



STScI | SPACE TELESCOPE
SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

Exploring the Galactic Metal Budget with FOGGIE

Kathleen Hamilton-Campos

Mentor: Dr. Raymond Simons

Co-mentor: Dr. Molly Peeples

Maryland Space Grant Consortium

Student Research Symposium

Saturday, July 27, 2019



Undergraduate research - particularly in particle astrophysics - has been a theme in my education.



HOWARD
COMMUNITY COLLEGE

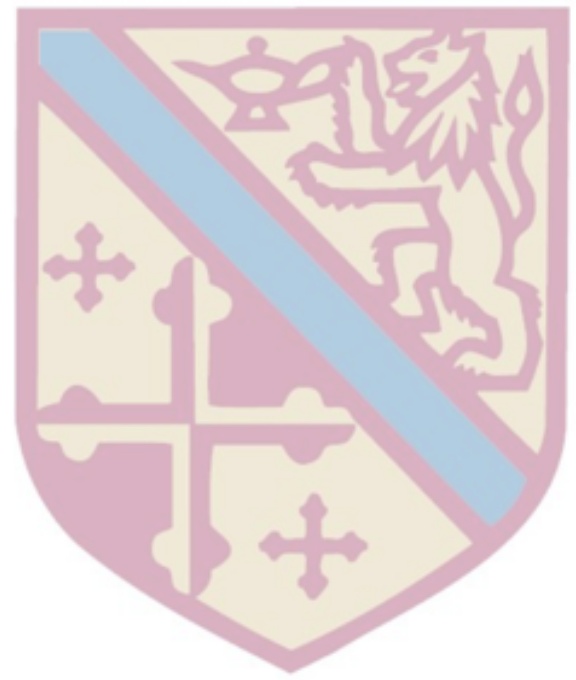
Howard Community College



Howard Community College



Undergraduate research - particularly in particle astrophysics - has been a theme in my education.



HOWARD
COMMUNITY COLLEGE

Howard Community College



Howard Community College



University of Maryland College Park



FIRE: THE FIRST-YEAR
INNOVATION & RESEARCH
EXPERIENCE

CAPITAL ONE MACHINE LEARNING

K. Hamilton-Campos: "Exploring the Galactic Metal Budget with FOGGIE"

University of Maryland College Park



FIRE: THE FIRST-YEAR
INNOVATION & RESEARCH
EXPERIENCE

SIMULATING PARTICLE DETECTION

University of Maryland College Park

STScI | SPACE TELESCOPE
SCIENCE INSTITUTE



Undergraduate research - particularly in particle astrophysics - has been a theme in my education.



HOWARD
COMMUNITY COLLEGE

Howard Community College



Howard Community College



University of Maryland College Park



Advanced Accelerator Concepts Workshop

TREND
REU

TREND REU



FIRE: THE FIRST-YEAR
INNOVATION & RESEARCH
EXPERIENCE

CAPITAL ONE MACHINE LEARNING

K. Hamilton-Campos: "Exploring the Galactic Metal Budget with FOGGIE"

University of Maryland College Park



FIRE: THE FIRST-YEAR
INNOVATION & RESEARCH
EXPERIENCE

SIMULATING PARTICLE DETECTION

University of Maryland College Park

STScI | SPACE TELESCOPE
SCIENCE INSTITUTE



The FOGGIE collaboration analyzes galaxy evolution via an unprecedented high resolution simulation.



