What drives dusty winds? Radiation hydrodynamics of the parsec-scale environment of AGN

David Williamson, Marta Venanzi,
& Sebastian Hönig

UNIVERSITY OF Southampton

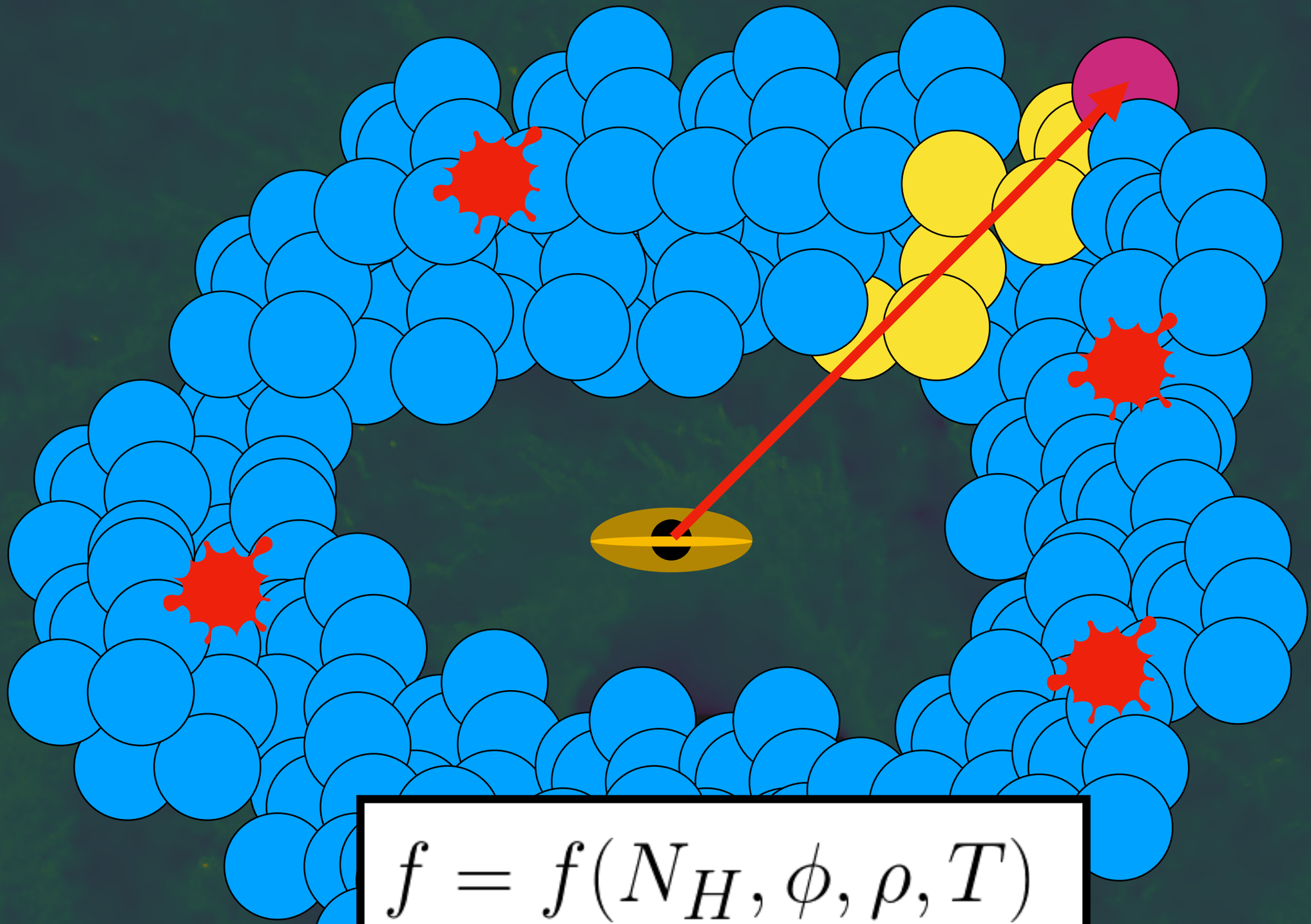
Model Features

3D Smoothed Particle Hydrodynamics
Gadget (Springel)->GIZMO (Hopkins)

Raytracing
Pretabulated heating/cooling/etc (Venanzi)
CLOUDY
Non-LTE; local *ionisation* equilibrium
(No secondary Radiation yet)

Self-gravity

Stellar background
Supernova feedback?

