Simultaneous ram pressure and tidal stripping; how dwarf spheroidals lost their gas

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Dwarf Spheroidal

Leo I dSph
250 kpc

Extremely faint galaxies

No significant recent star formation

Gas poor to devoid of gas

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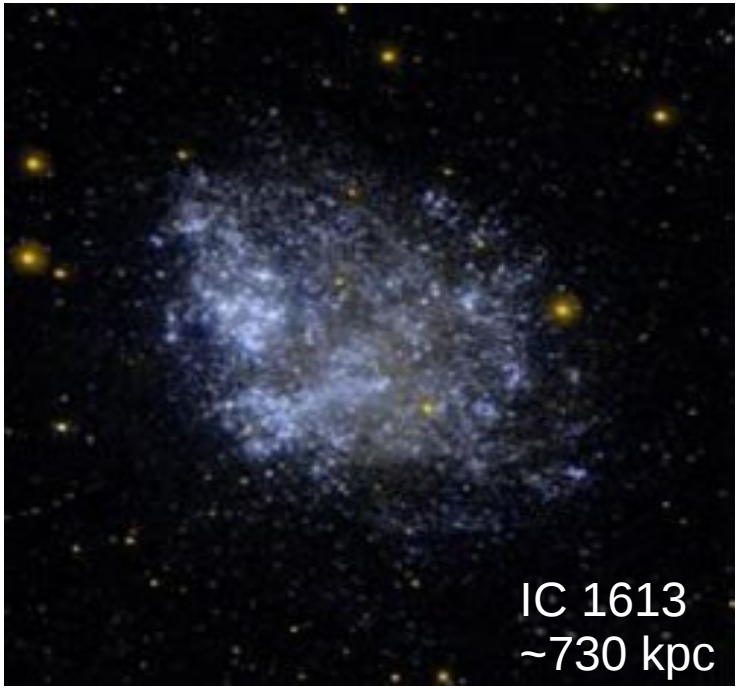
But what about density morphology relationship?

Dwarf Irregular



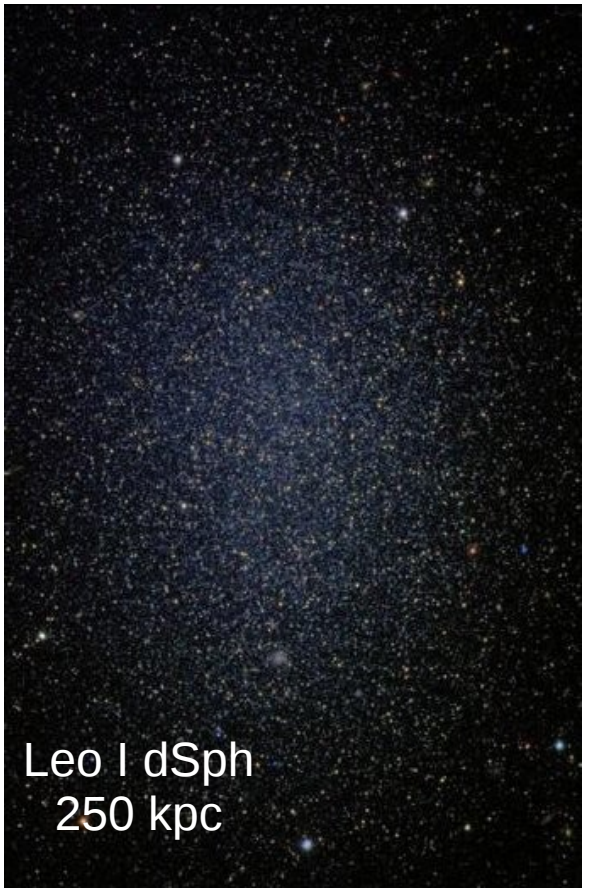
Faint, like dSph... but:

Gas-rich with recent SF

Disc-like

Exponential surface brightness

Dwarf Spheroidal

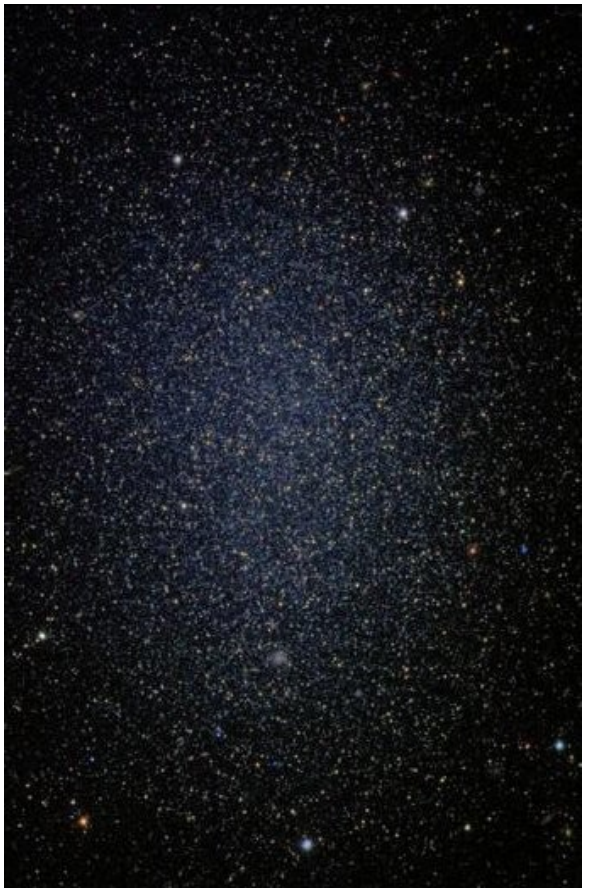


Dwarf Irregular

Preferentially found in
low density regions

Significant stellar rotation

Dwarf Spheroidal



Found as satellites close to a host

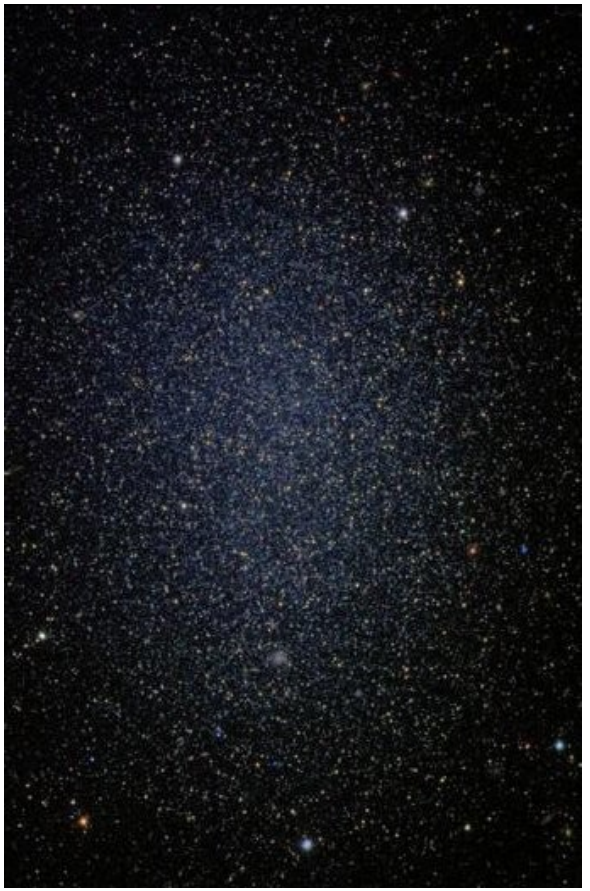
Pressure supported

Dwarf Irregular

Is there an evolutionary path

?