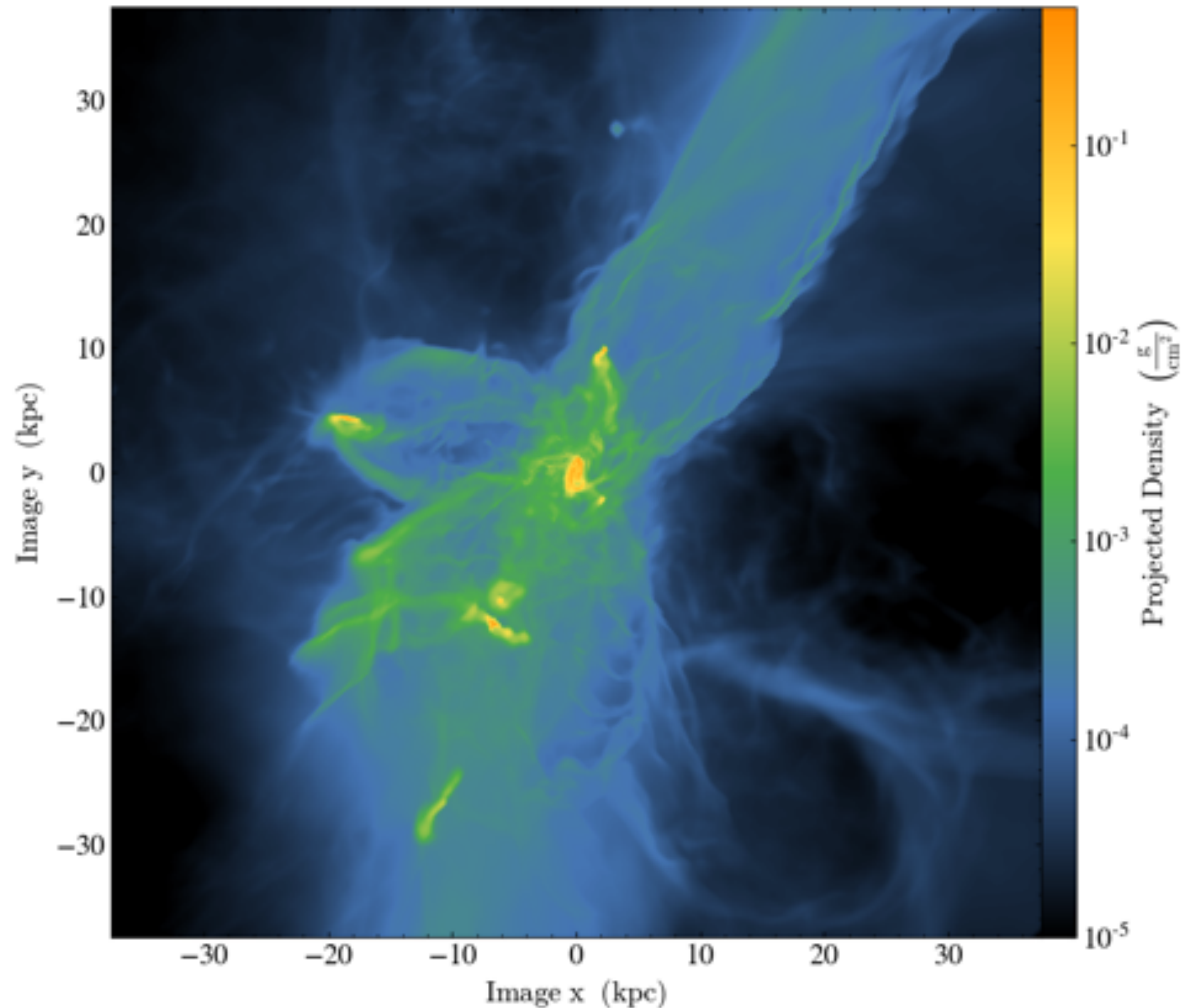
Space Telescope Science Institute



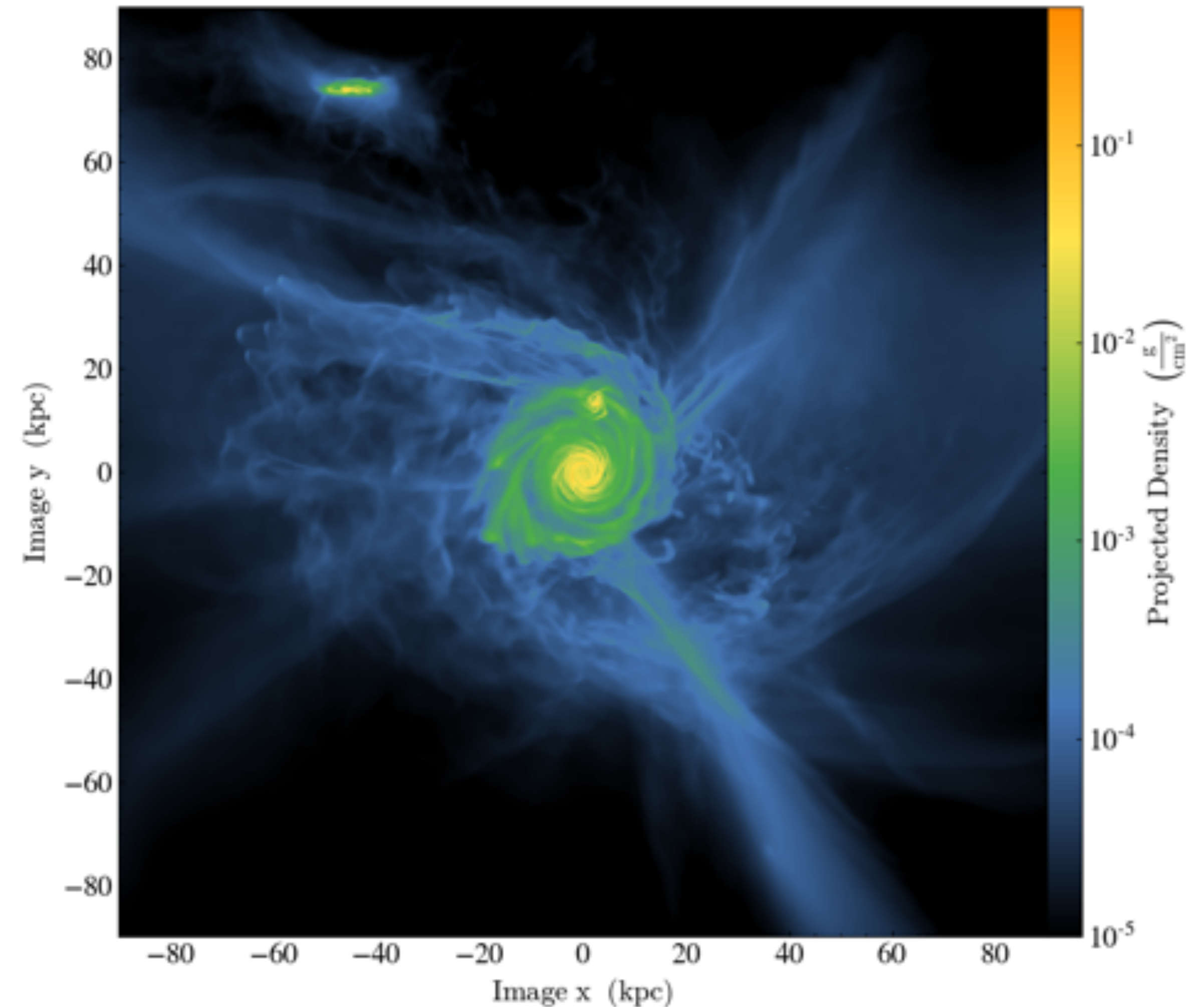


As gas extends outward from the heart of galaxies, it becomes more tenuous - so where do galaxies end?

$z = 1.67$



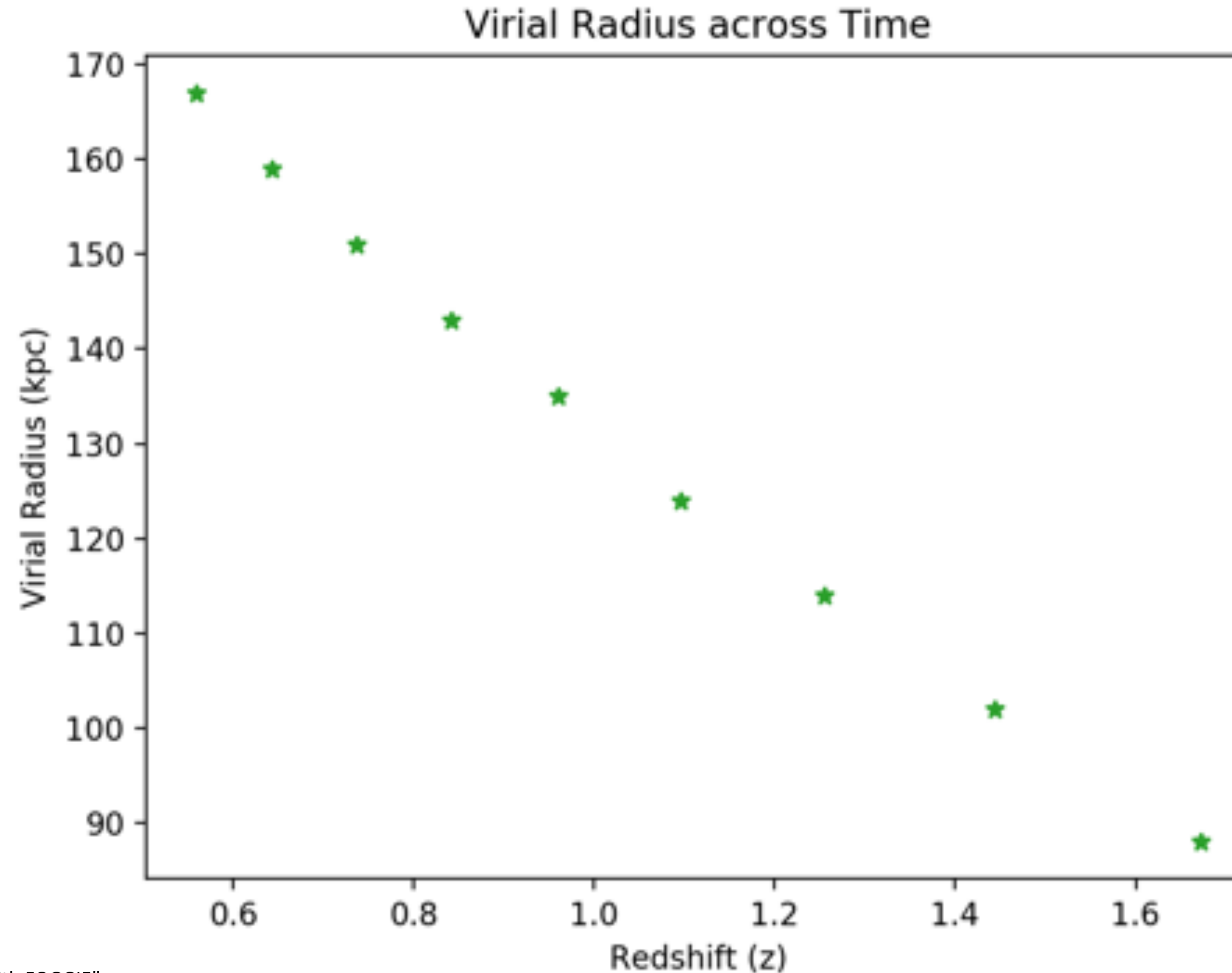
$z = 0.56$





Defining a “galactic barrier” is difficult, but a commonly-accepted outer limit is the virial radius.