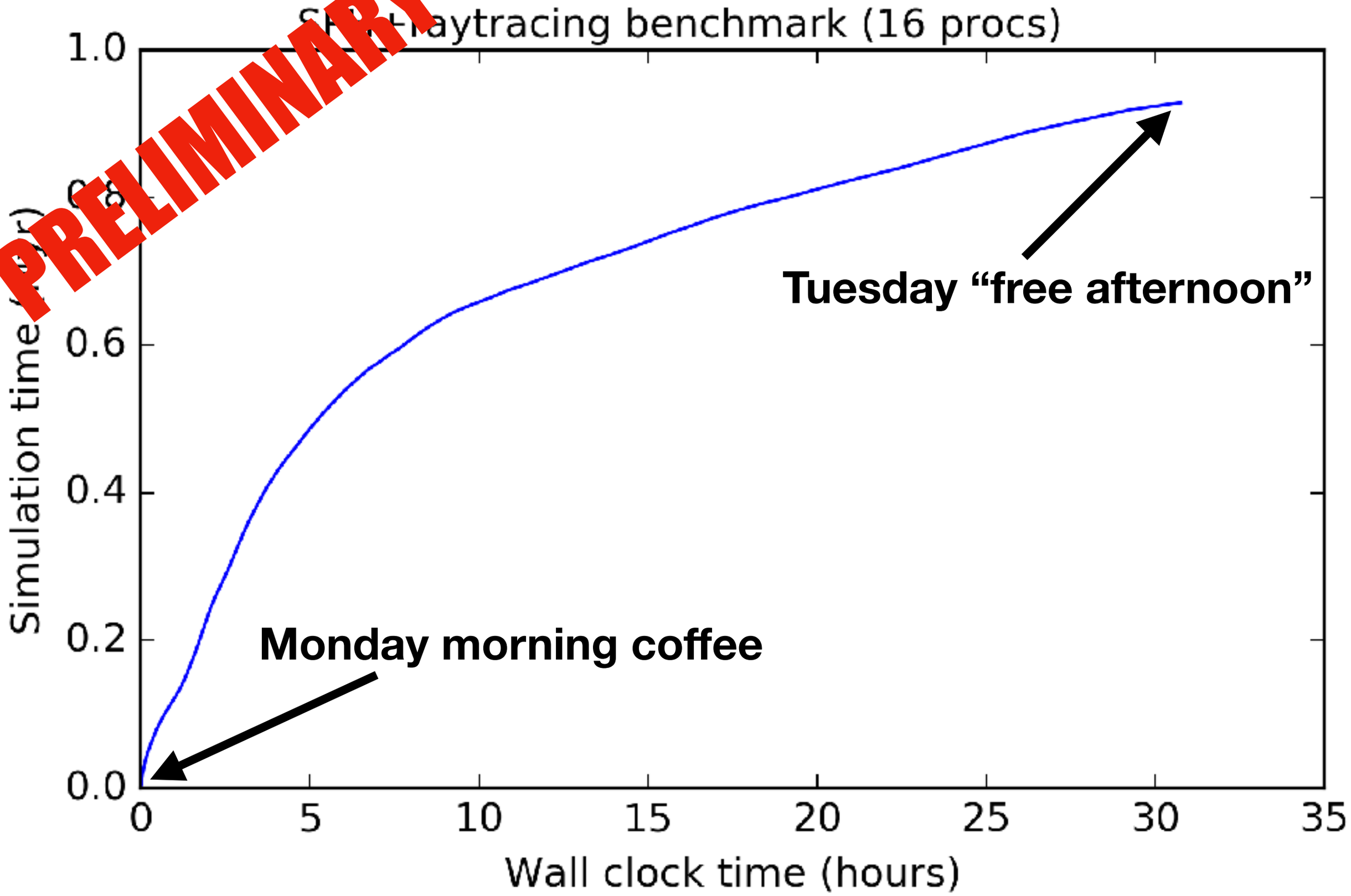


$$f = f(N_H, \phi, \rho, T)$$

where

$$f = \Lambda, \Gamma, a_{\rm rad}, U, \ldots$$

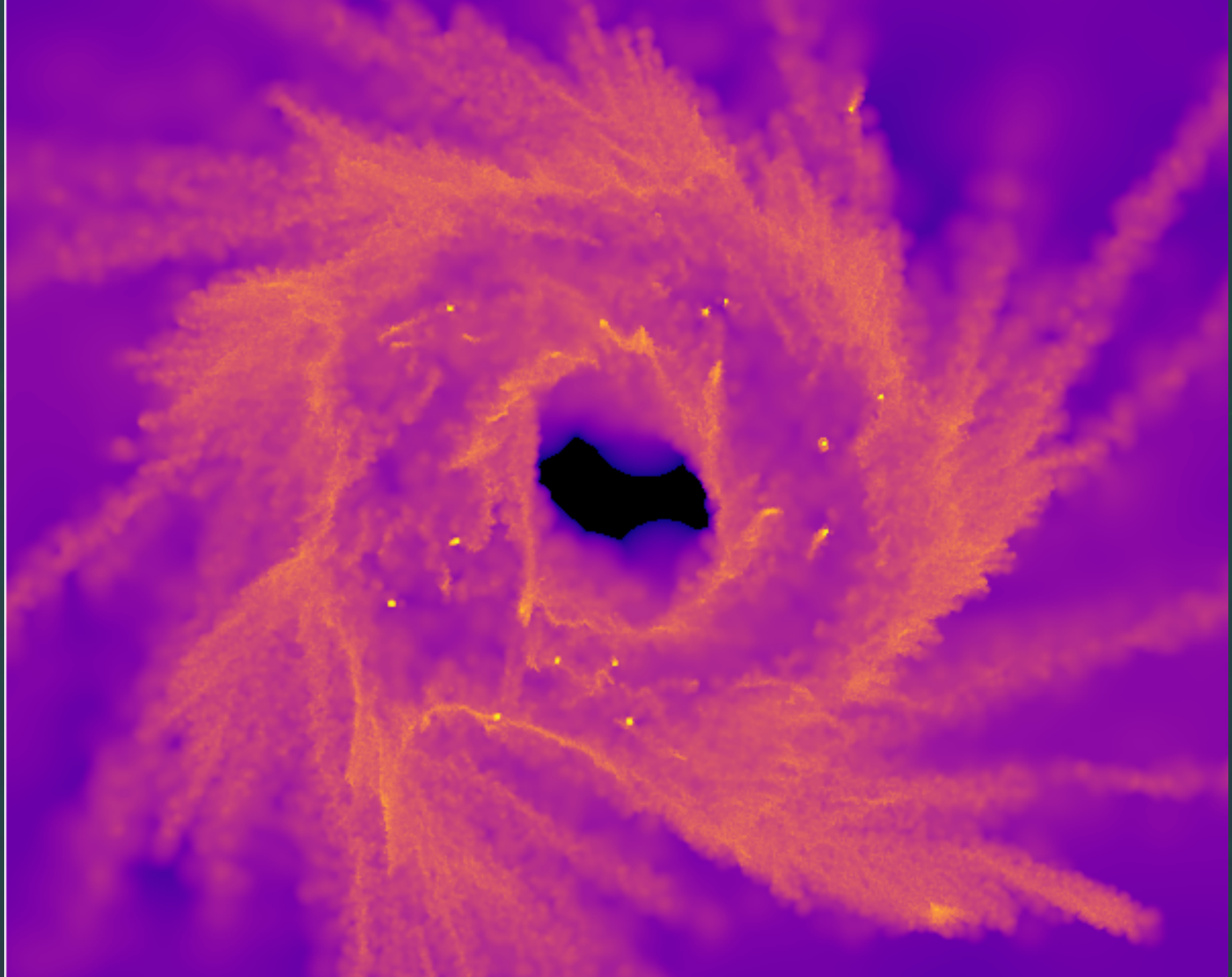
