Gas density in merging quenched dwarf galaxies

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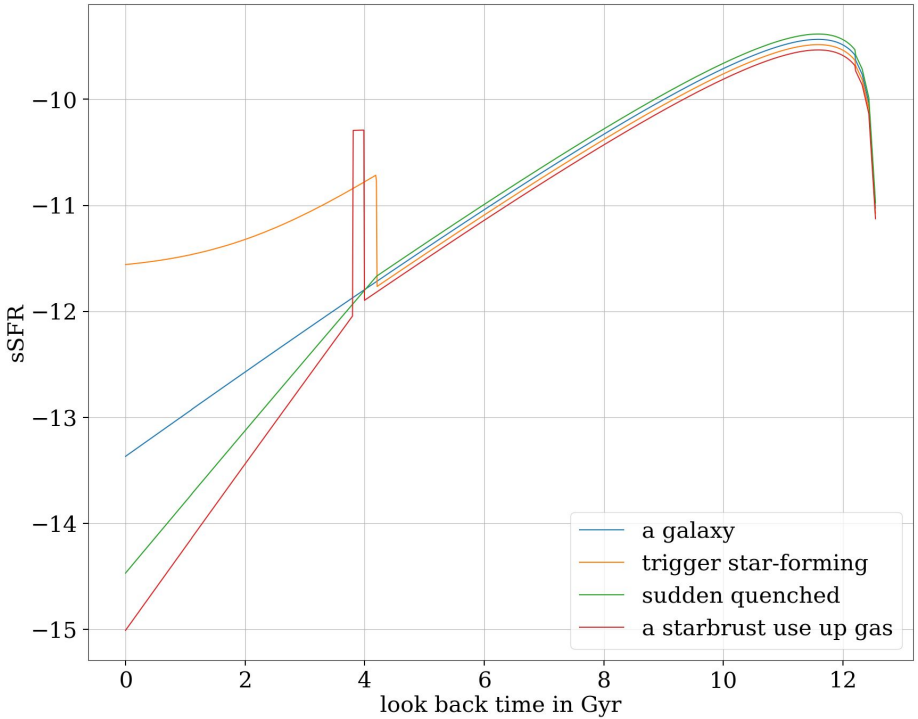
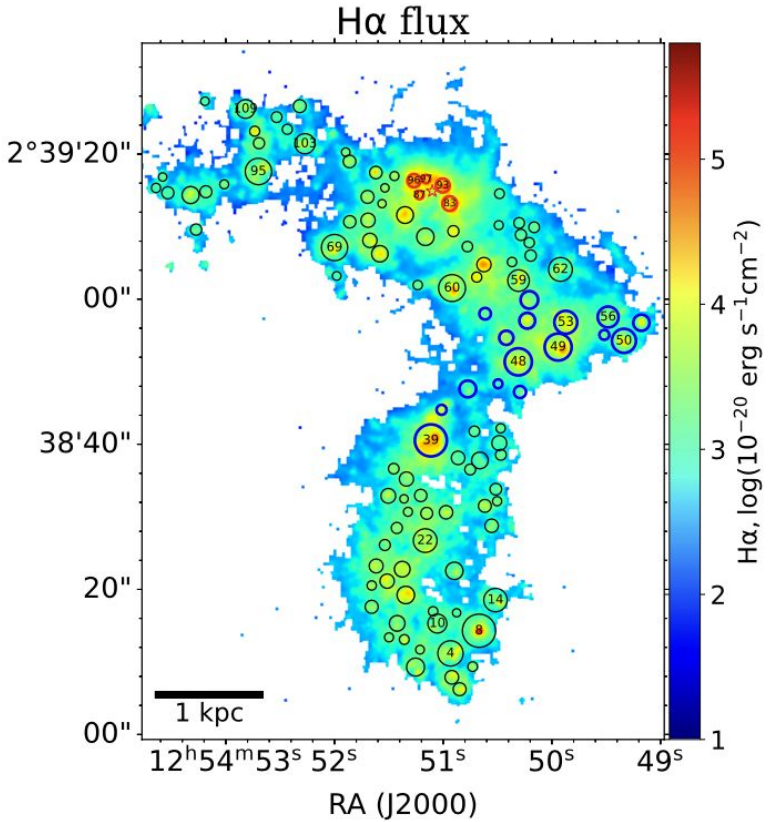
Theoretical background