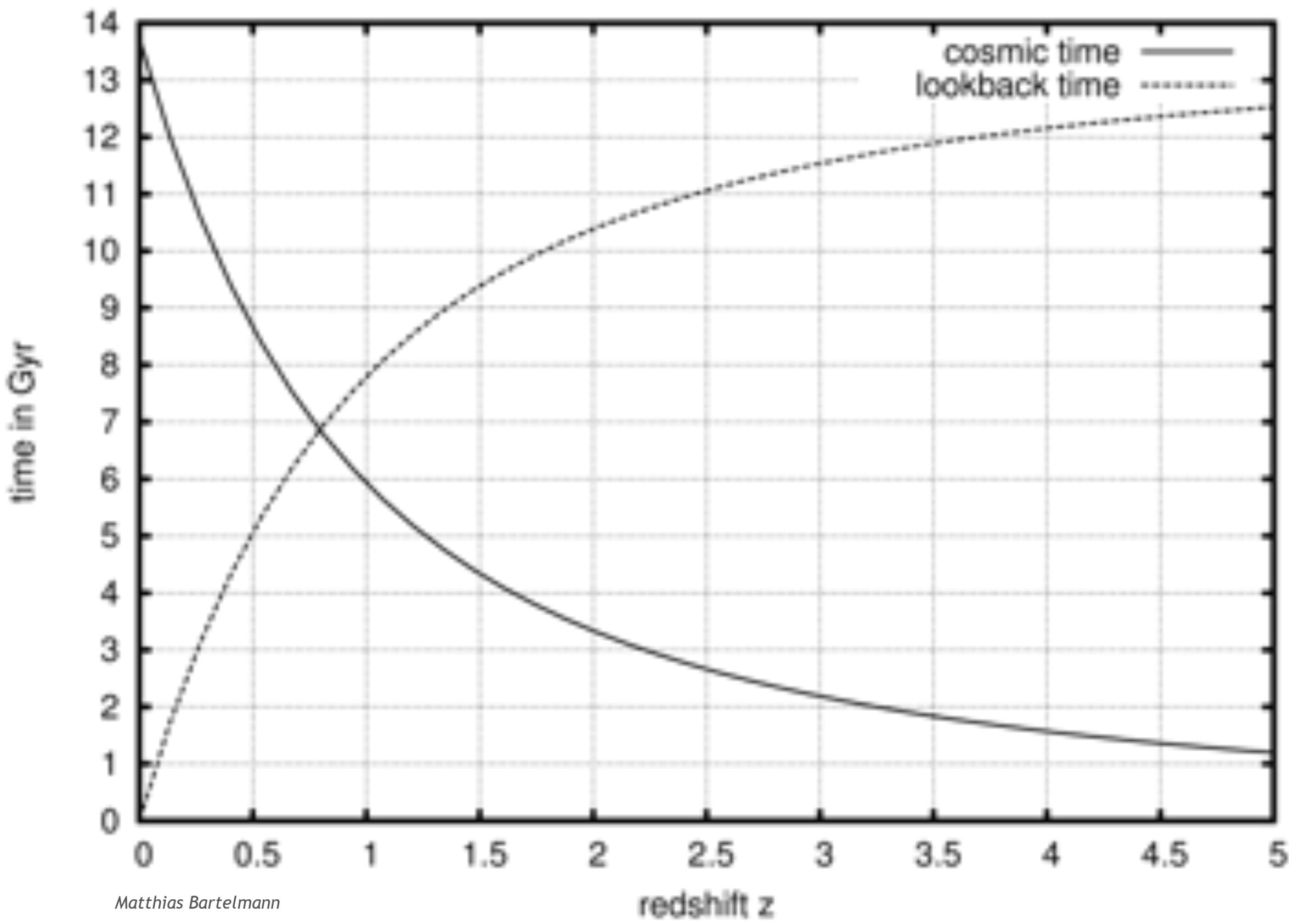
$$\rho_{encl} = 200 * \rho_{crit}$$



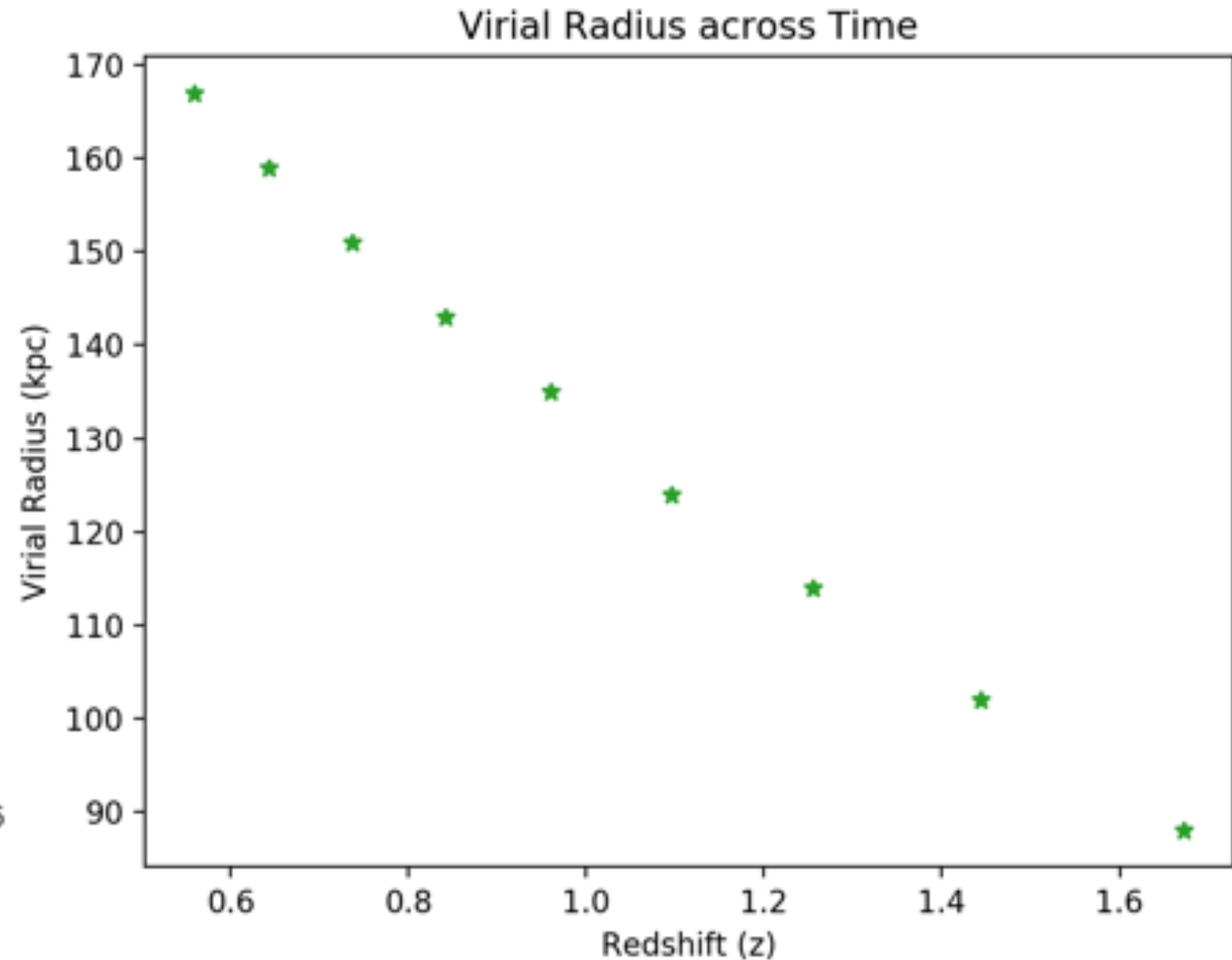


Defining a “galactic barrier” is difficult, but a commonly-accepted outer limit is the virial radius.