PRELIMINARY



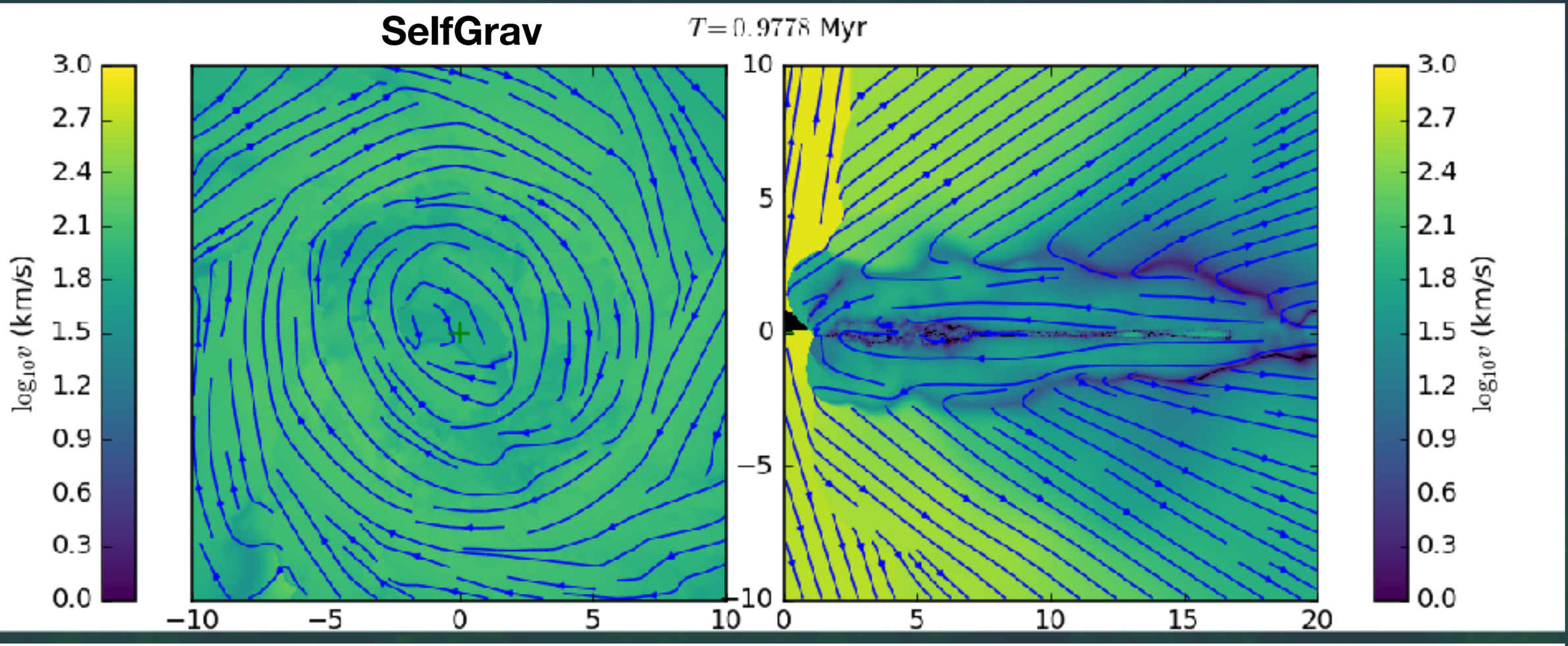
$t = 0.1021$ Myr

$\log_{10}\Sigma\ (M_\odot/pc^2)$

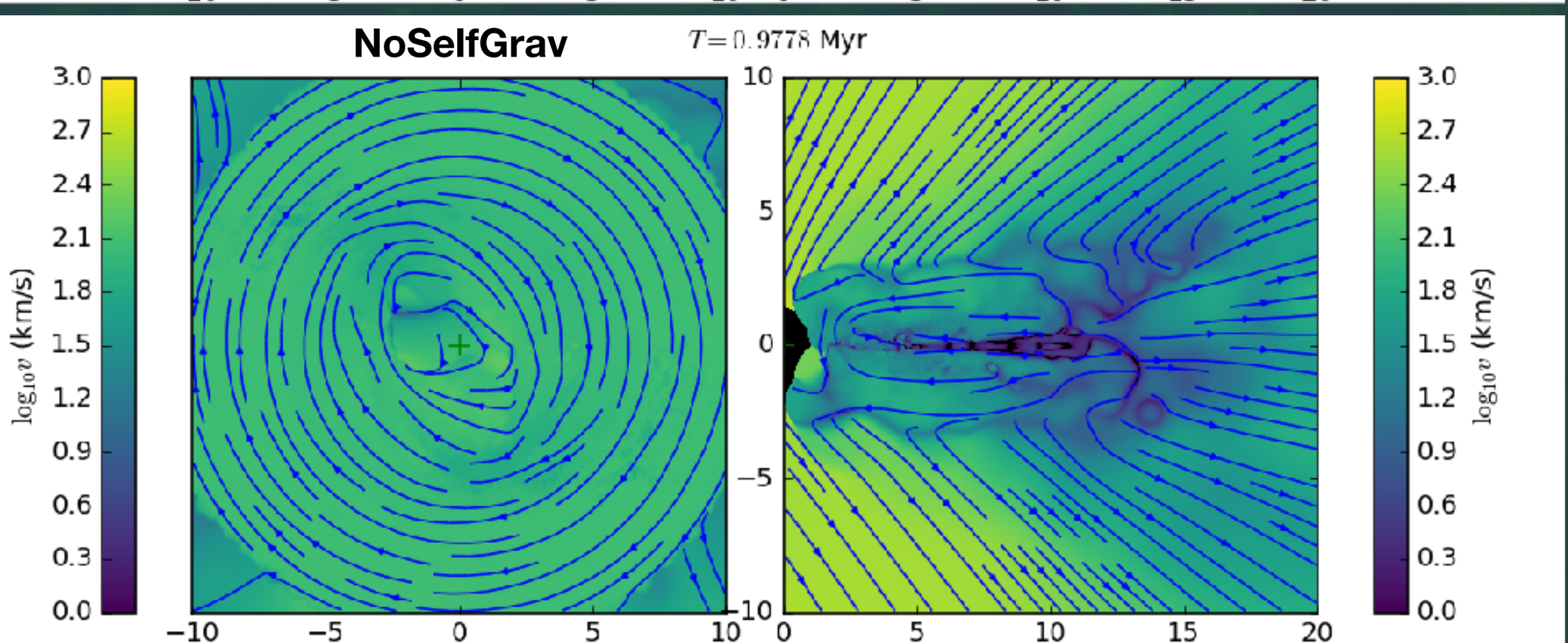
$\log_{10}T_g'$ (K)