Dwarf Spheroidal



Dwarf Spheroidal

Dwarf Irregular

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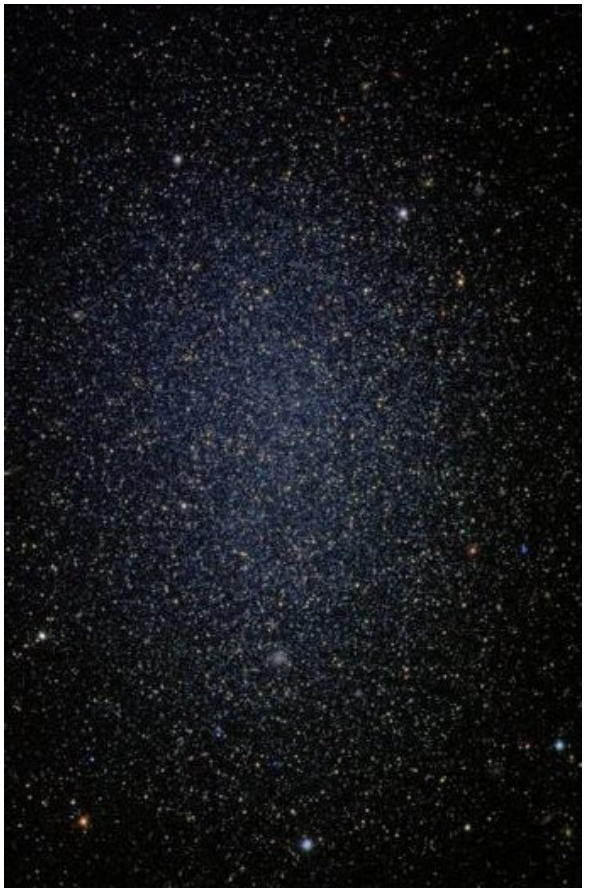


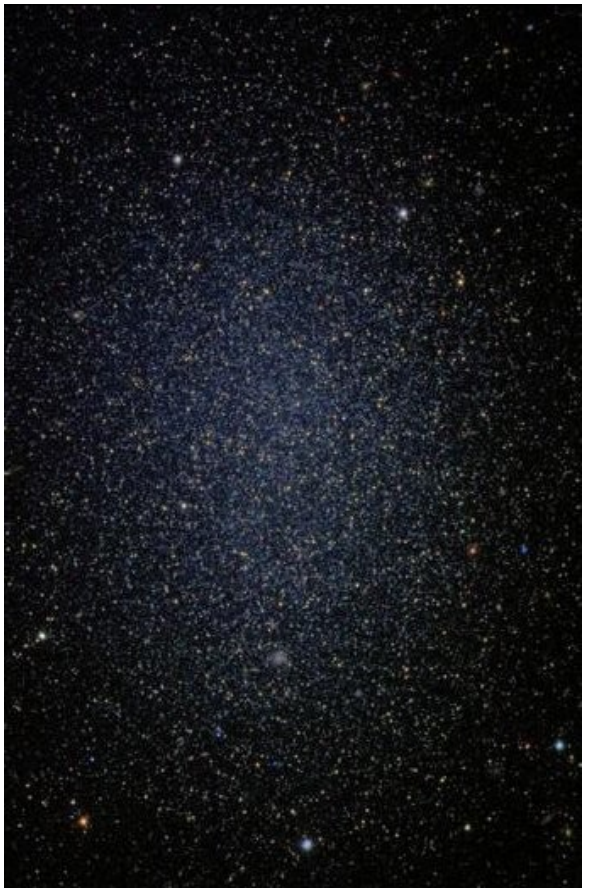
Supernova / Stellar Feedback

Dwarf Spheroidal

Dwarf Irregular

Is there an evolutionary path

?



Ram Pressure Stripping

Tidal Stripping and Interactions

Supernova / Stellar Feedback

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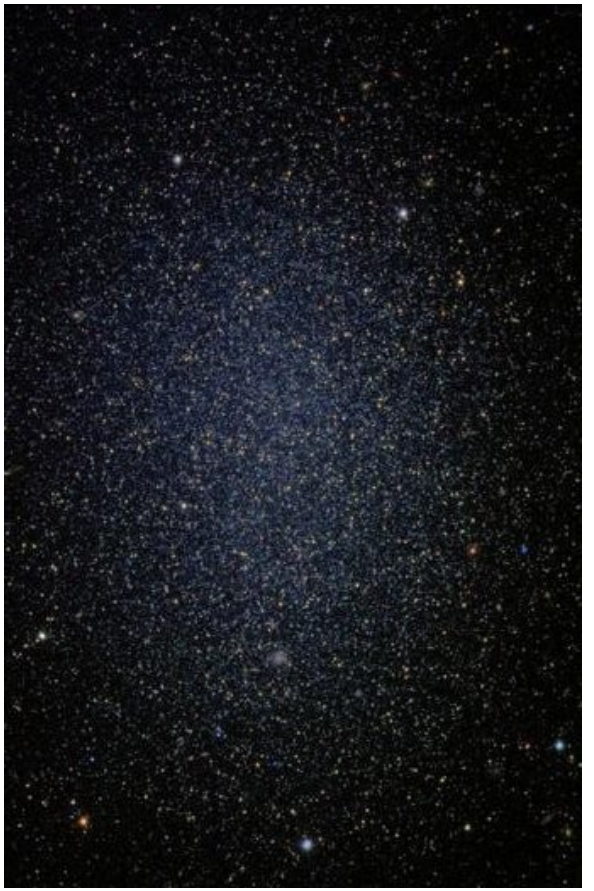

Ram Pressure Stripping

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Supernova / Stellar Feedback

Possible Associated SF

Dwarf Irregular

Is there an evolutionary path

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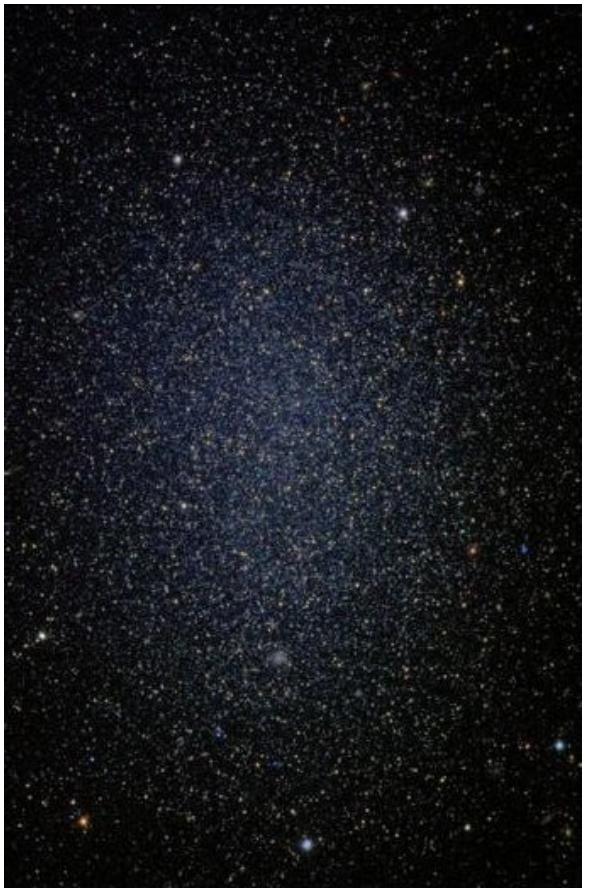
Dwarf Spheroidal