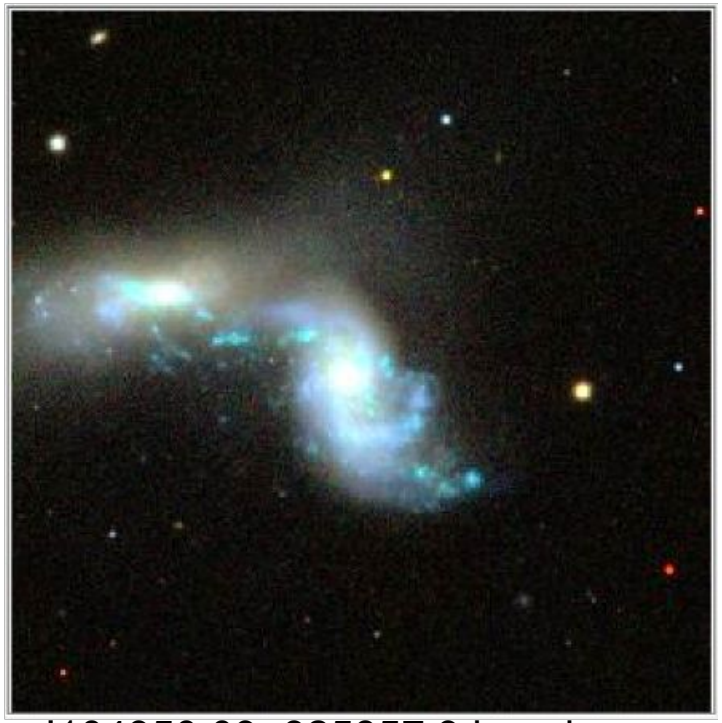
- Merging will trigger star-forming
  - There are observed starburst activities at the interaction areas(Gao et al. 2023)
  - **Minor mergers** are likely to be a major driver for sf (Rathore et al. 2023)
  - There is enough molecular gas present in close pairs to fuel the starburst (Reeves & Hudson 2024)
- Merging can not trigger but stop star-formation
  - Galaxy mergers is identified as potent mechanisms for quenching of star-formation.(Croton et al. 2006; Gabor et al. 2010; Bluck et al. 2020).
  - galaxy mergers, including those that involve gas-rich and nearly equal-mass galaxies, exert a minimal impact on their SFR, specific SFR, or star formation efficiency.(Li et al. 2023)
- Mix
  - Mergers have little effect on SFR, but can induce starbursts (Pearson et al. 219)