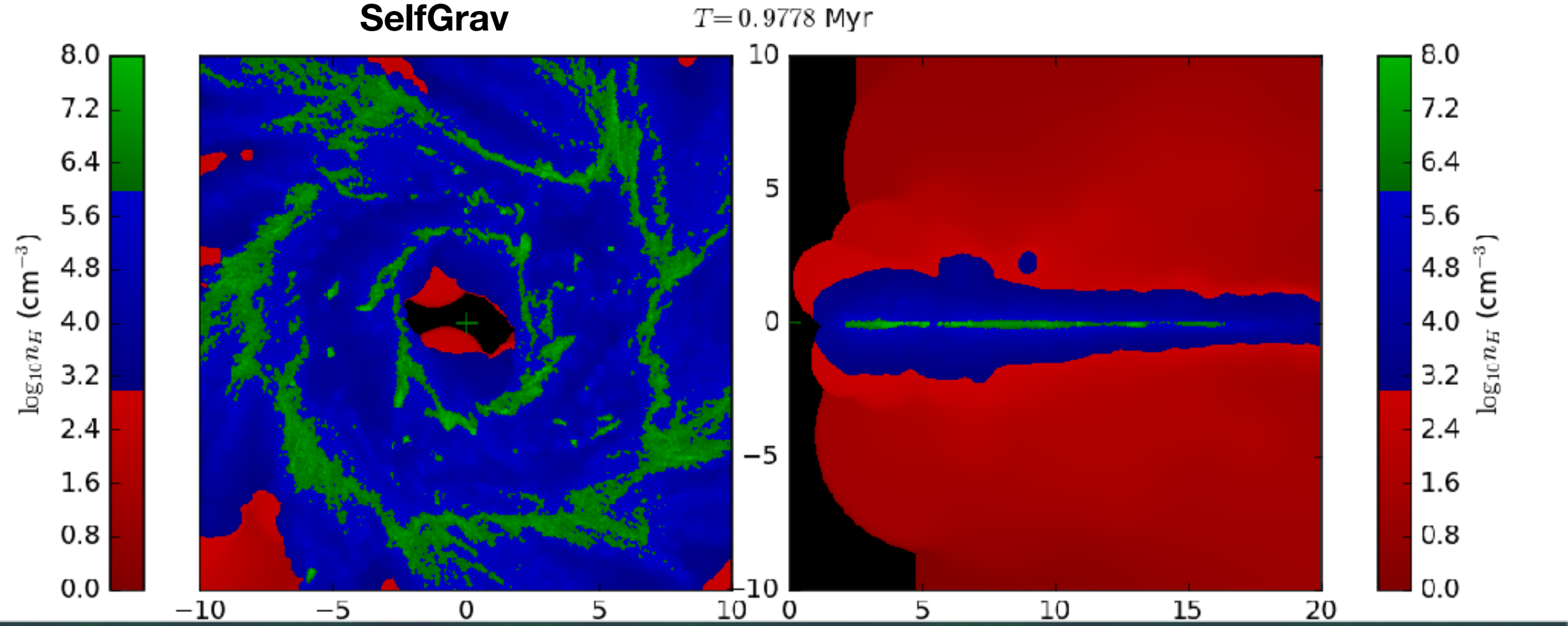
SelfGrav



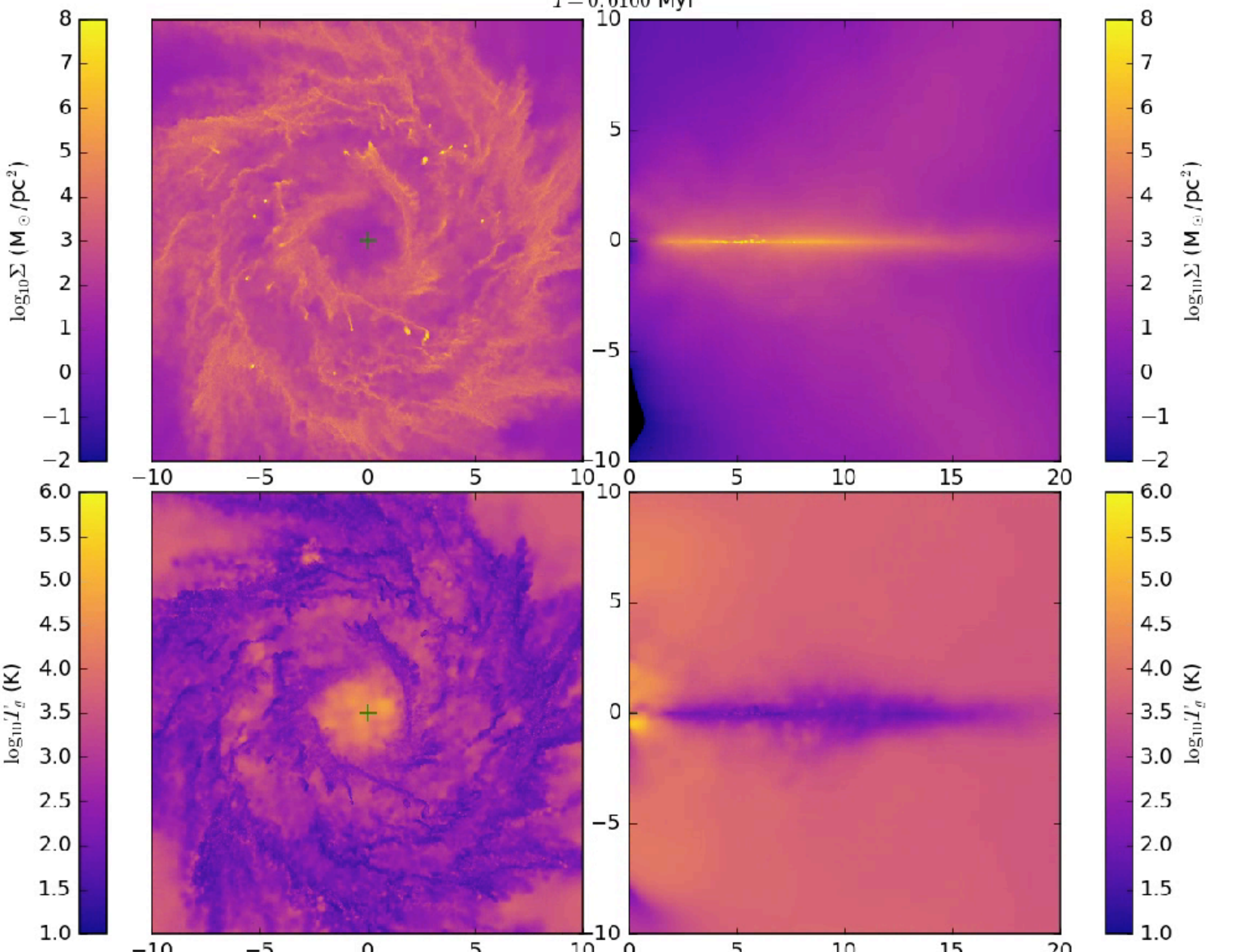
NoSelfGrav



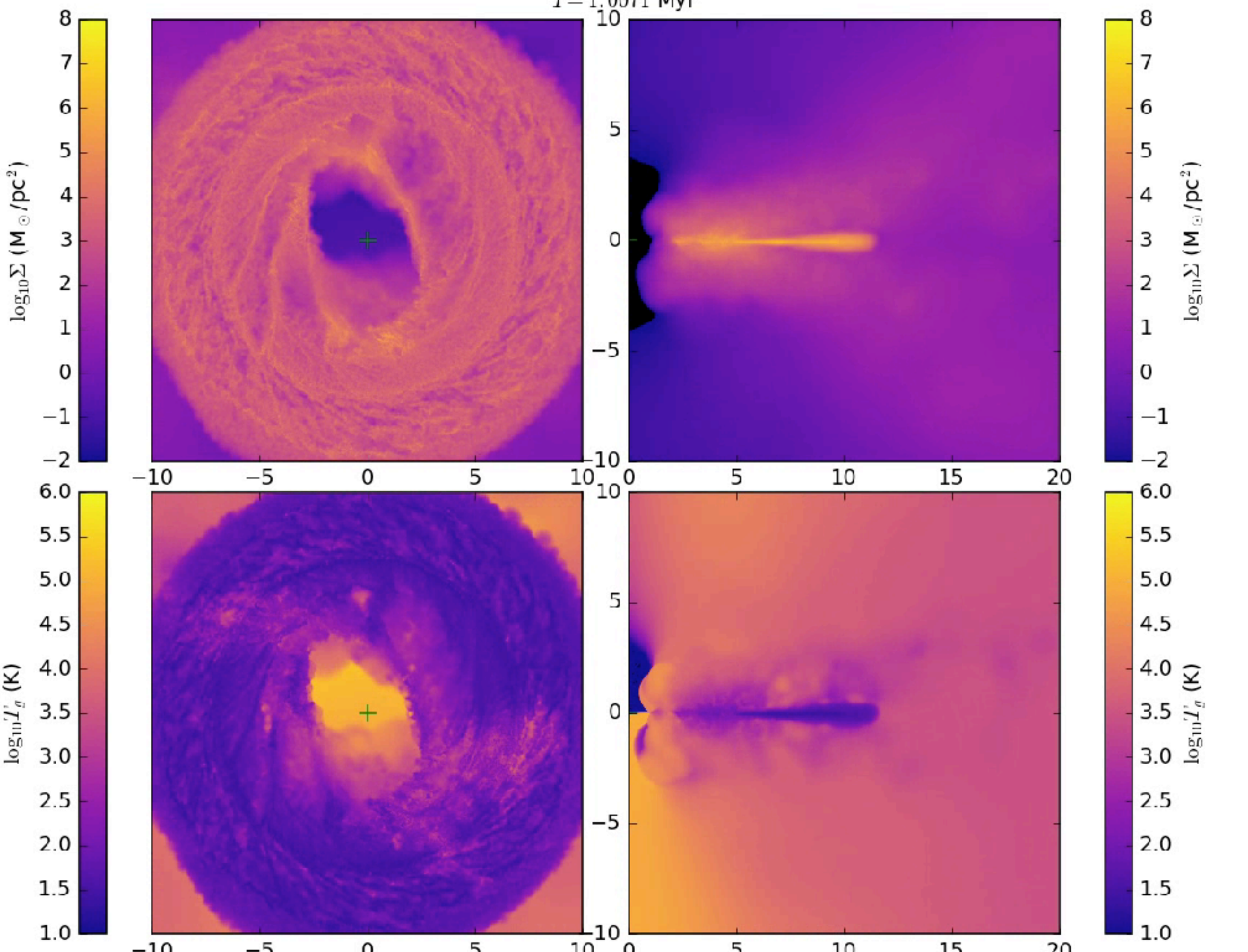
SelfGrav


$T = 0.9778$ Myr
$\log_{10} n_H$ (cm^{-3})
8.0
7.2
6.4
5.6
4.8
4.0
3.2
2.4
1.6
0.8
0.0
10
5
0
−5
−10
0
5
10
15
20