Focus of Mayer et. al. 2006

Ram Pressure Stripping

Tidal Stripping and Interactions

Supernova / Stellar Feedback

Possible Associated SF

Simulation Design: Galaxy Model

Dwarf: Gas + stars in disc + live NFW halo

Host: Live NFW halo (no disk)
Hot Corona - 10^6 K and 8 x 10^{-5} cm^{-3} at 50 kpc

3 Dwarfs: Peak rotation velocity = 28, 42, 62 km/s
Concentration = 4, 20, 4

Disc mass ~ 4% of total mass

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Resolution:
Dwarf: $3x10^5$ (DM) + $3x10^4$ (stars + gas)
Host : $5x10^5$ (DM) + $5x10^5$ (hot gas)

Dwarf Galaxy Orbits

Bound, eccentric orbits with $r_{apo}/r_{peri} = 5$

250 kpc / 50 kpc OR 150 kpc / 30 kpc

Orbital times ~ 3.2 OR 1.2 Gyr

Simulate 3 – 5 orbits

Disc begin at 60 degree incline to orbit

Simulation Code

GASOLINE – Tree+SPH code

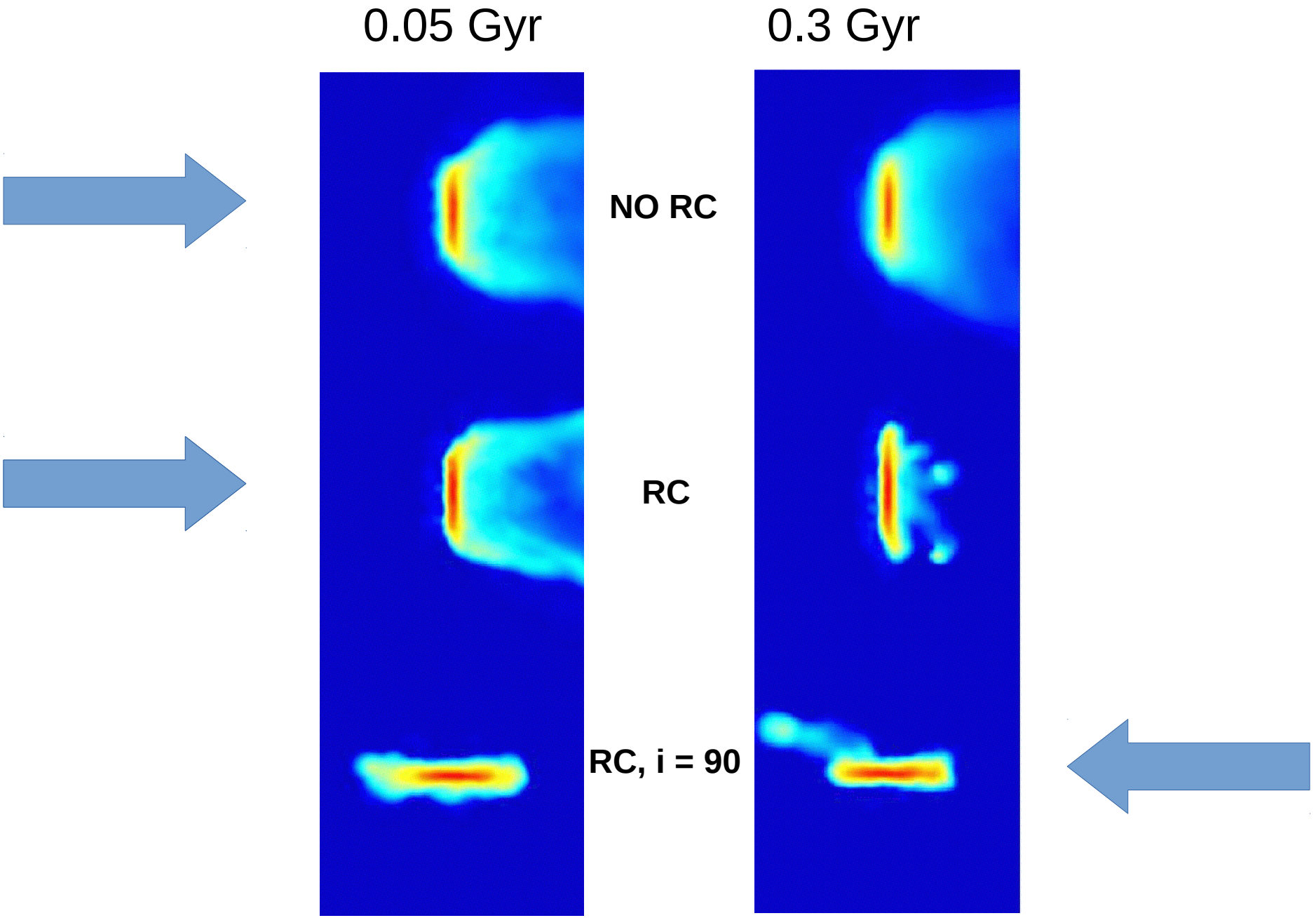
Physics Varied in Simulations:

Radiative Cooling: On or Off (adiabatic cooling)