$$\rho_{encl} = 200 * \rho_{crit}$$

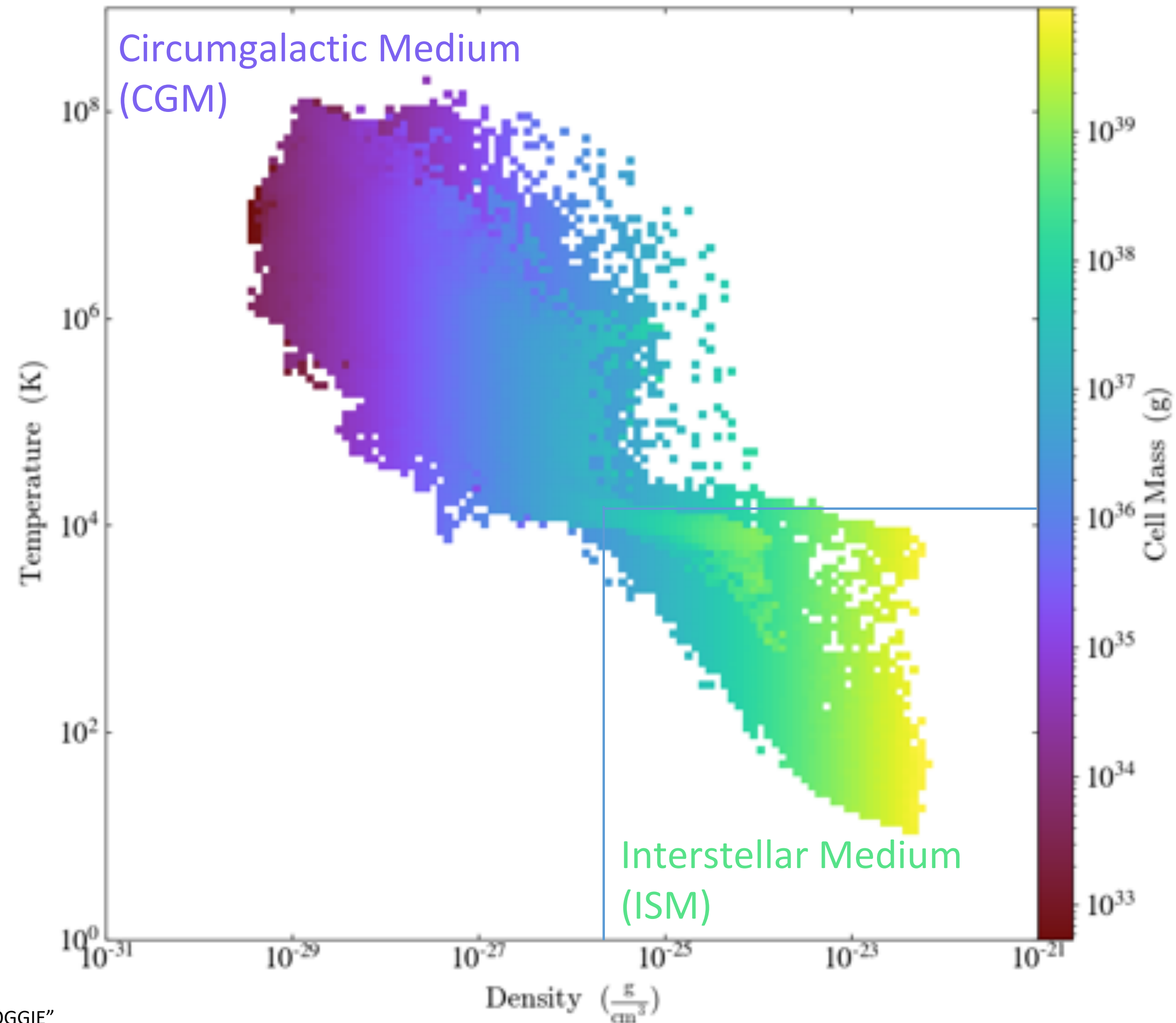


Matthias Bartelmann



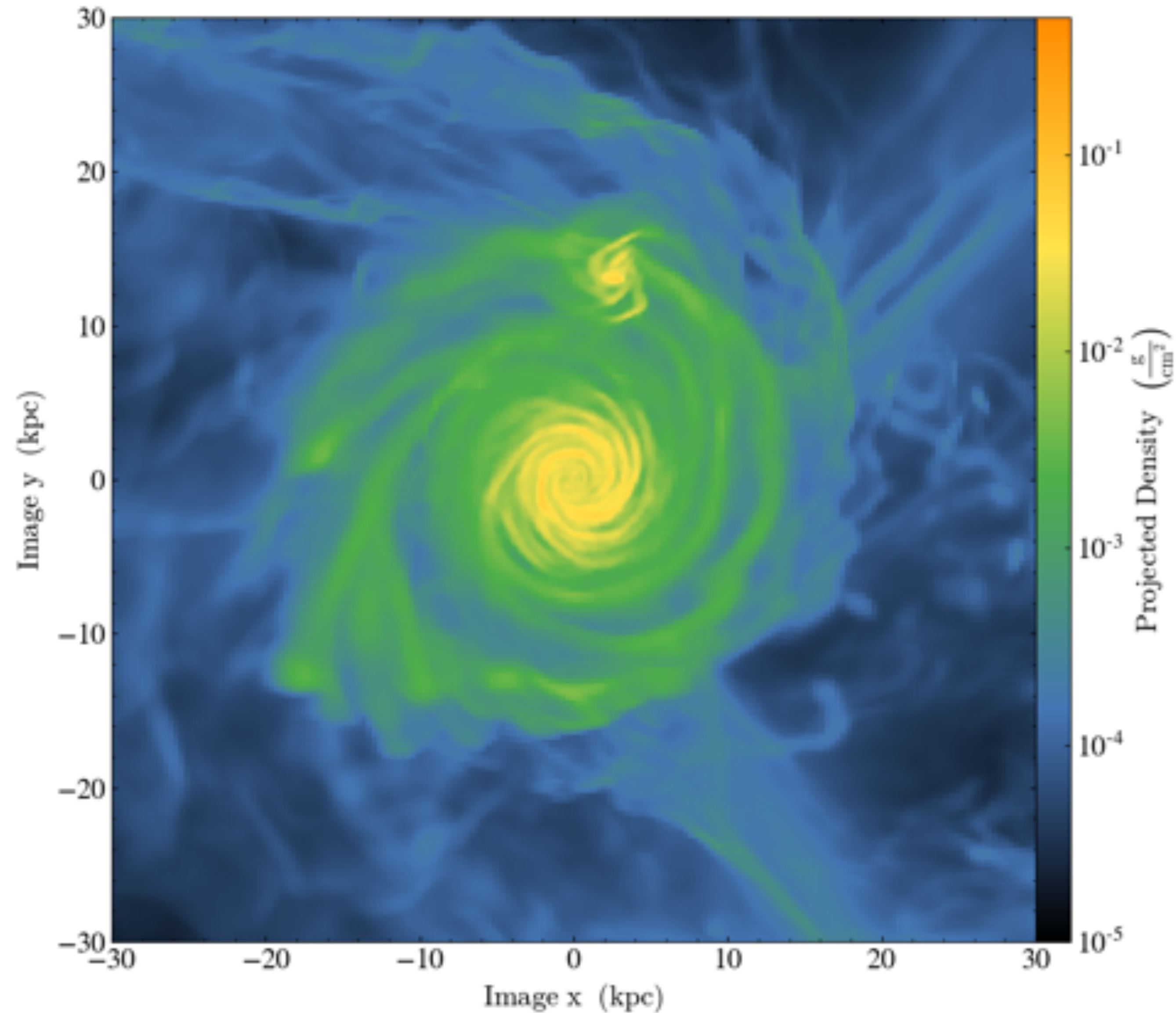
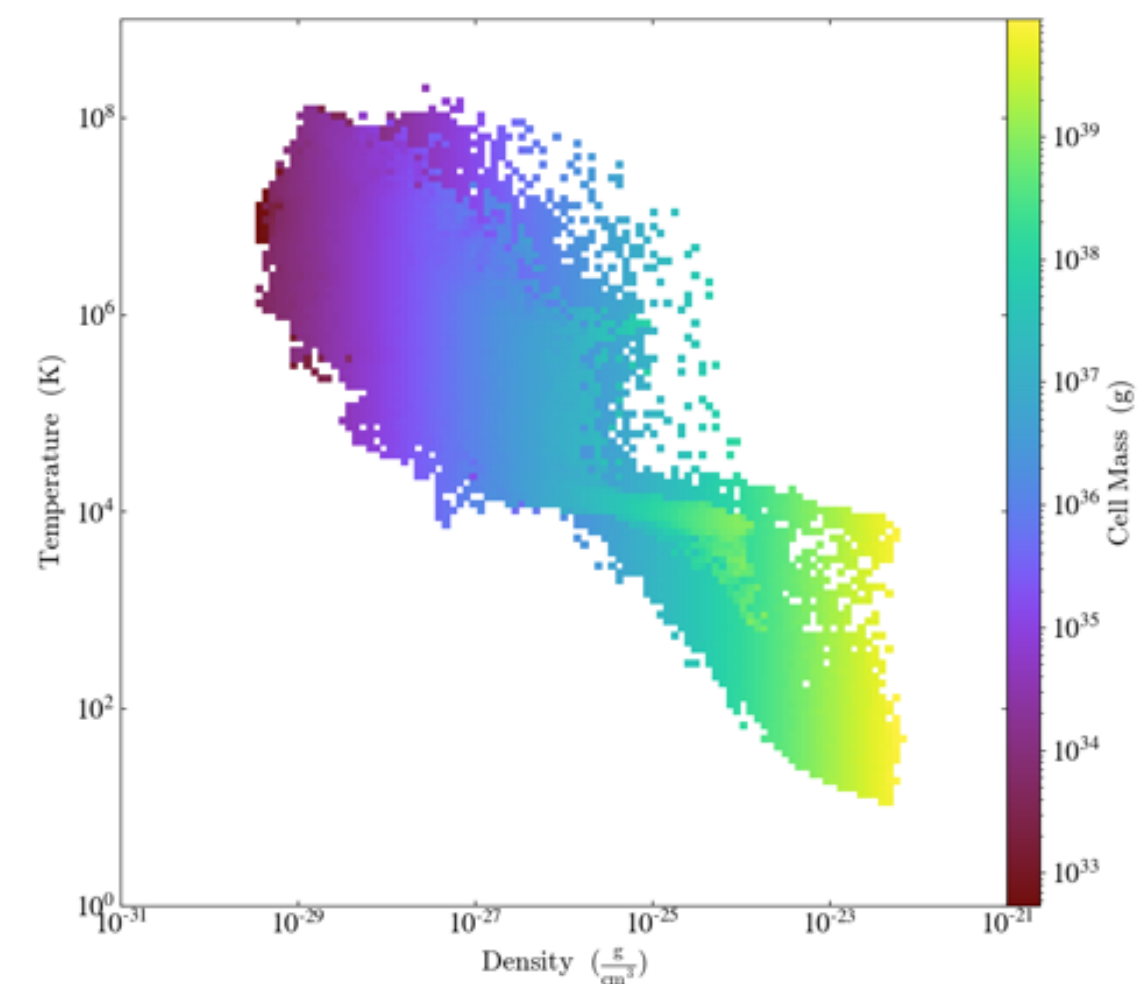


Galaxies consist of gas at a range of temperatures and densities, which can be separated into regions.



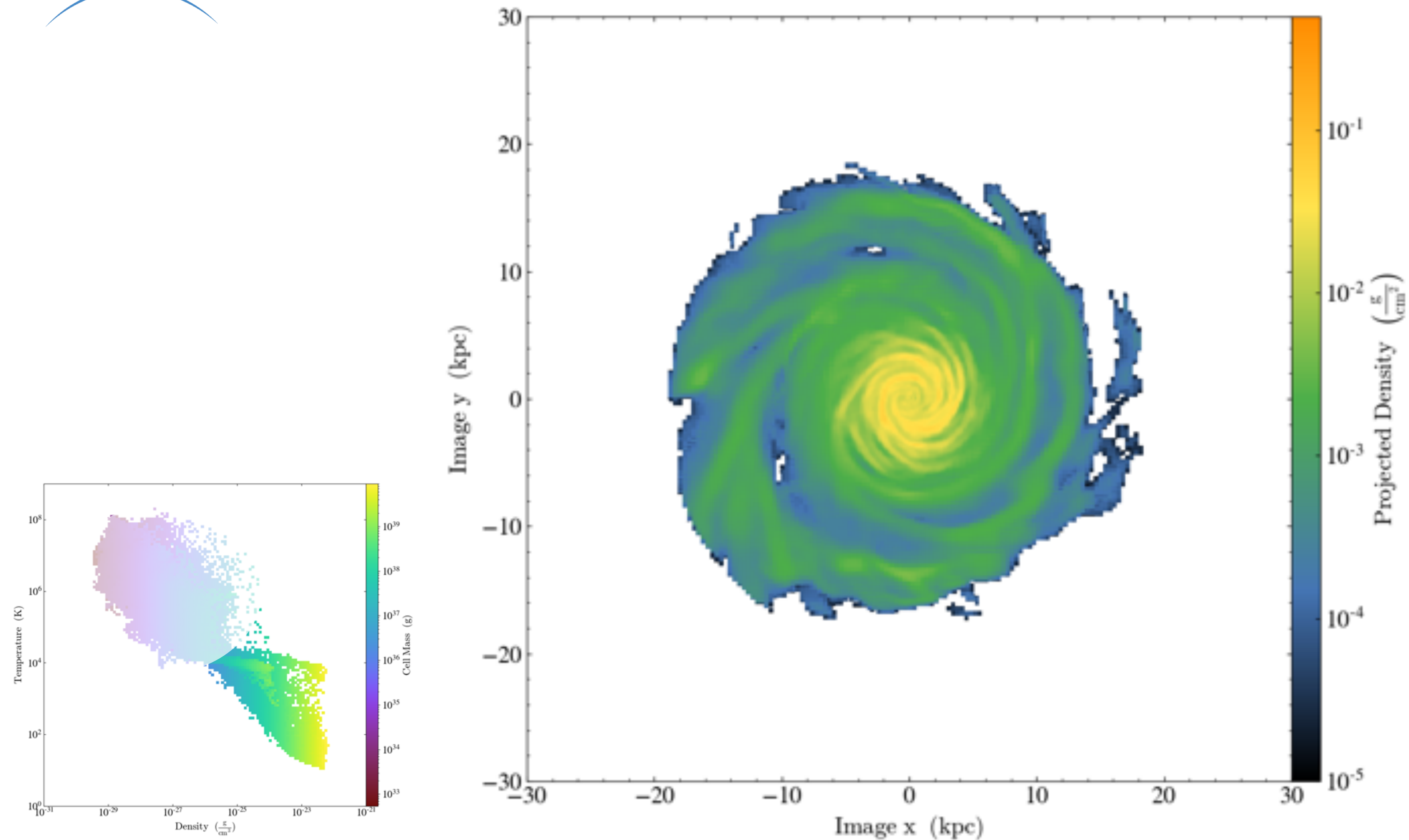


Galaxies consist of gas at a range of temperatures and densities, which can be separated into regions.