What we might observe

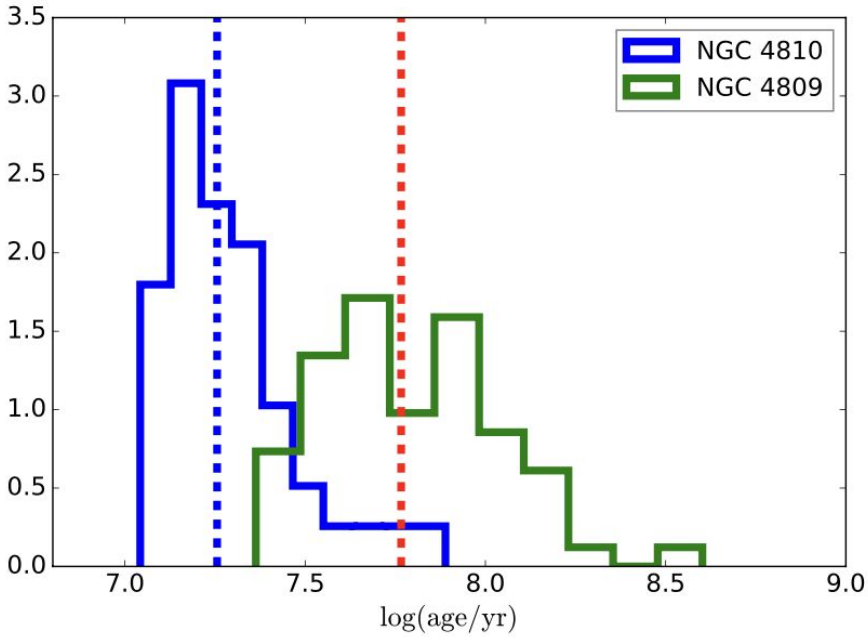




(Gao et al. 2023)



J104950.09+325857.9 by sdss



(Gao et al. 2023)

The key: gas

- The decrease in SFR is due to the consumption of molecular gas by the starburst. (Baron et al. 2023)
- There is enough molecular gas present in close pairs to fuel the starburst (Reeves & Hudson 2024)
- Stars are born from gas (Common Sense)
- **Minor merger**s are likely to be a major driver for star-forming through bring gas (Rathore et al. 2023)
- Galaxies may still be quenched if they have plenty of cold gas but do not form star efficiently. (Luo et al. 2020)

Conclusion poem

- Gas, gas, gas, without you no stars can be formed.
- Merging brings gas fuel stars to born.
- Using up the last gas this pair owned.
- Formation stops as gas gone.
- That is the starburst we called.
-
- After the merging, little gas remained, the merger goes into its good night.
- Sigh, sigh for the dying of the light.

NGC 4038/4039 by HST

Methodology

- Set up of galaxy particles:
  - Galactics for stars/dark matter particles (only occupying bulge, to create dwarf galaxy shape)
    - Make two galaxies and add them into one
  - Molecular_cloud code for gas particles

- Hydrodynamical code (fi) for gas
- Barnes-Hut tree (bh-tree) for stars/dark matter, gravitational background

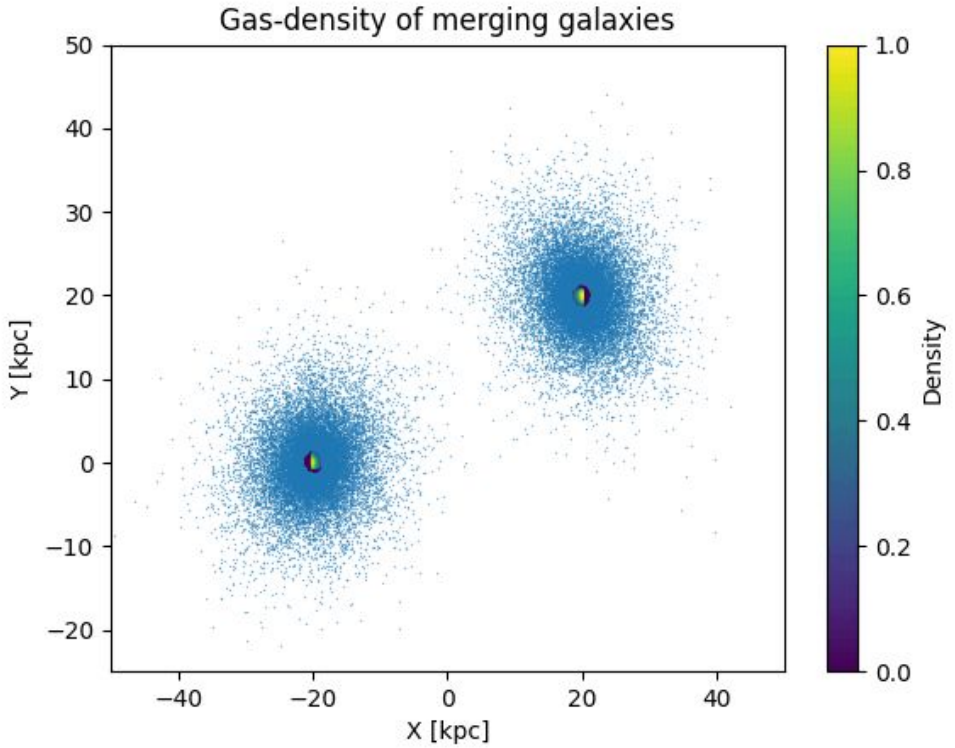
- Bridge between hydrodynamical with gravitational code