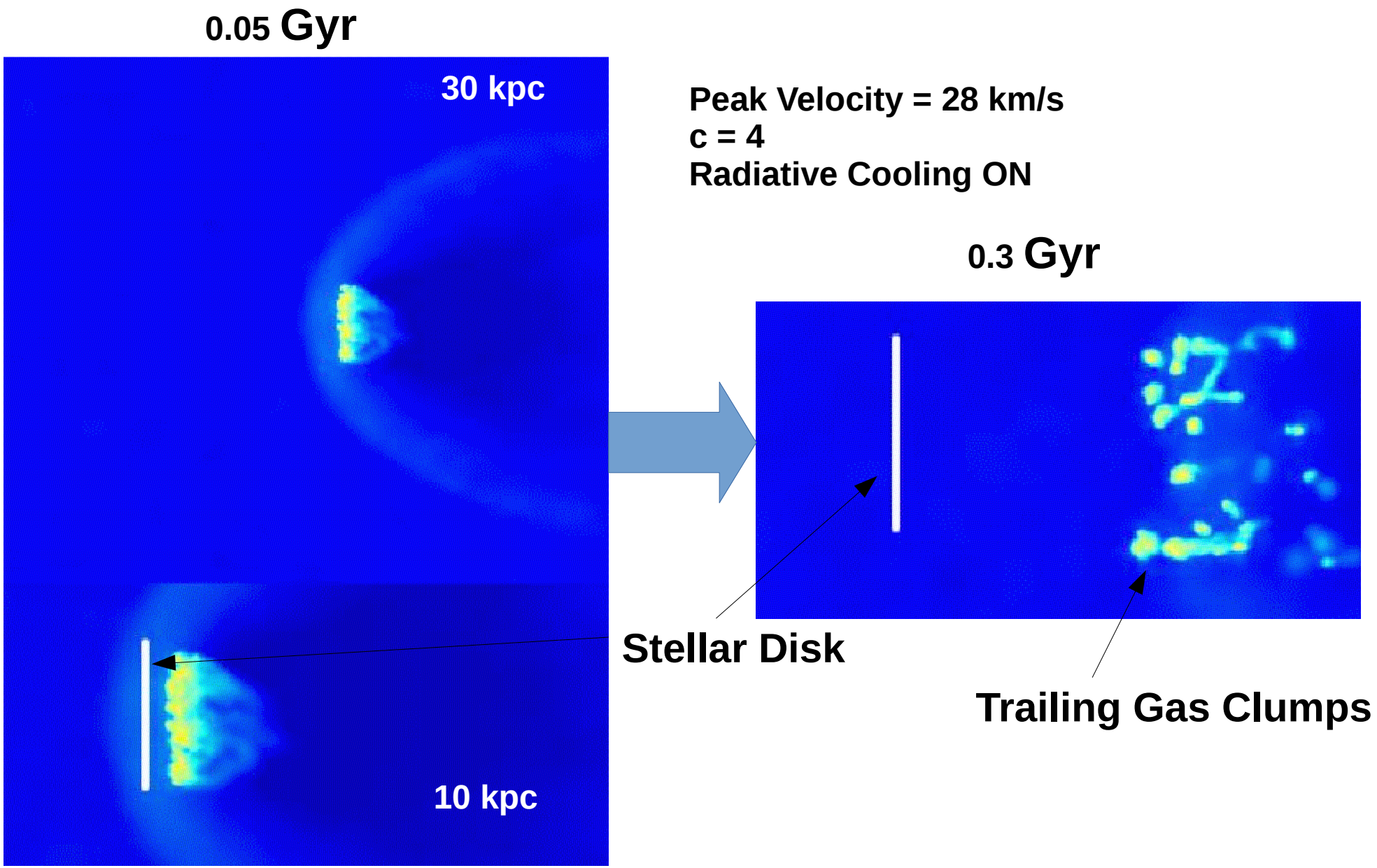
UV Background : On in some RC runs

Wind Tunnel : Some RPS only runs

Wind Tunnel Tests

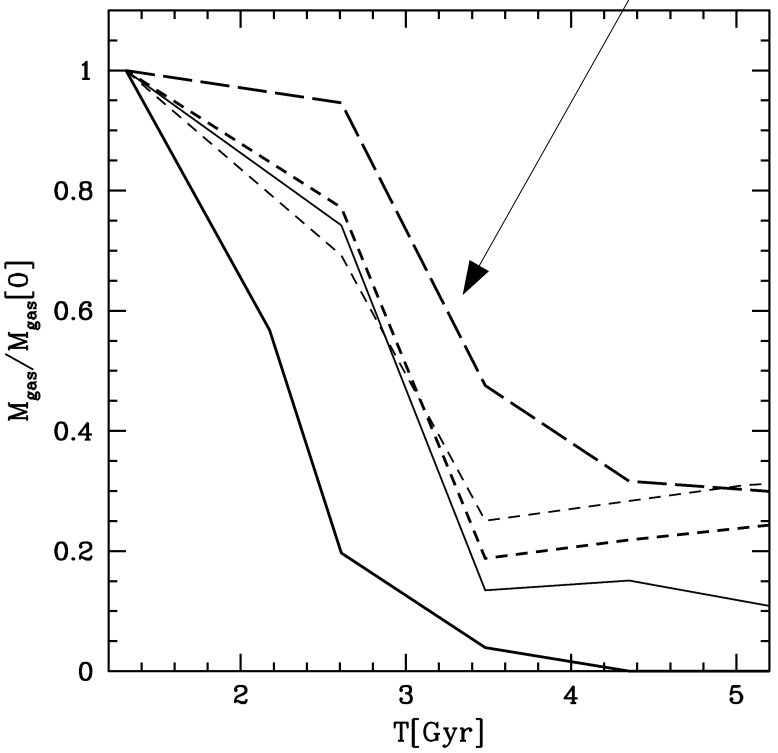


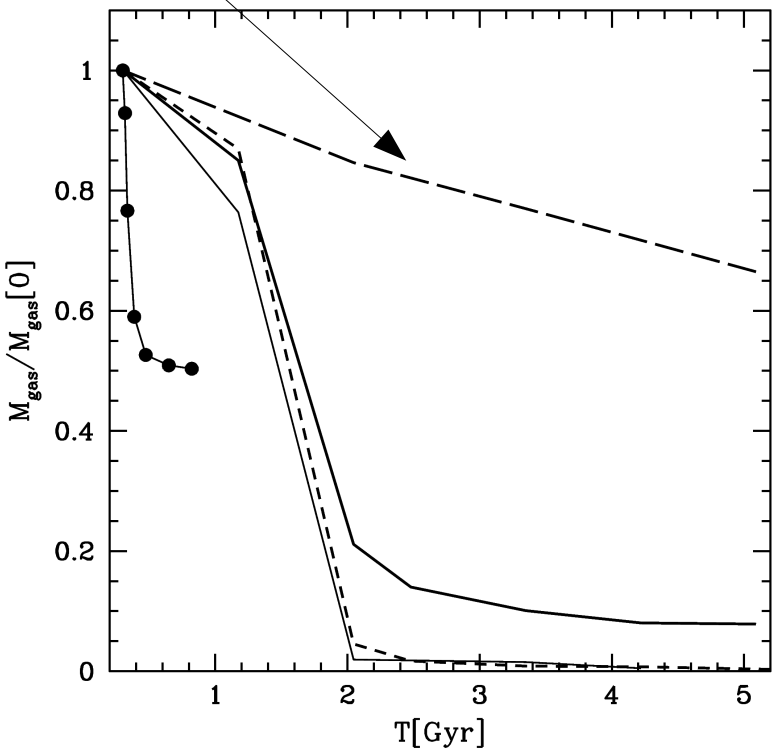
Example of Complete RPS