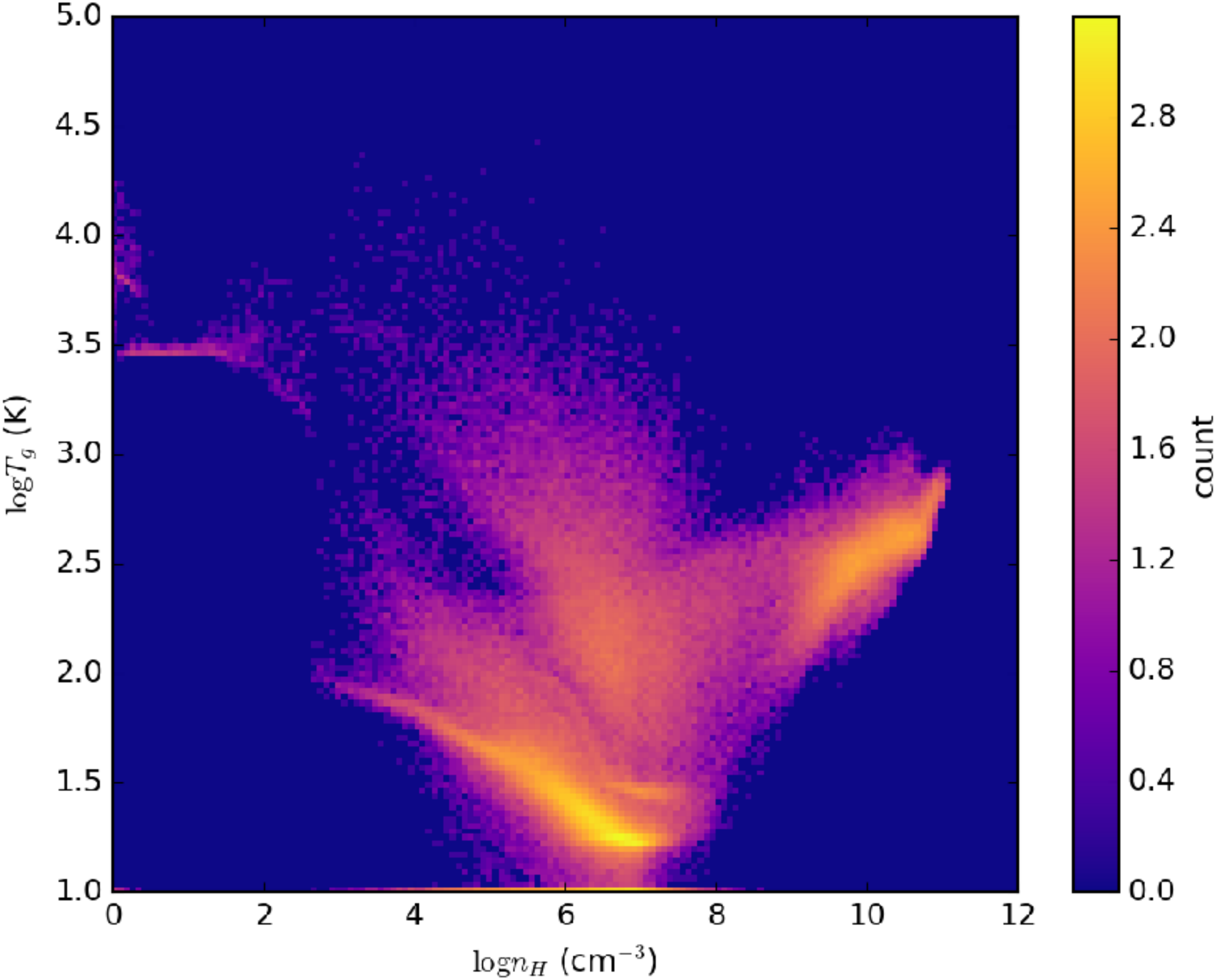
$t = 0.6160$ Myr


$\log_{10}\Sigma$ ($M_\odot$/pc^2)
$\log_{10}T'_g$ (K)
8
7
6
5
4
3
2
1
0
−1
−2
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
10
5
0
−5
−10
15
20