Initial conditions

- Number of particles
  - 10.000 gas particles
  - 20.000 stars
- Masses
  - Gas: 10^8 solar masses
  - Stars: 10^9 solar masses
- Sizes
  - Gas cloud: 3 kpc
  - Galaxies: 3 kpc
- Position/Distance
  - Initial distance ~45 kpc → close enough for merger to occur without initial velocity
- Velocity
  - Parameter that we varied to simulate both major and minor merger
- Timescale
  - 3000 Myr

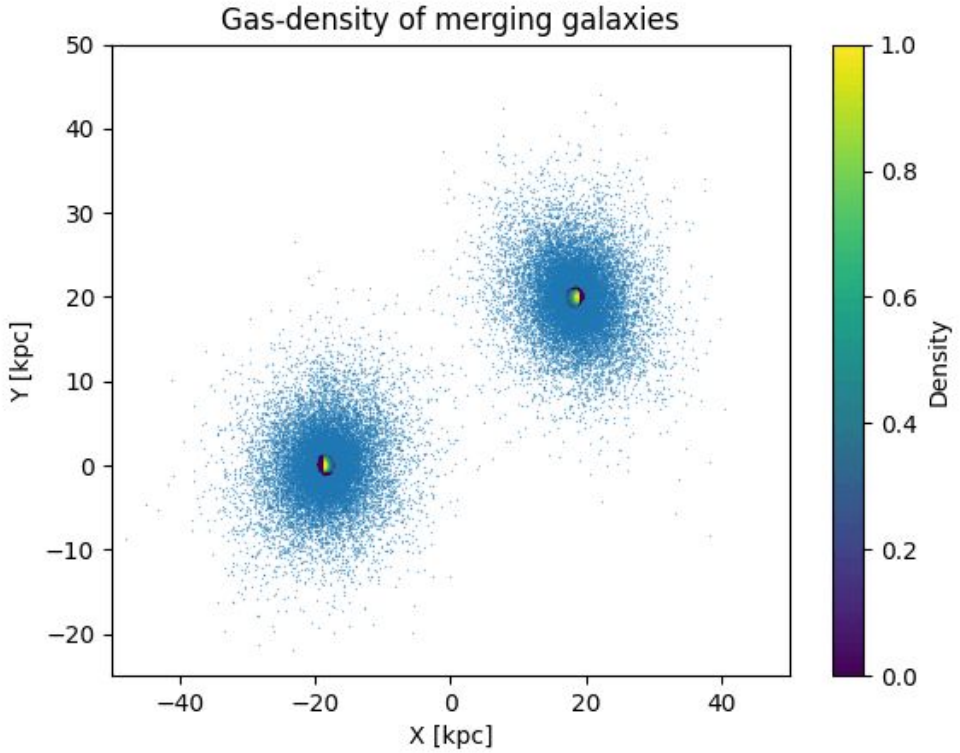
Results

- Initial velocity 0 km s^{-1}
- Major merger
- First pass at ≅700 Myr
- Merger at ≅900 Myr
- Mixing and slowly expanding until 3000 Myr