Tides Alone

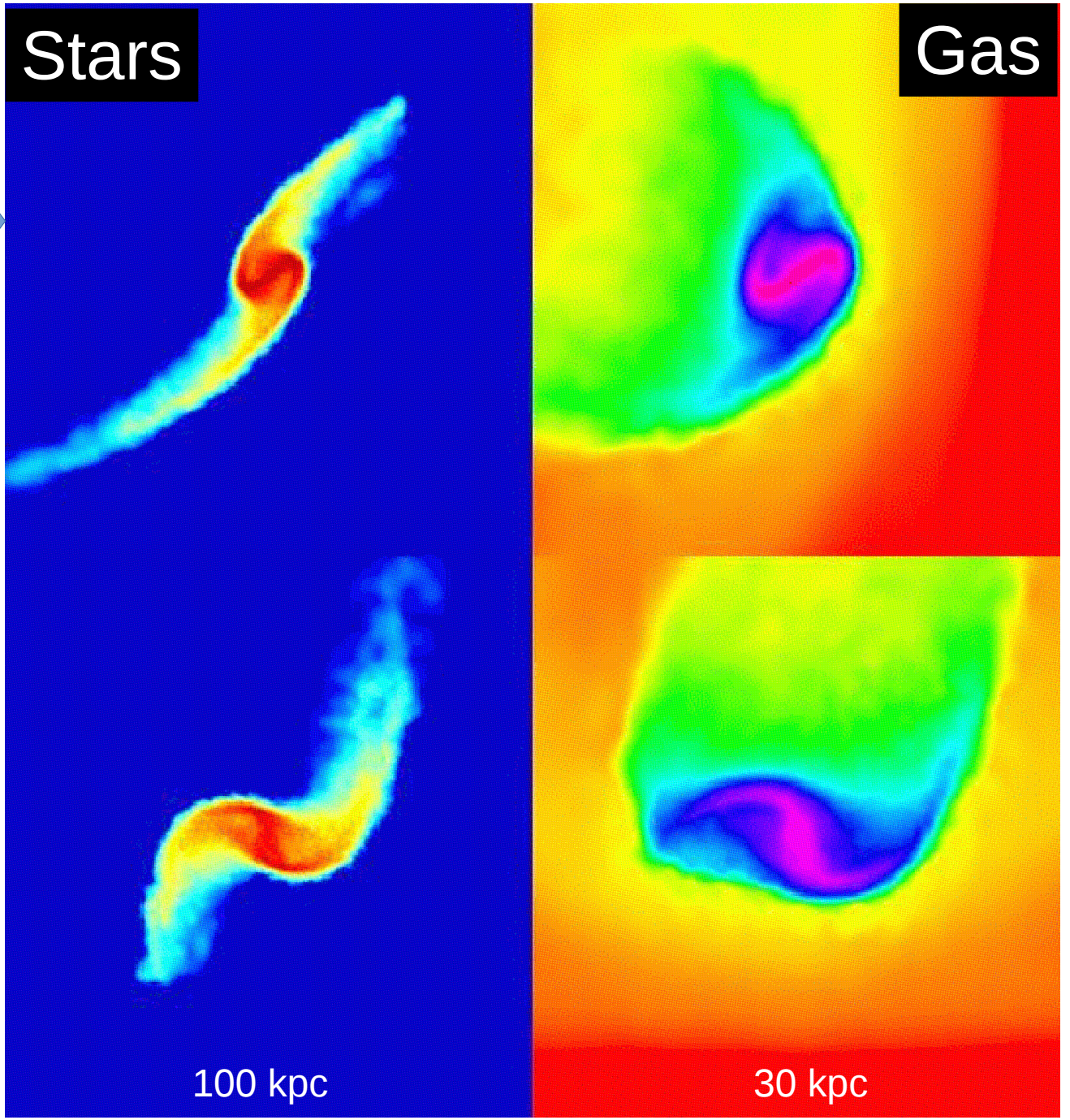
v_peak -= 40 km/s

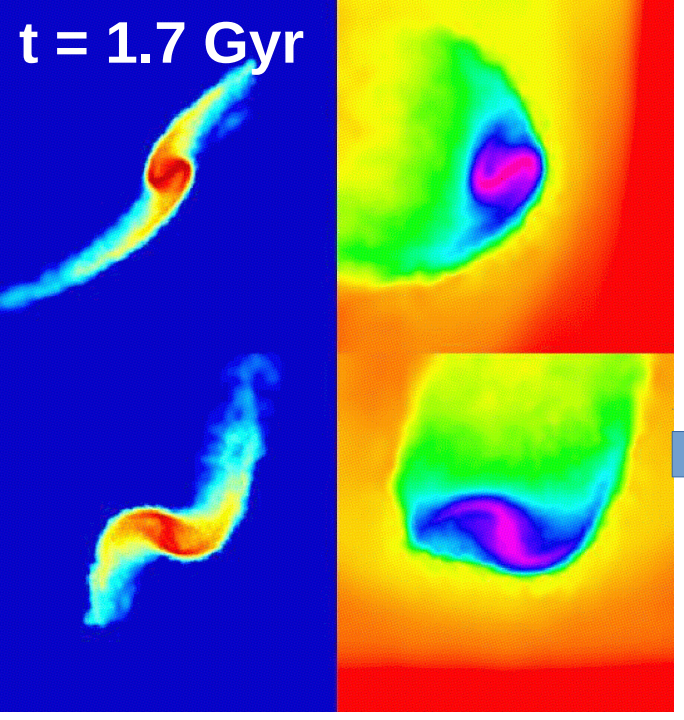




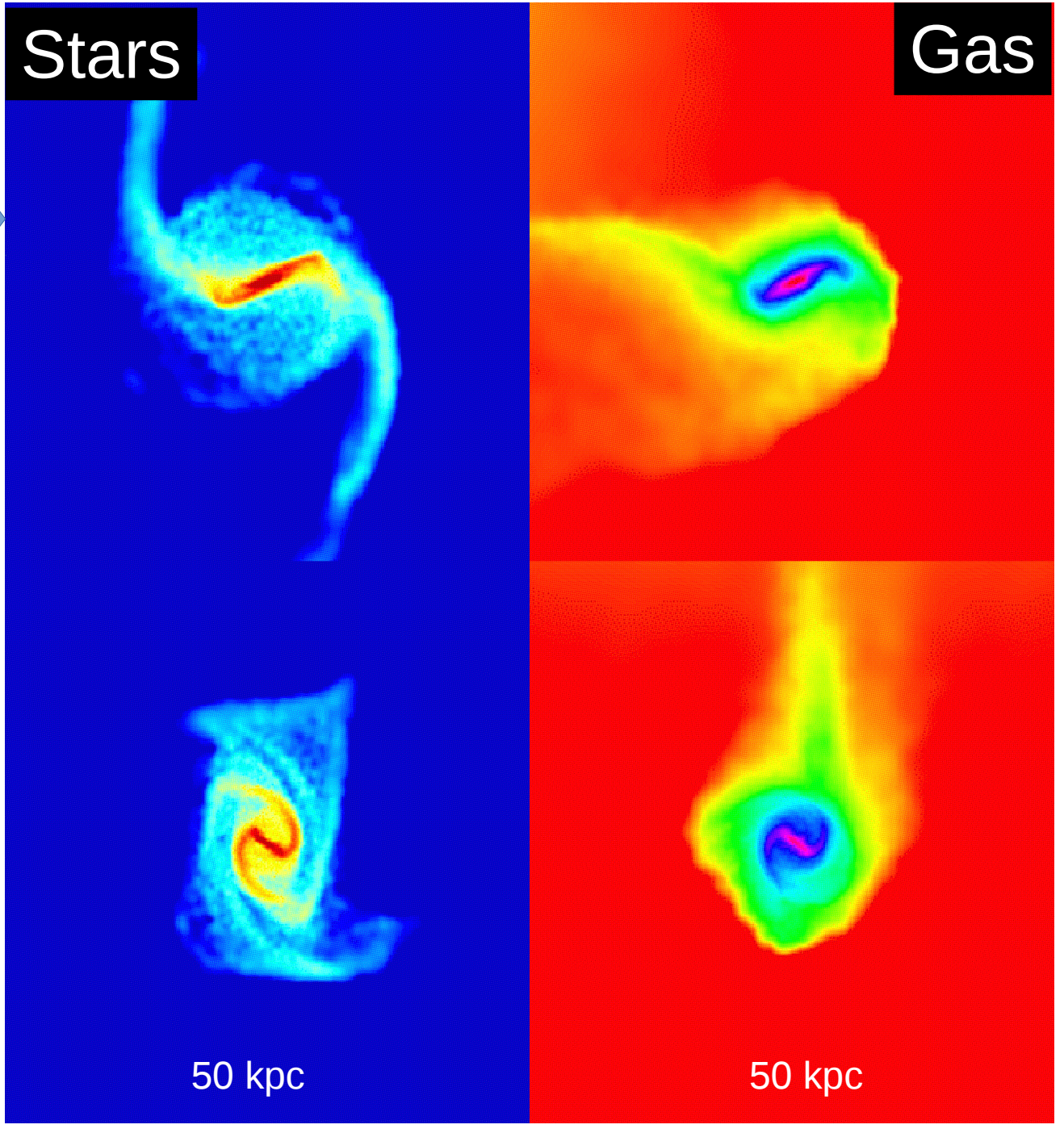
t = 0 Gyr:
- Adiabatic
- Peak Vel ~ 62 km/s
- Concen. c = 4
- Gas Mass = 450 Msun

