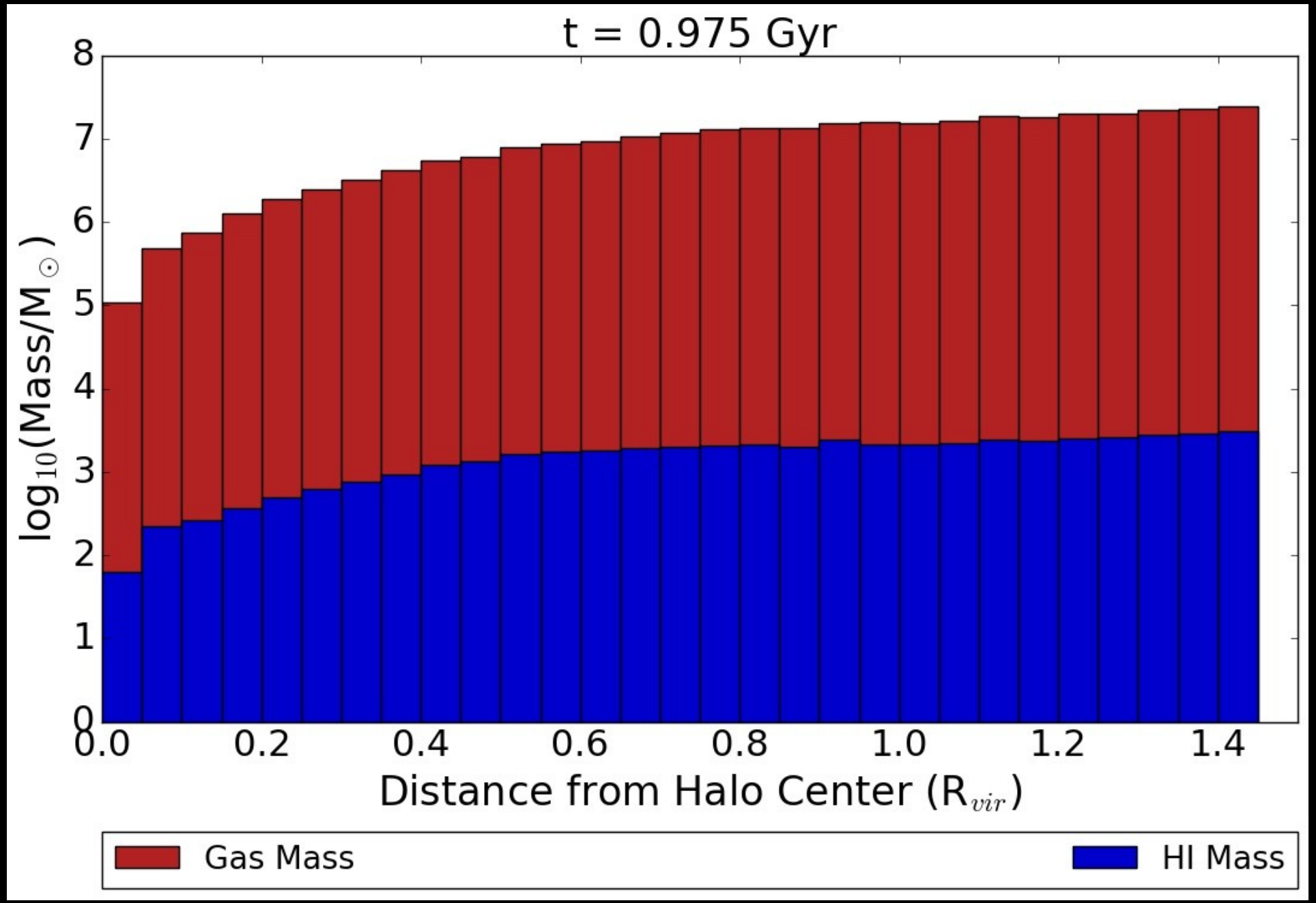

z=0
3
2
1
0
−1
−2
−3
−4
−5
−6
−8
−10
−12
−14
−16
log10(MHI/M*)
MV
Gappy
Continuous
Stripped
Dead
Local Group