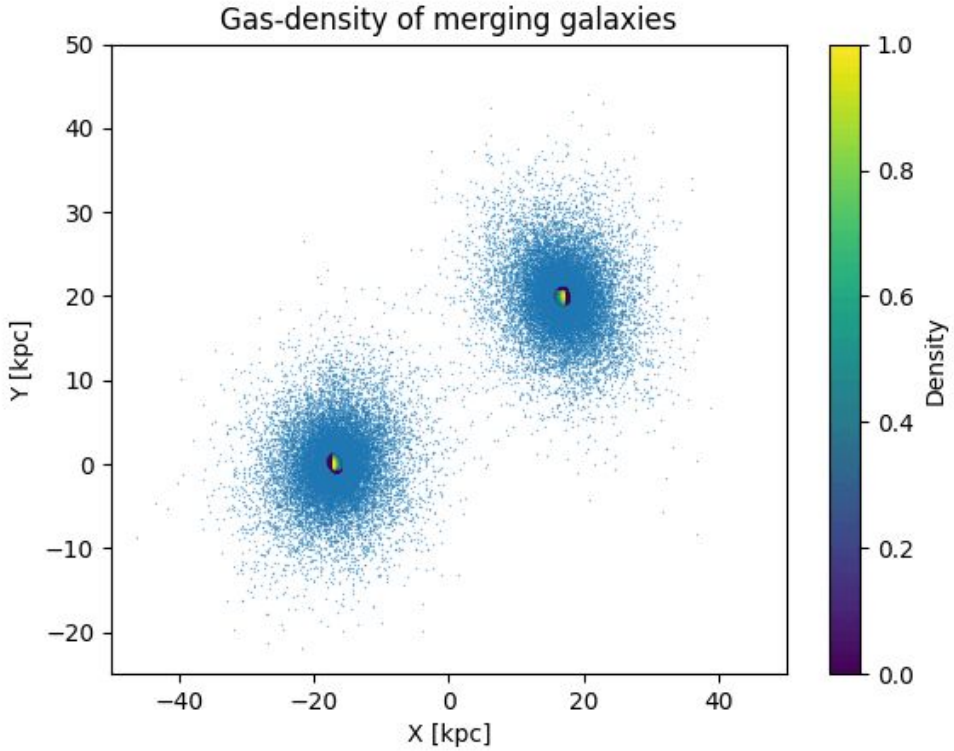
Results

- Initial velocity 30 km s^{-1}
- Major merger
- Merger at ≅700 Myr



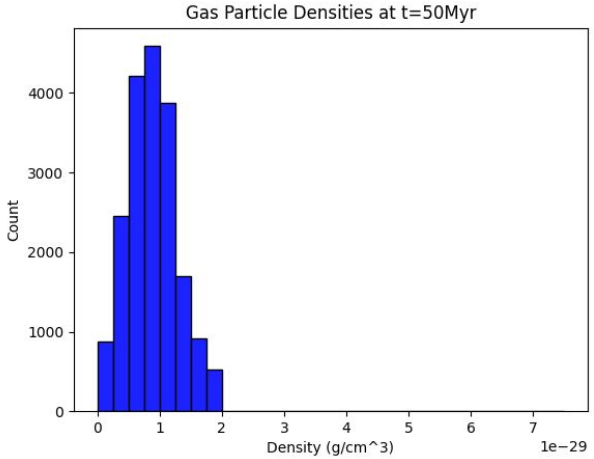
Results

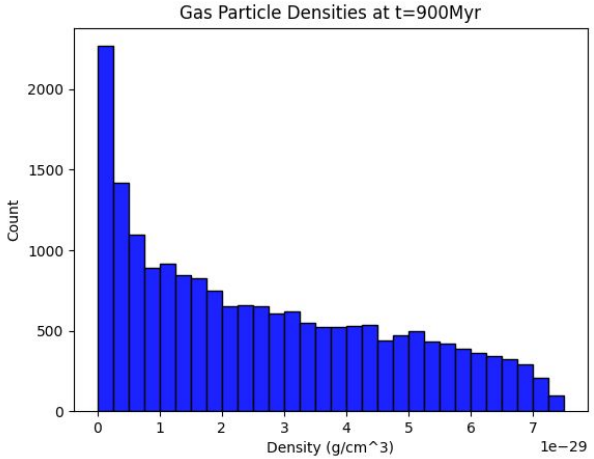
- Initial velocity 60 km s^{-1}
- Minor merger
- Graze at ≅300 Myr