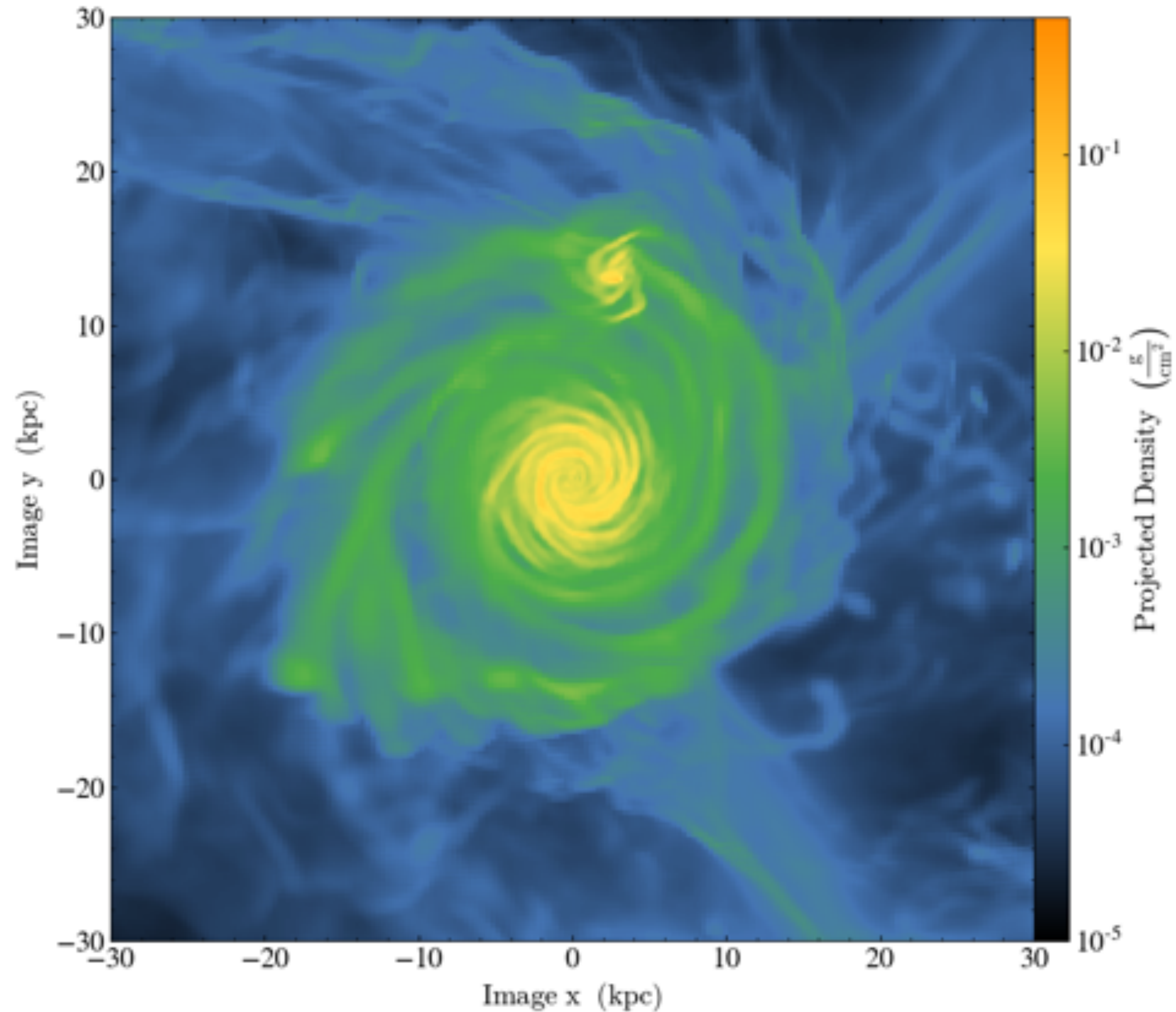
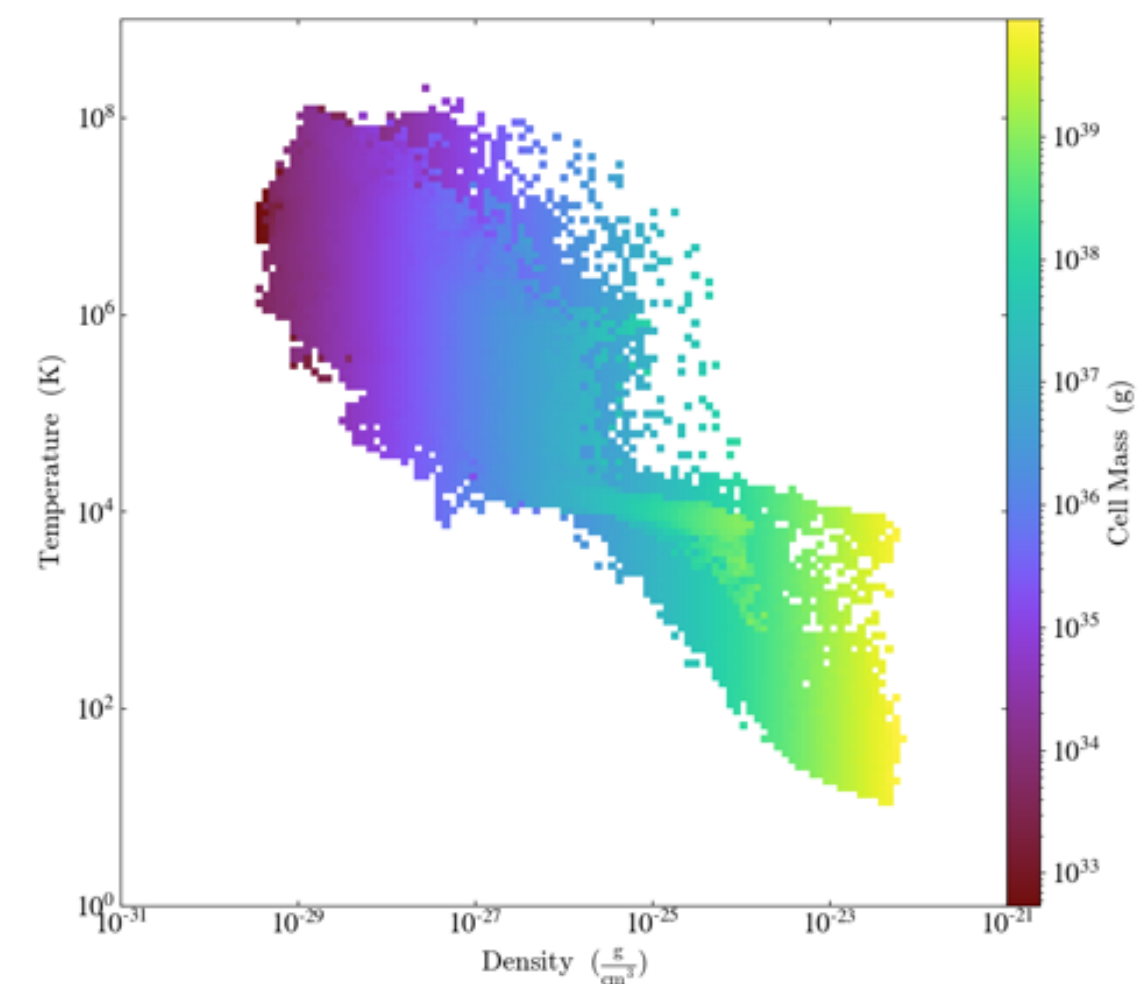


Galaxies consist of gas at a range of temperatures and densities, which can be separated into regions.