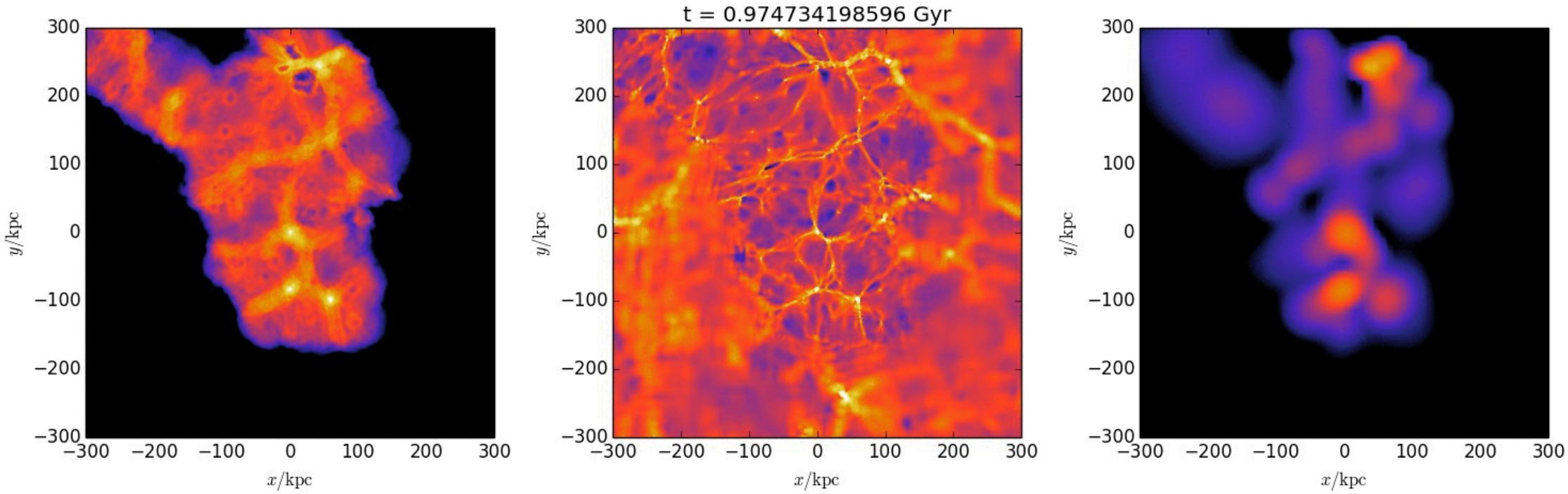

z=0
log10(MHI/M*)
log10((MHI+M*)/M⊙)
Gappy
Continuous
Stripped
Dead
Local Volume

Summary

- A dwarf galaxy quenched by reionization is not necessarily permanently quenched
- Star formation can be reignited when ram pressure from an interaction with a dense stream of gas in the intergalactic medium causes halo gas to collapse onto the disk of a galaxy
- Dwarf galaxies in which star formation has been reignited by this process have high M_{HI}/M_* at z=0, even if the reignition event took place several Gyr ago

arXiv:1802.03019


t = 0.975 Gyr
log10(Mass/M⊙)
0
1
2
3
4
5
6
7
8
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Distance from Halo Center (Rvir)
Gas Mass
HI Mass


t = 0.974734198596 Gyr
300
200
100
0
−100
−200
−300
y/kpc
−300 −200 −100 0 100 200 300
x/kpc