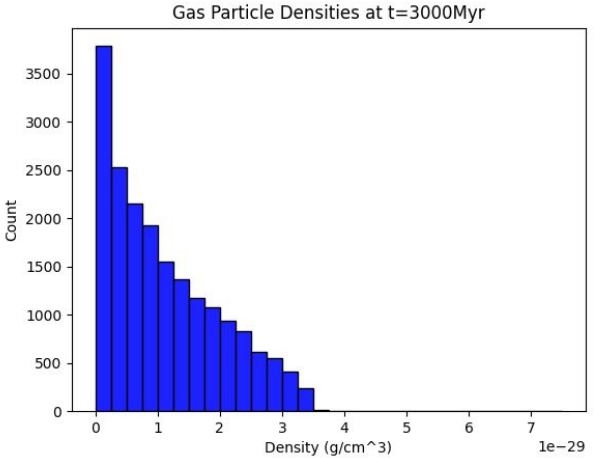


Gas density: Major merger - frontal

Densities required for star formation ~ $10^{-19}\ g/cm^3$ (Mo, van den Bosch, White, 2010)



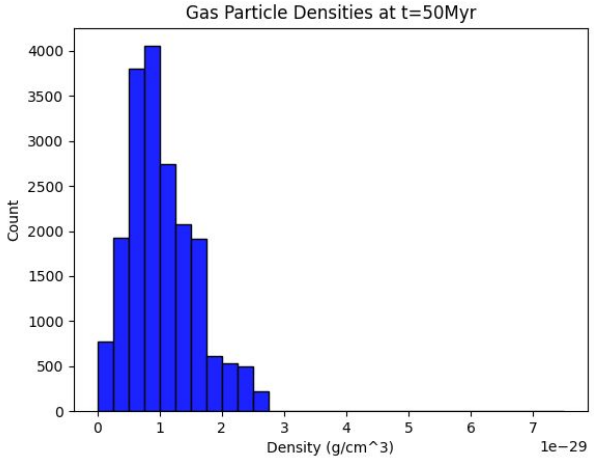


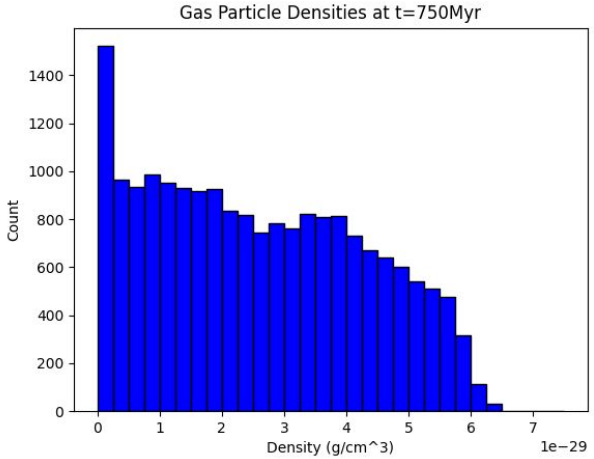


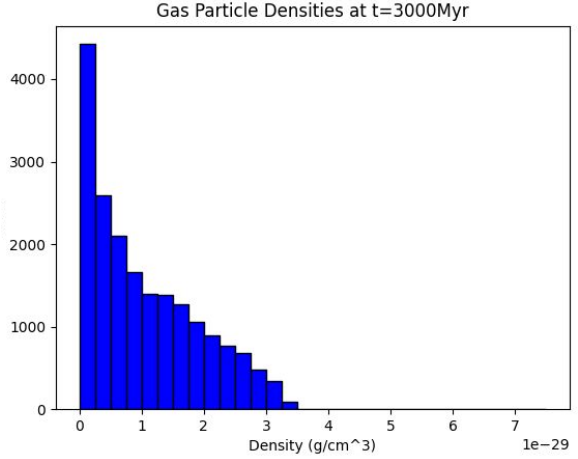
→ Densities increase short-term

Gas density: Major merger - with rotation

Densities required for star formation ~ $10^{-19}\ g/cm^3$ (Mo, van den Bosch, White, 2010)