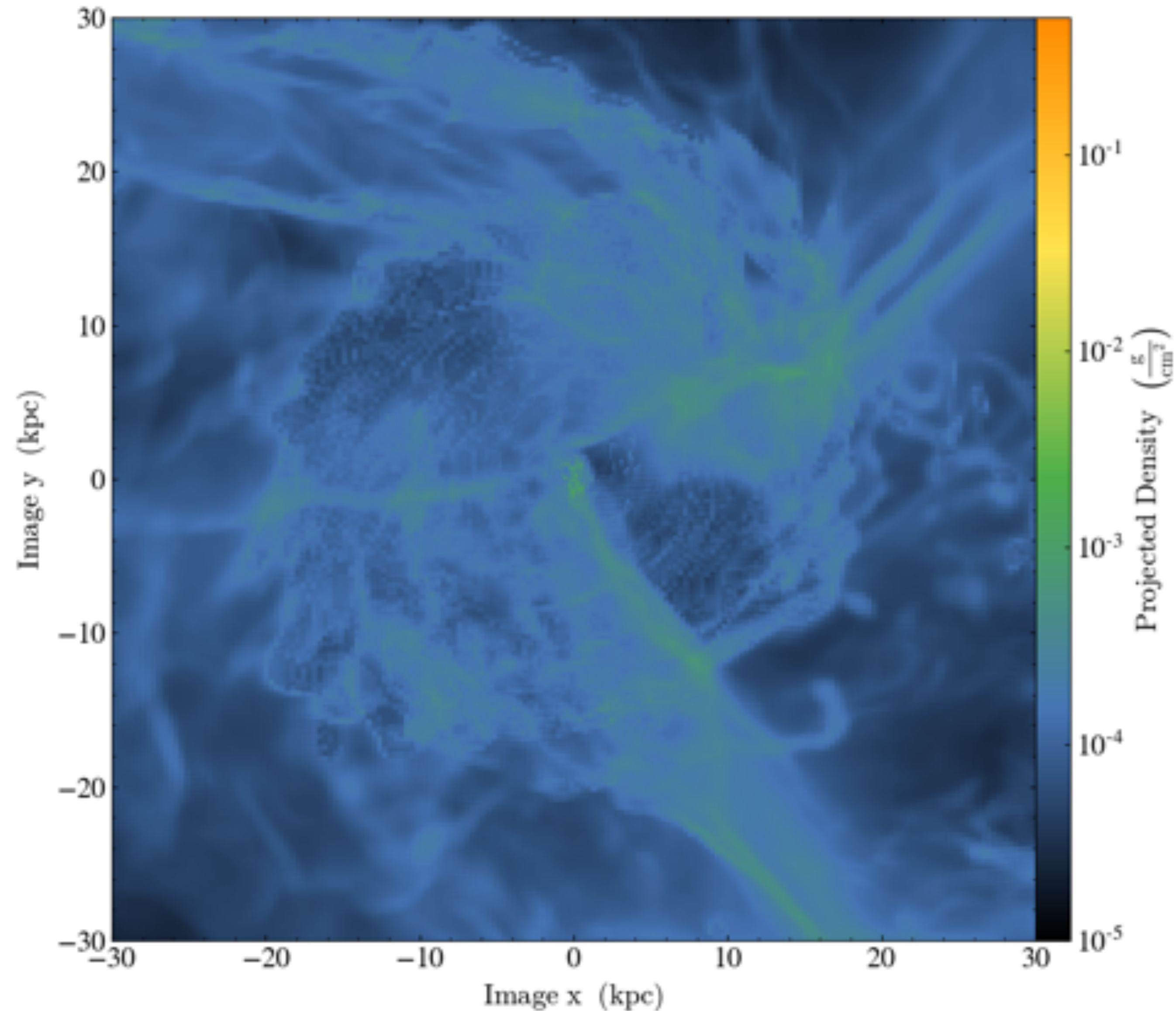
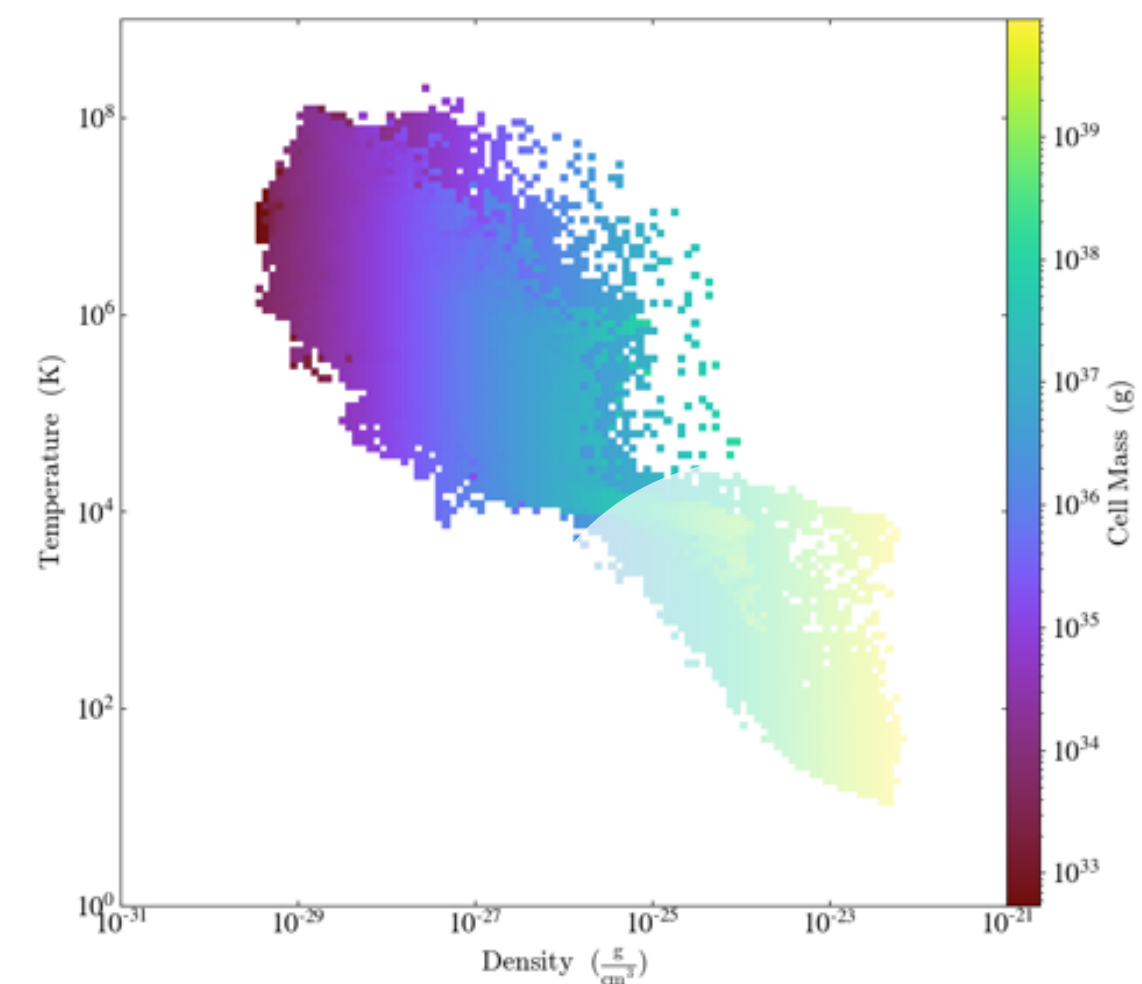


Galaxies consist of gas at a range of temperatures and densities, which can be separated into regions.