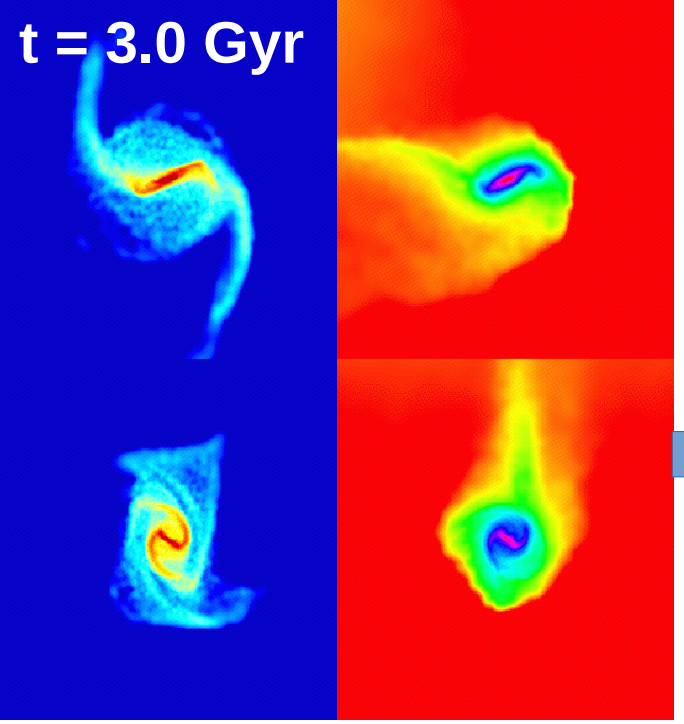
1.7 Gyr after First Pericenter Passage



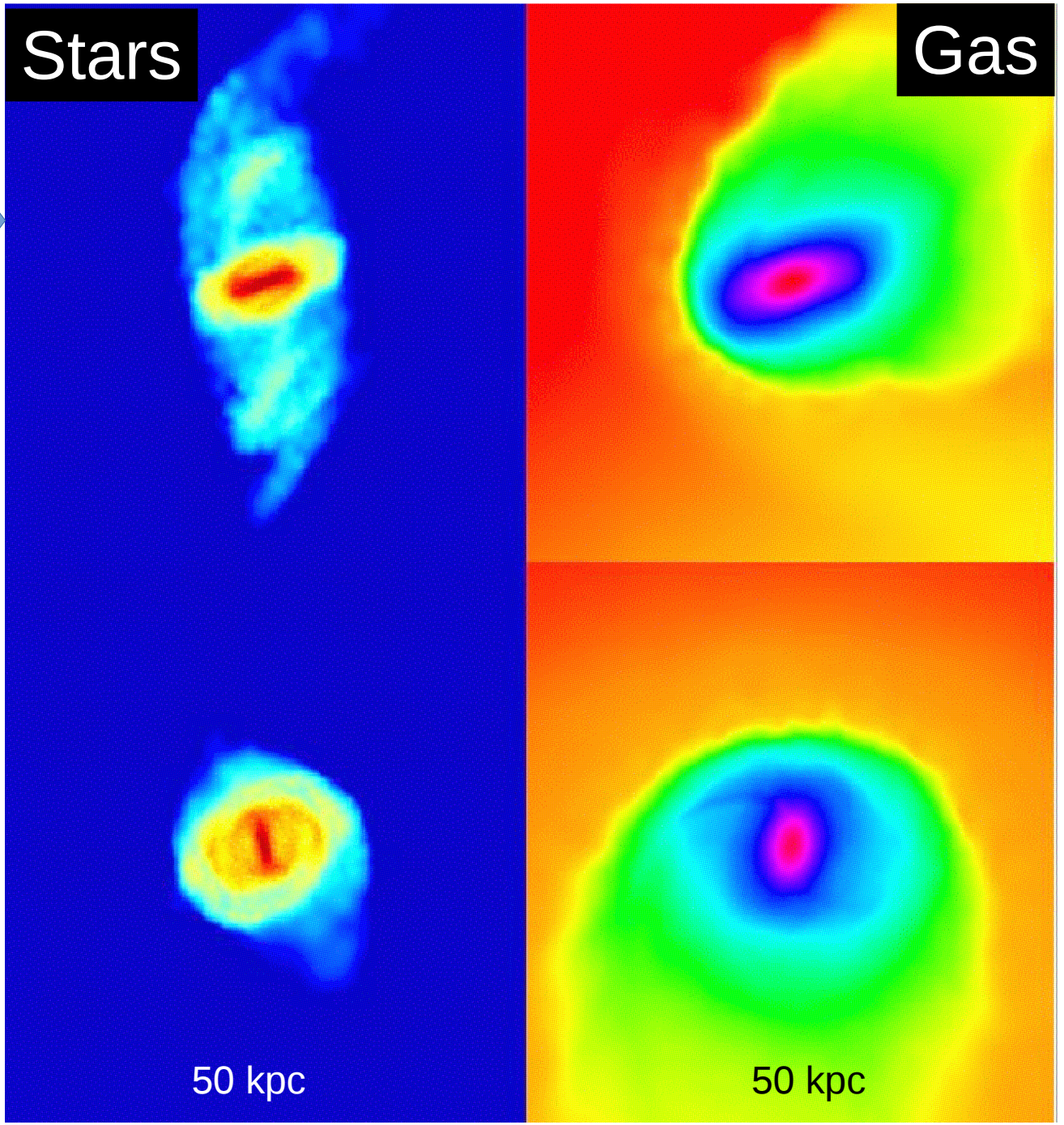


3.0 Gyr after First Pericenter Passage





6.0 Gyr after Second Pericenter Passage



Final Gas Mass:
60 Msun

(450 Msun Initial)