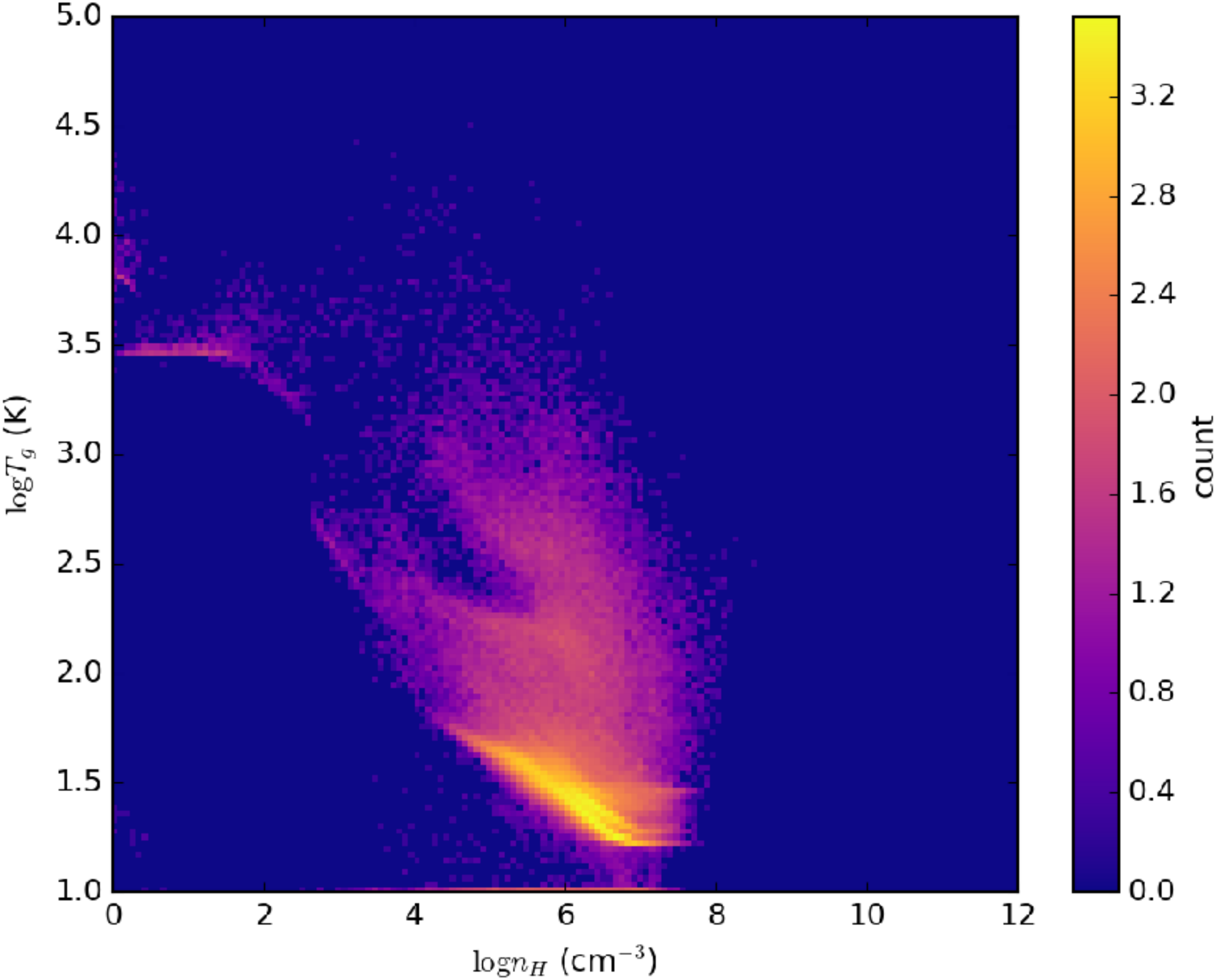
t = 1.0571 Myr

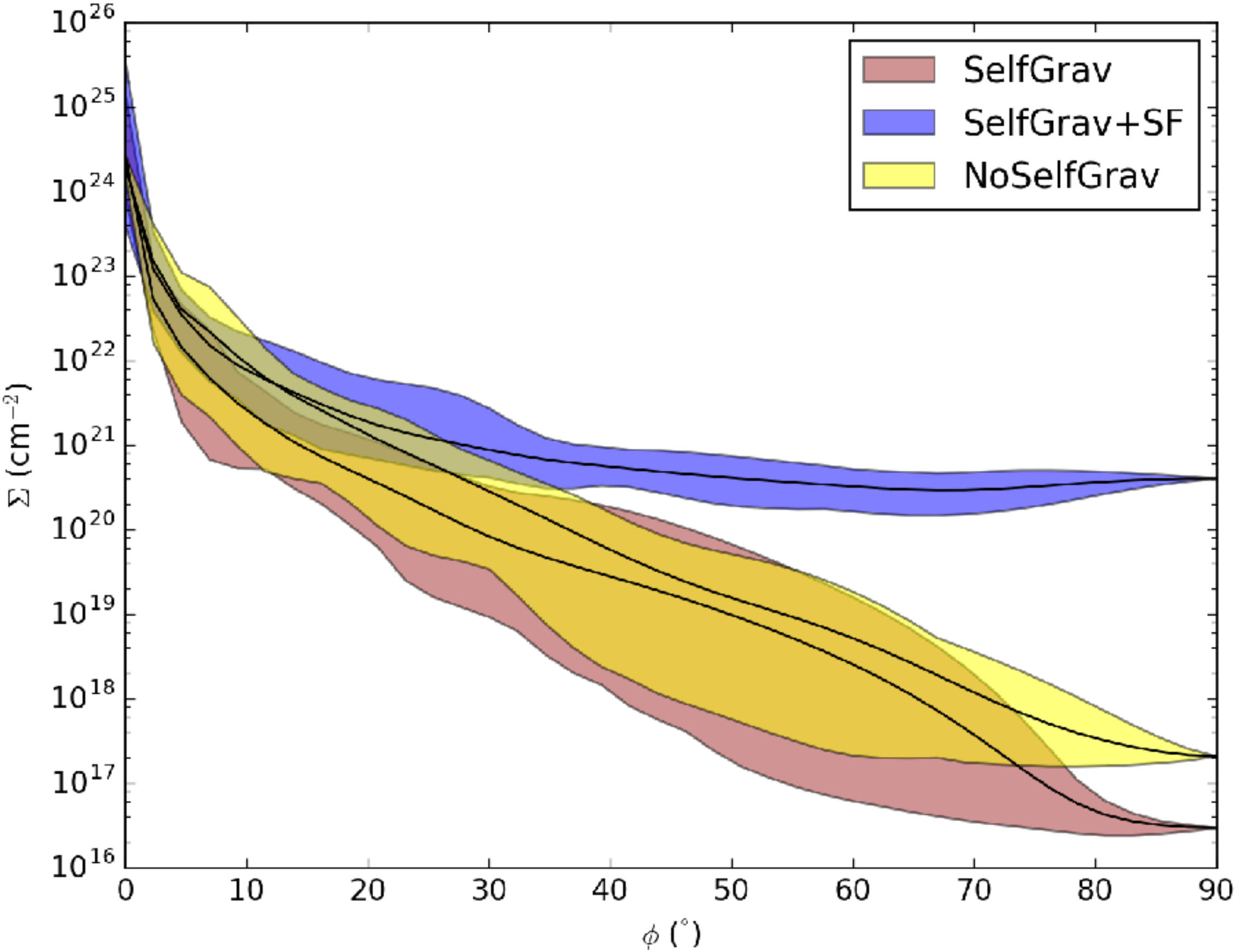

$\log_{10}\Sigma$ ($M_\odot$/pc^2)
$\log_{10}\Sigma$ ($M_\odot$/pc^2)
$\log_{10}T_g'$ (K)
$\log_{10}T_g'$ (K)
8
7
6
5
4
3
2
1
0
−1
−2
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
10
5
0
−5
−10
0
5
10
15
20

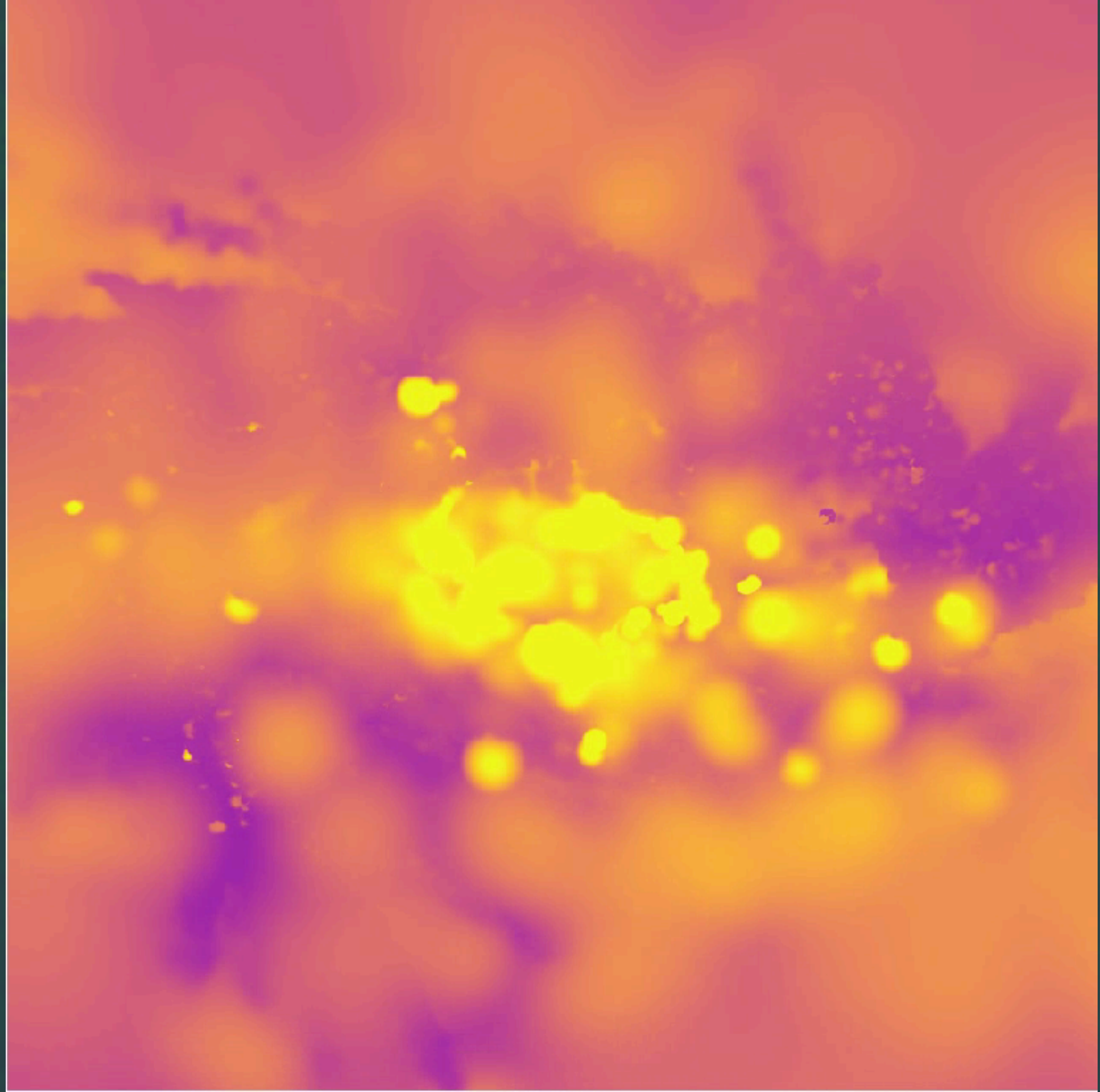
With self-gravity



Without self-gravity




SelfGrav
SelfGrav+SF
NoSelfGrav
10^{26}
10^{25}
10^{24}
10^{23}
10^{22}
10^{21}
10^{20}
10^{19}
10^{18}
10^{17}
10^{16}
Σ (cm^{-2})
0
10
20
30
40
50
60
70
80
90
ϕ ($^\circ$)



PRELIMINARY

Summary

- **Using an efficient self-gravitating radiation hydrodynamics code, we have produced a promising dusty wind torus model**

- **Self gravity in the gas appears important for the development of fine structure (filaments, clumps, etc)**

- **A high supernova rate can increase the column density at high latitudes, and we expect the future inclusion of “secondary” radiation to increase this further**