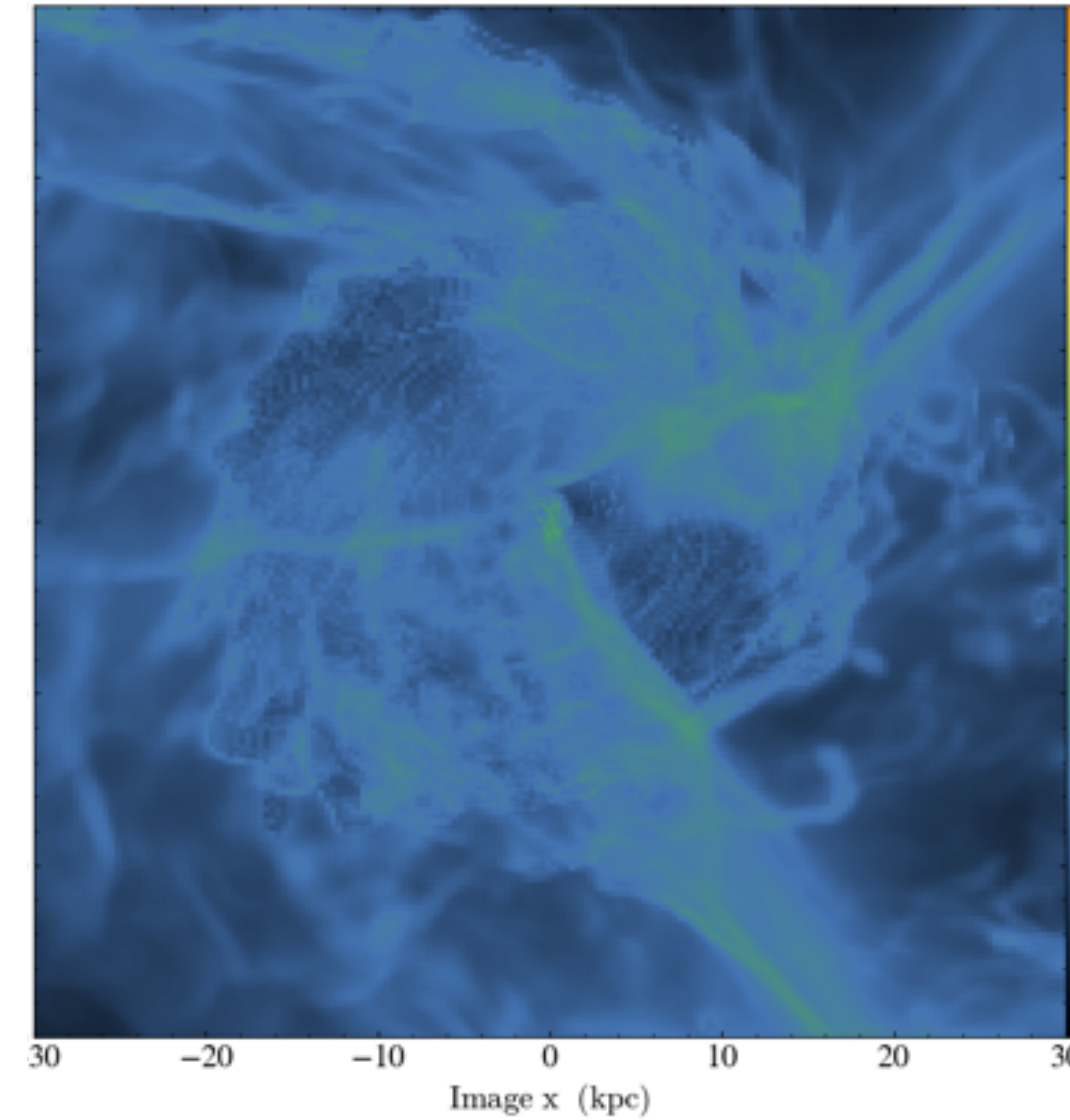
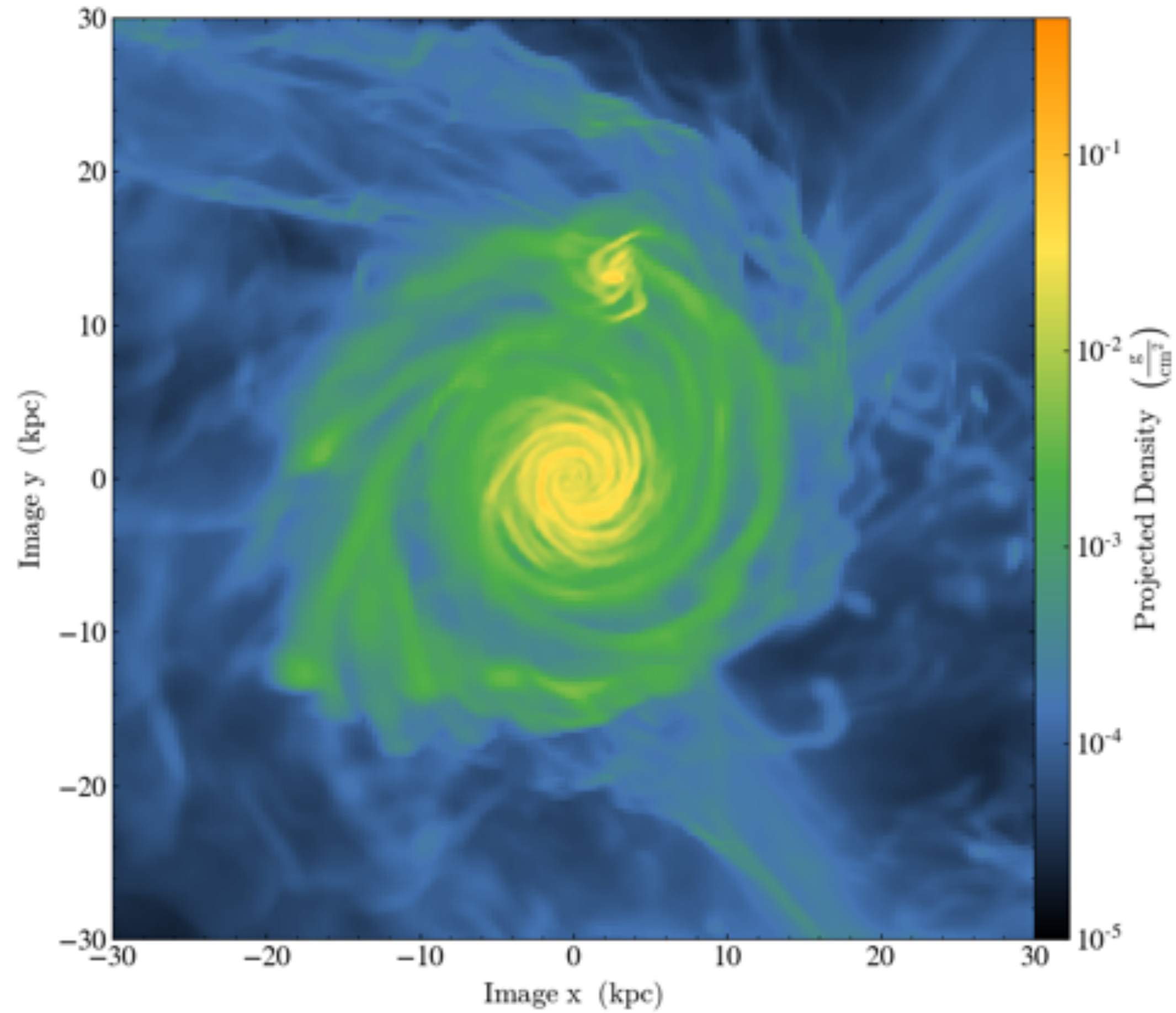
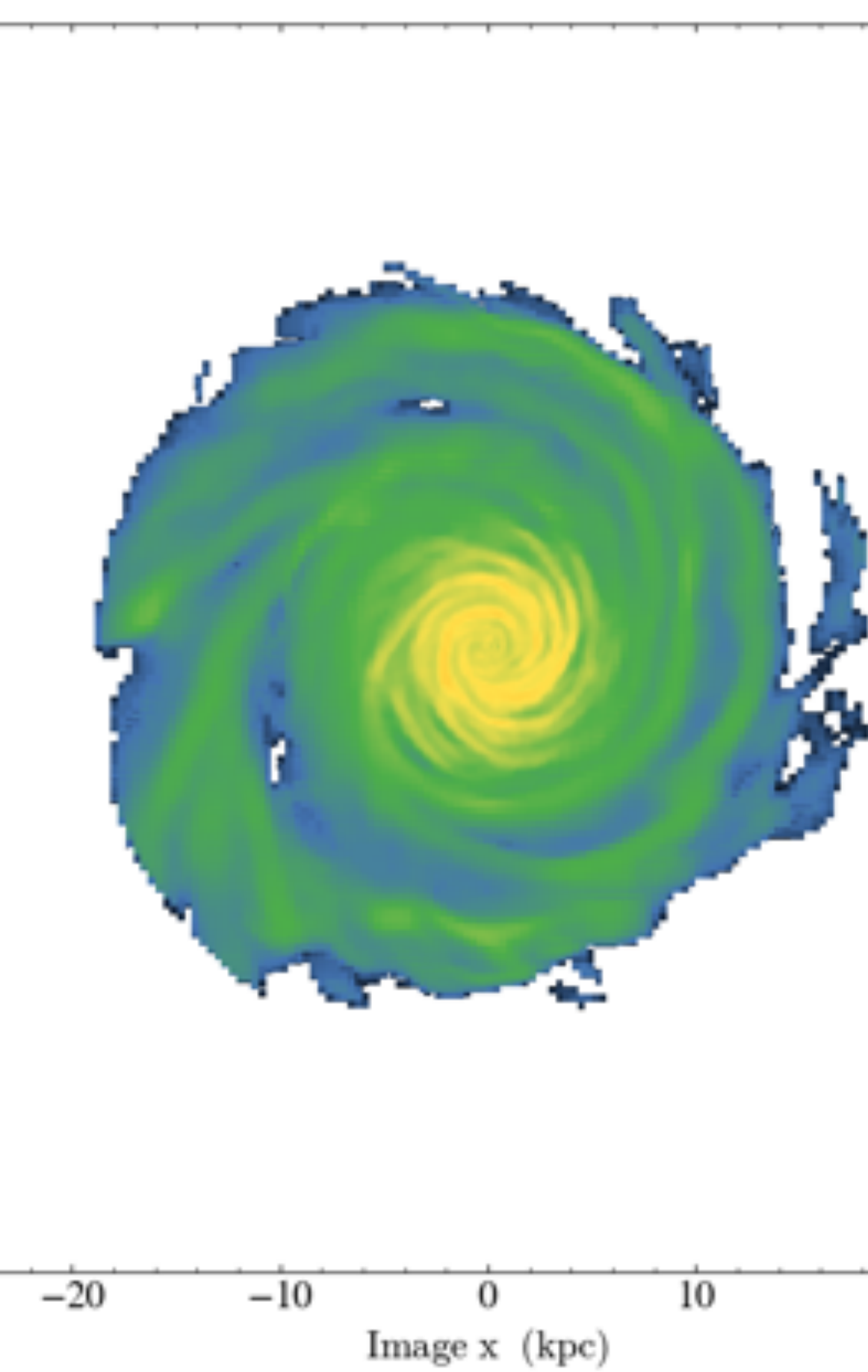


Galaxies consist of gas at a range of temperatures and densities, which can be separated into regions.