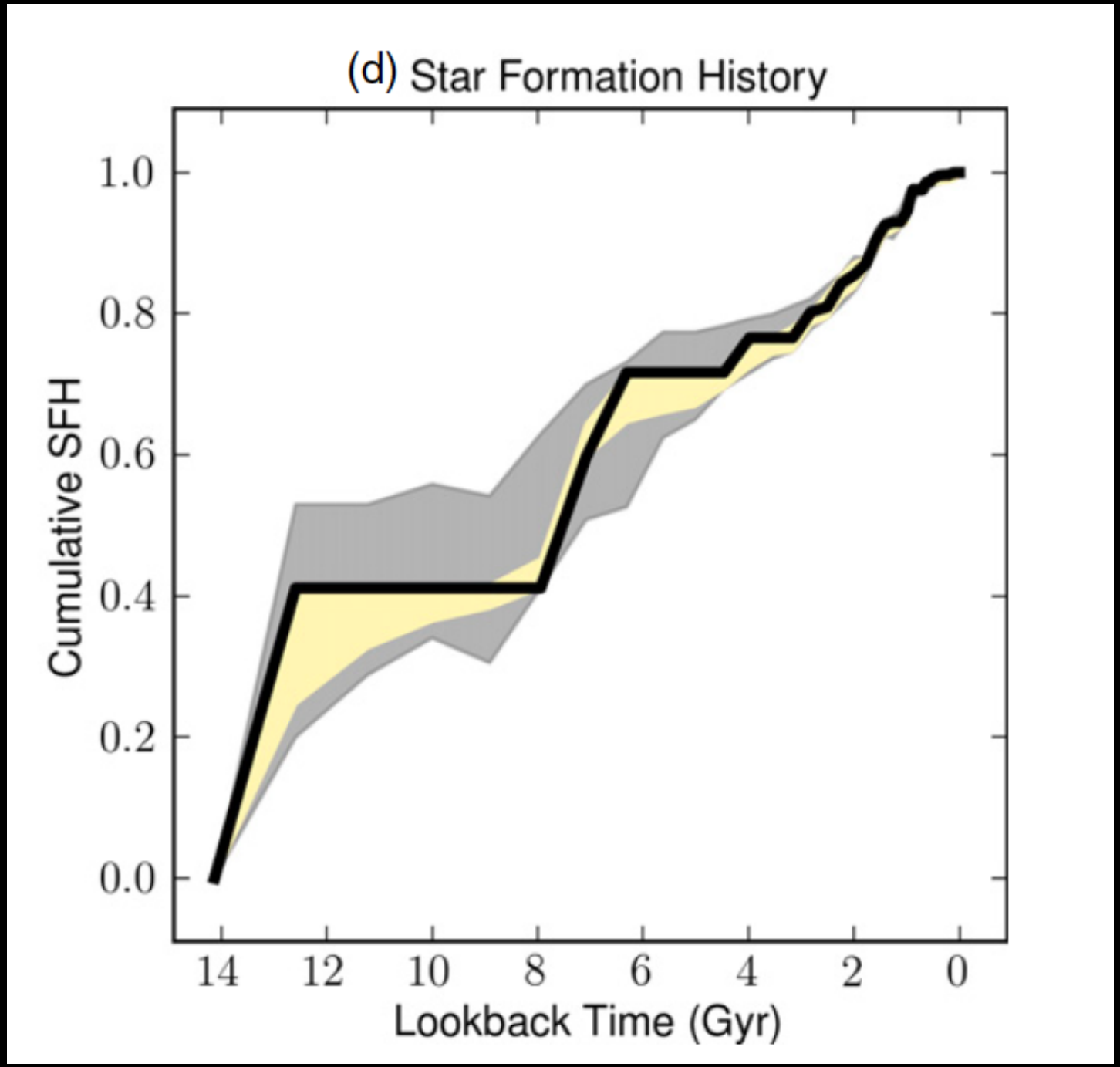


Figure 4, panel d from Weisz et al., 2014

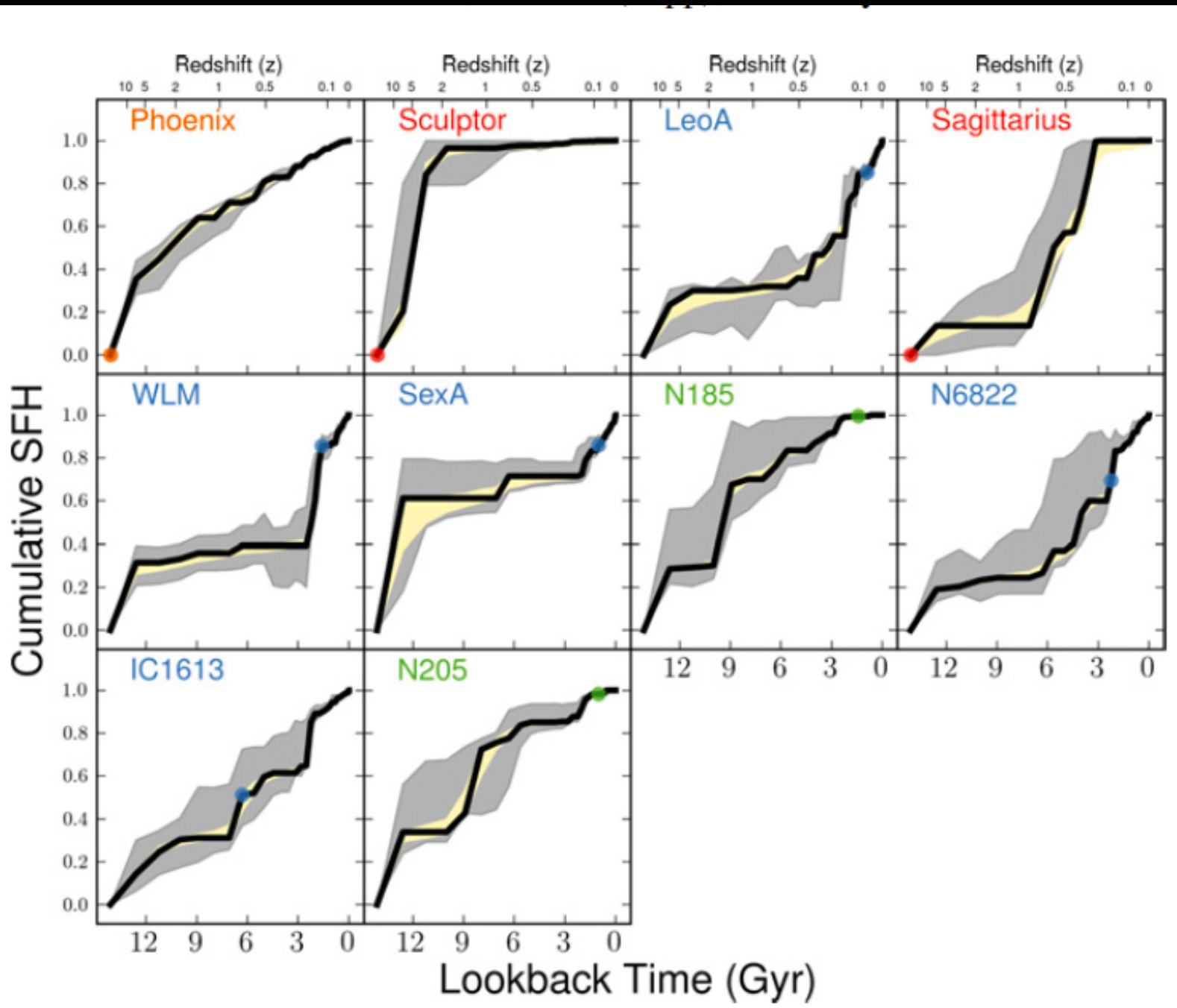