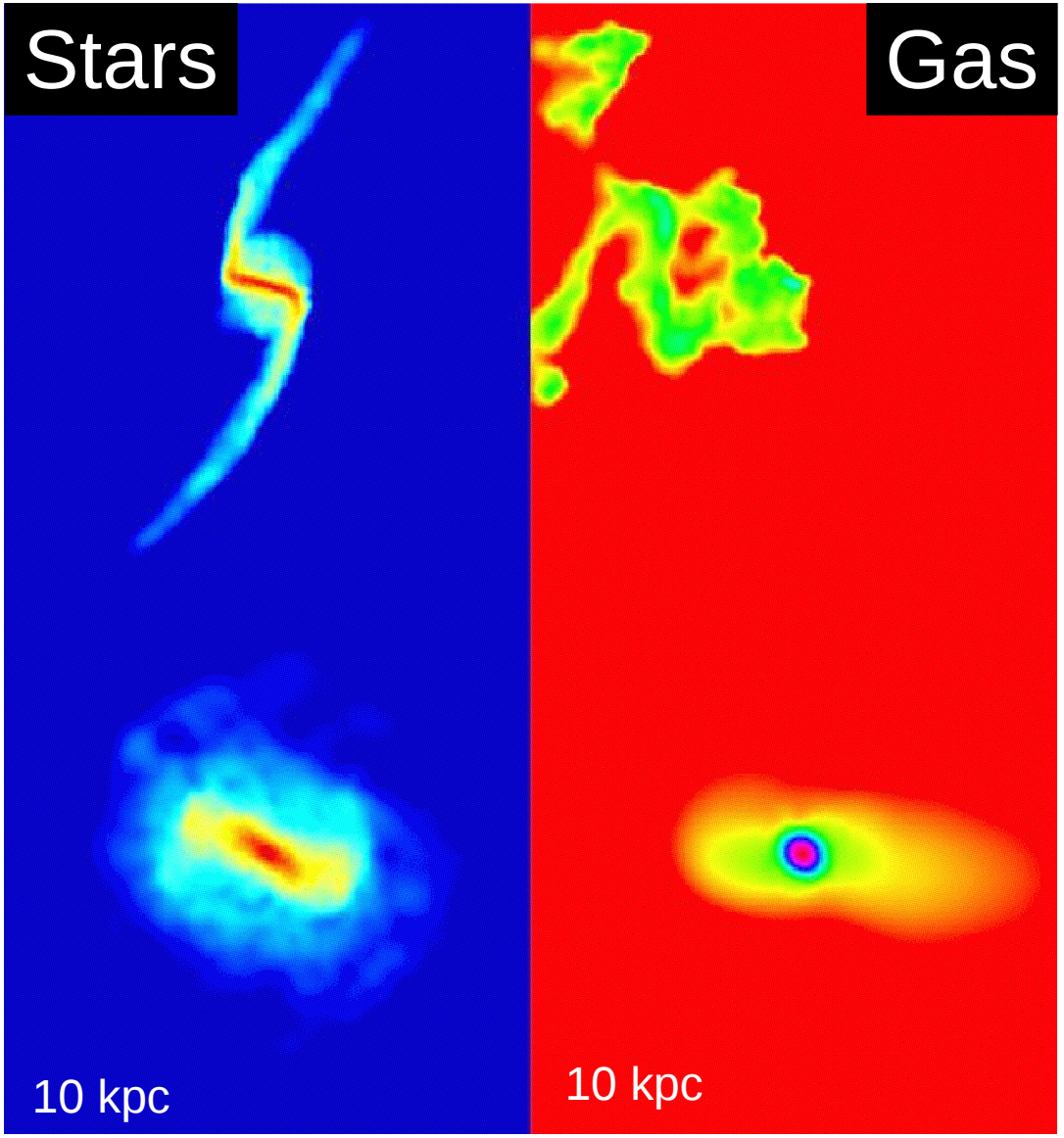
Complete RPS Dwarf + Tidal Effects

After 2nd Pericenter

t = 1.7 Gyr

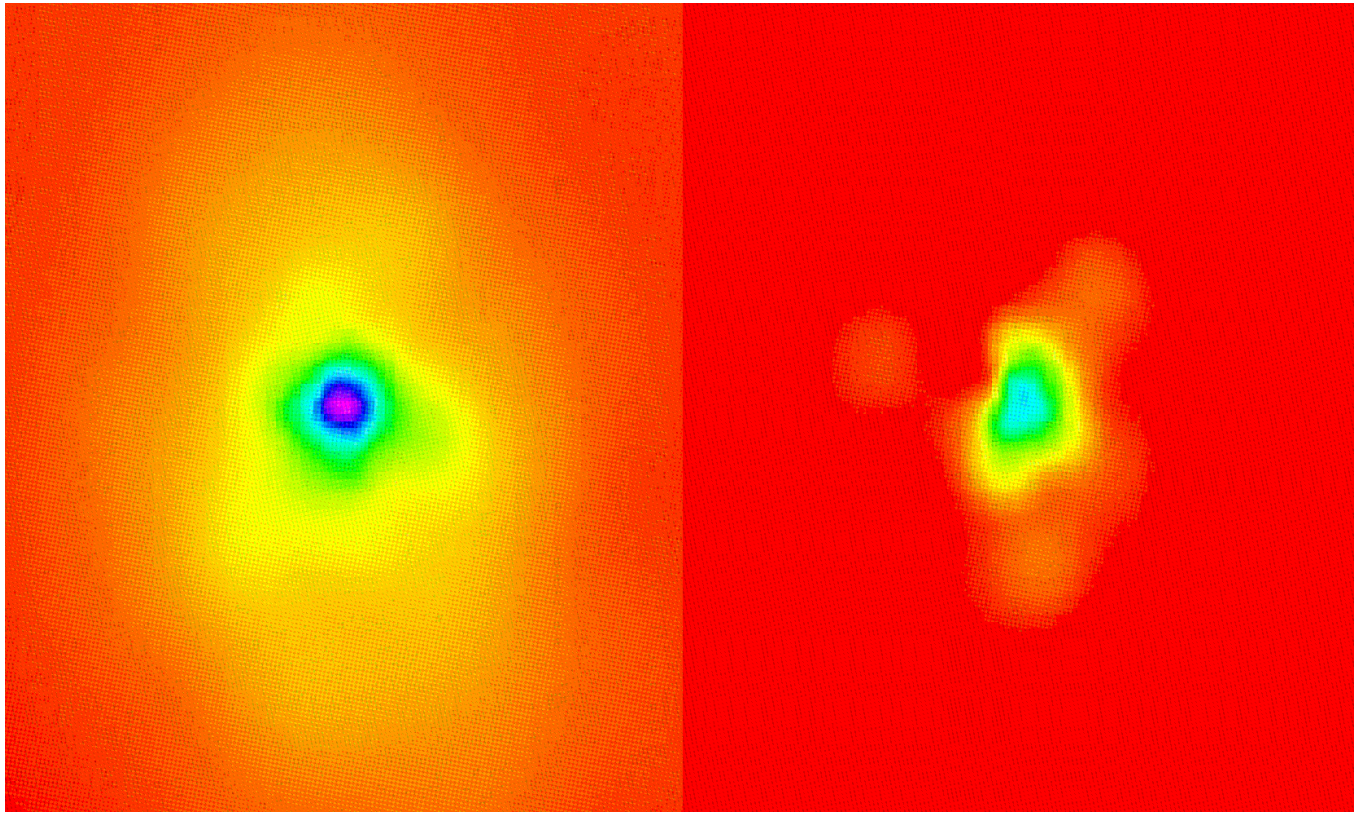
After 2nd Pericenter

t = 6.0 Gyr



RC + Photoionization

RC – No UV **RC – UV Background**



5 Gyr after 3rd pericenter passage

Results Summary

RPS + Tids → 50 – 100% gas mass loss

Greater loss with closer pericenters

UV ionizes gas ($M_{HI} < 0.01$ Mstar)