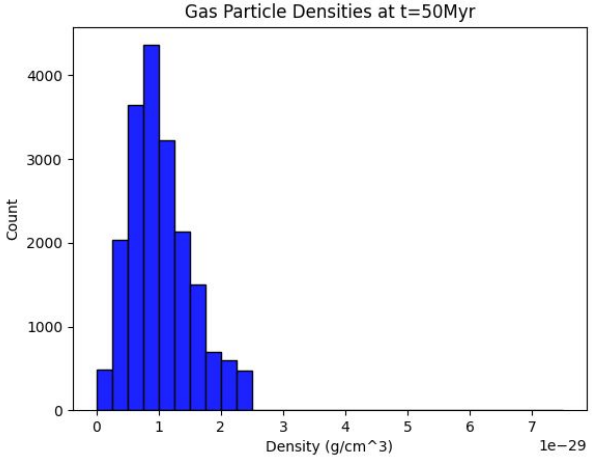


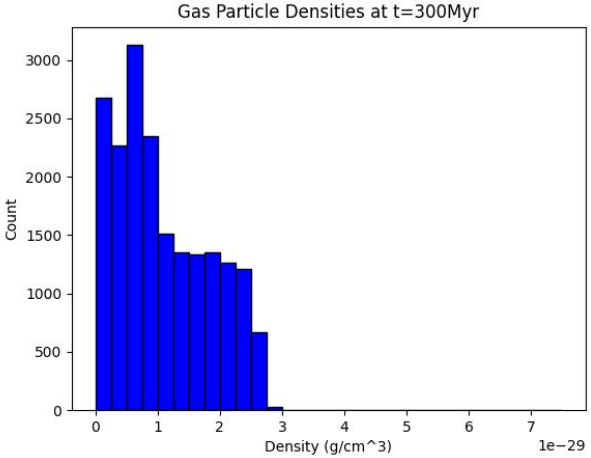


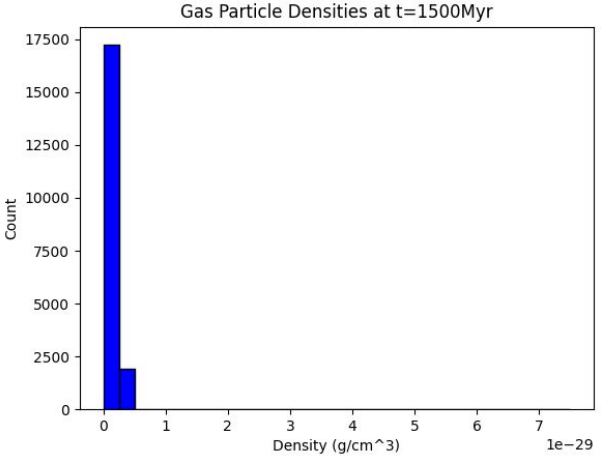
→ Densities increase short-term

Gas density histograms: Minor merger

Densities required for star formation ~ $10^{-19}\ g/cm^3$ (Mo, van den Bosch, White, 2010)







→ Densities become much much lower due to galaxies grazing each other

Conclusion

- Densities of major mergers actually become about as low after merger than before merger
  - The newly formed galaxy is just as quenched than the initial two

- Minor merger strips galaxies of gas

- At the time of the merger the densities are highest, but with our resolution not high enough for star formation or a short term starburst

Outlook:

- More resolution might yield better results, as local over-densities and perturbations in the central gas region could be resolved

Questions?

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