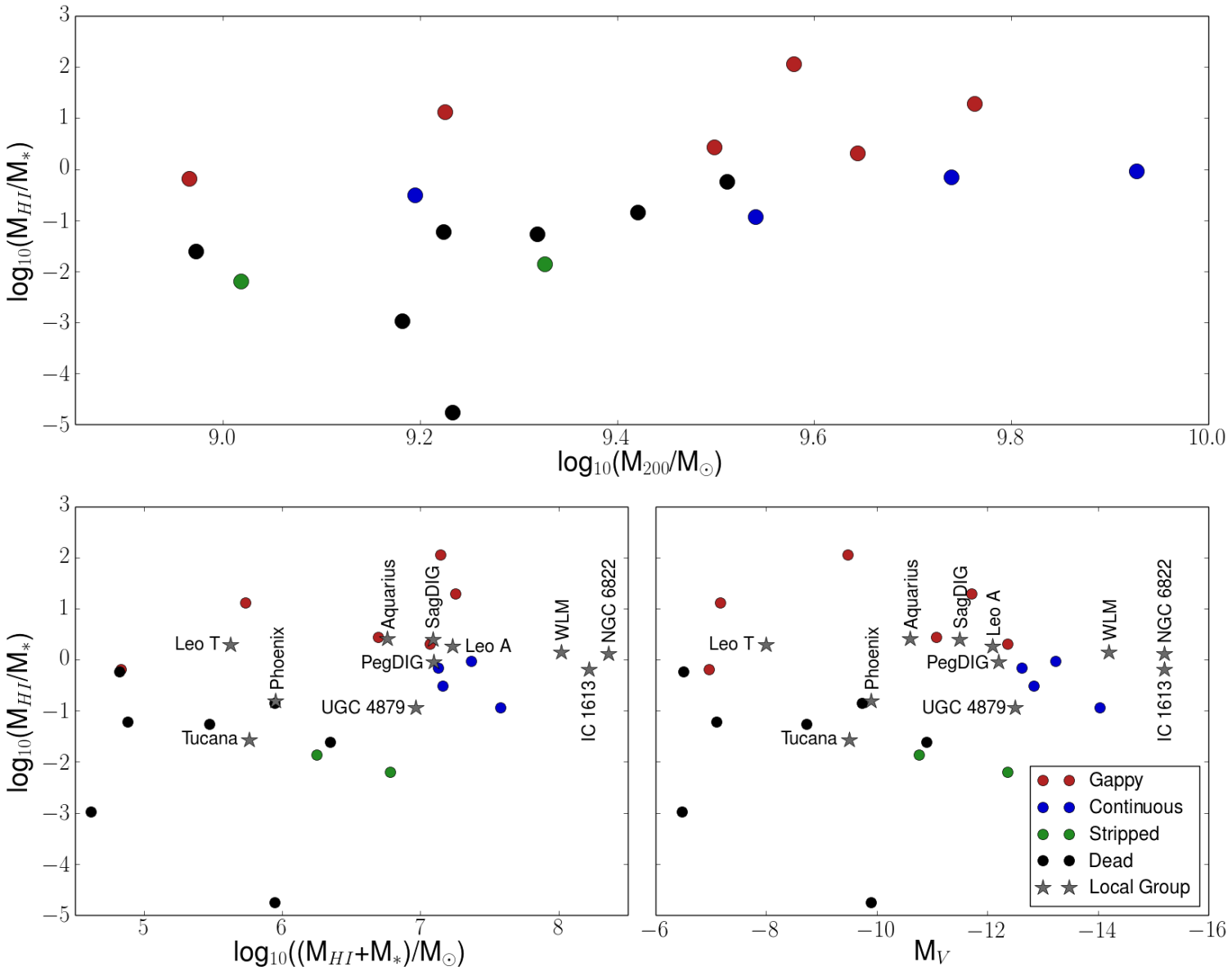


Figure 8 from Weisz et al., 2014


log10(MHI/M*)
log10(M200/M⊙)
log10((MHI+M*)/M⊙)
MV
Leo T
Phoenix
Aquarius
SagDIG
Leo A
PegDIG
UGC 4879
Tucana
WLM
IC 1613
NGC 6822
Gappy
Continuous
Stripped
Dead
Local Group