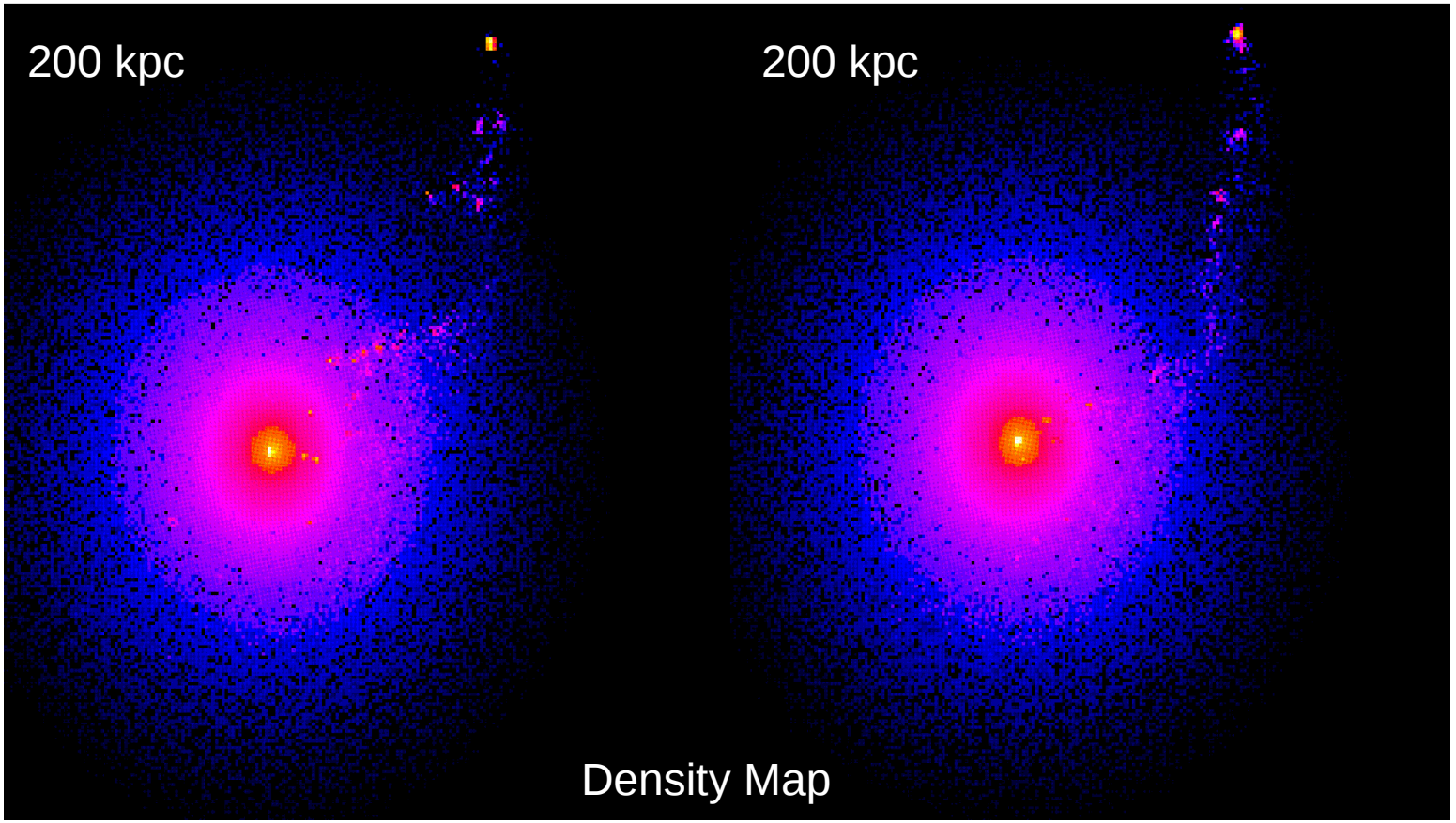
Vpeak < 30 km/s always stripped

Vpeak > 60 km/s always retains gas

- Potential dwarf elliptical progenitors

Fate of Stripped Gas

t = 1.5 Gyr

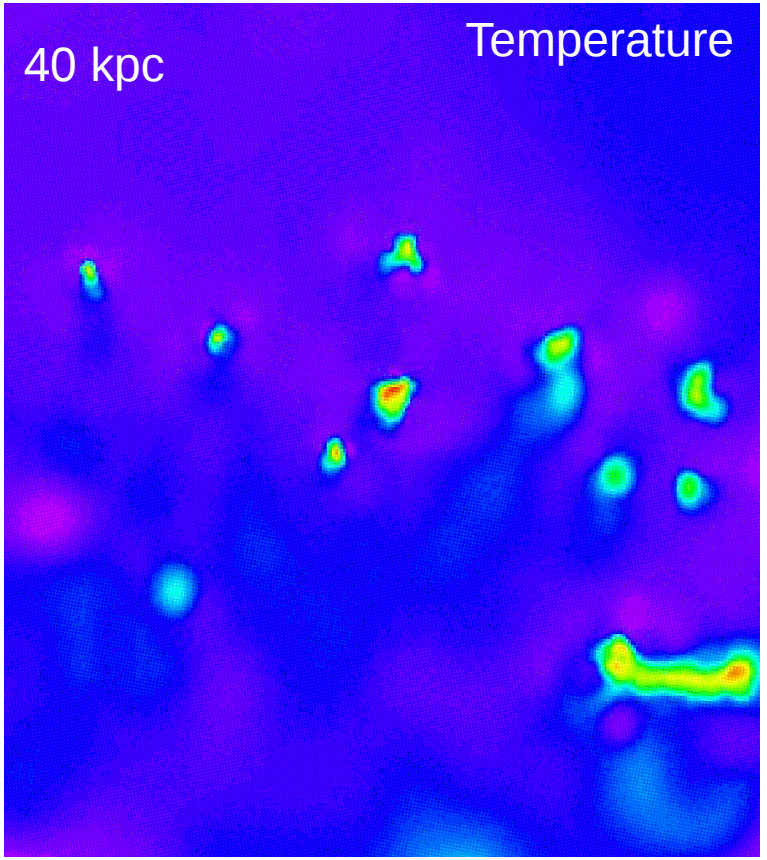


Vpeak = 40 - RC

Vpeak = 40 – RC + UV

Fate of Stripped Gas: Clumps

t = 1.5 Gyr



Vpeak = 40 - RC

Zooming in on
the gas clumps

Conclusions

RPS alone in some small dwarfs

Compressional heating enhances RPS w/o RC

Tides + RPS enhance total stripping

Tidal bar formation limits RPS

Realistic baryon content and M/L

Cloud fragments with RC realistic