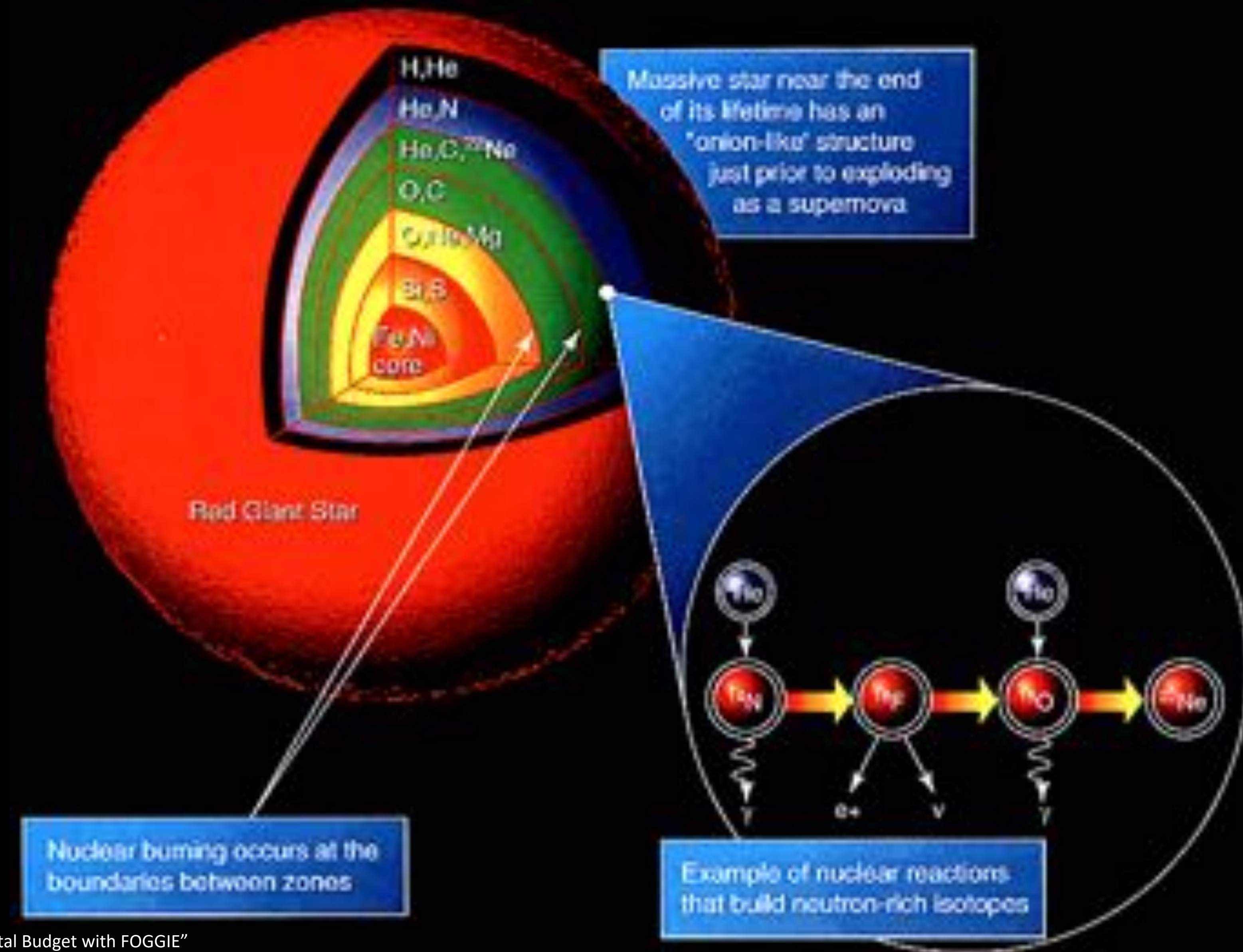


At different points, stars can trap metals and seed them through interstellar and circumgalactic media.



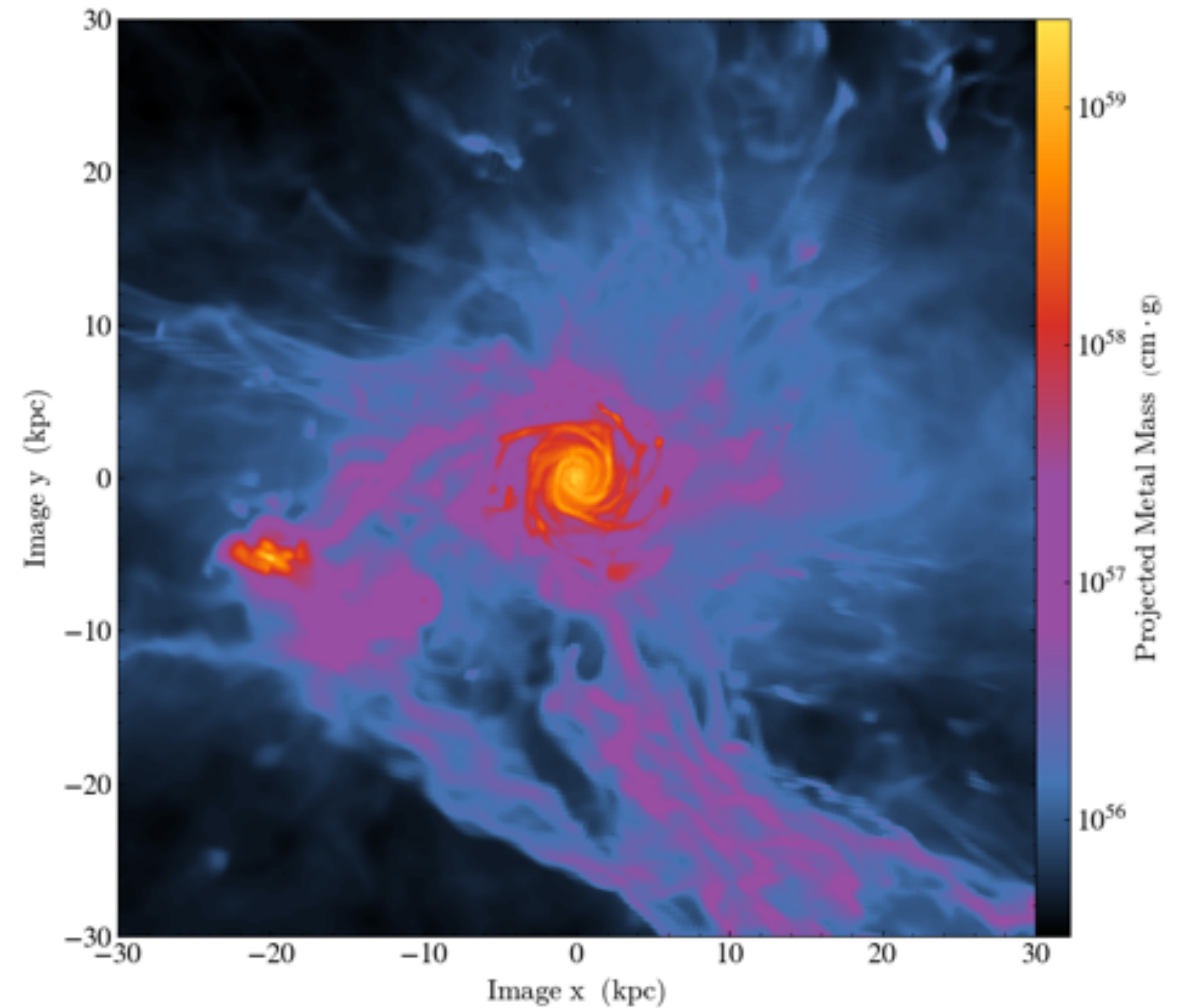
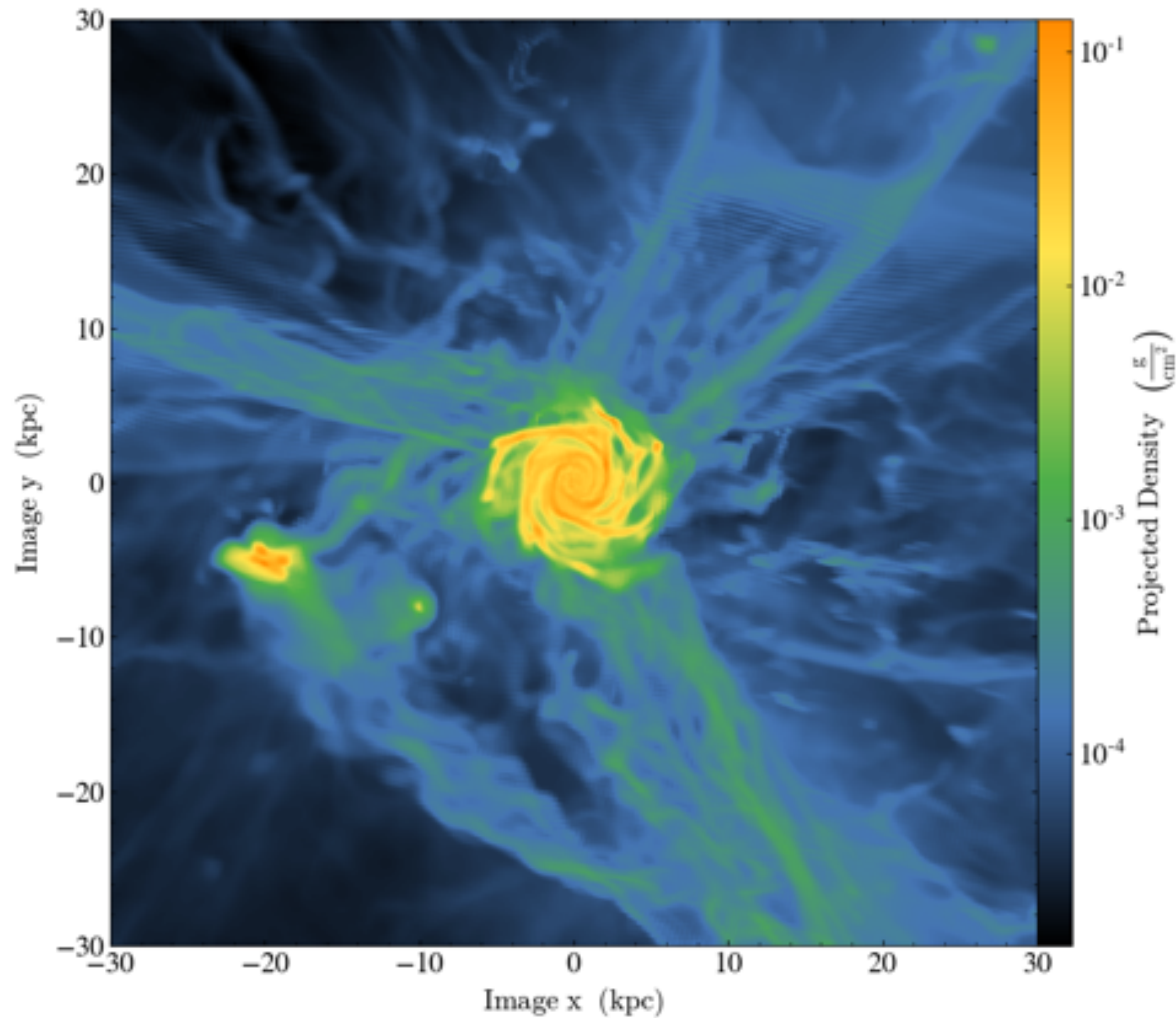


Stars create heavy elements whose abundances and locations are important to galactic evolution.



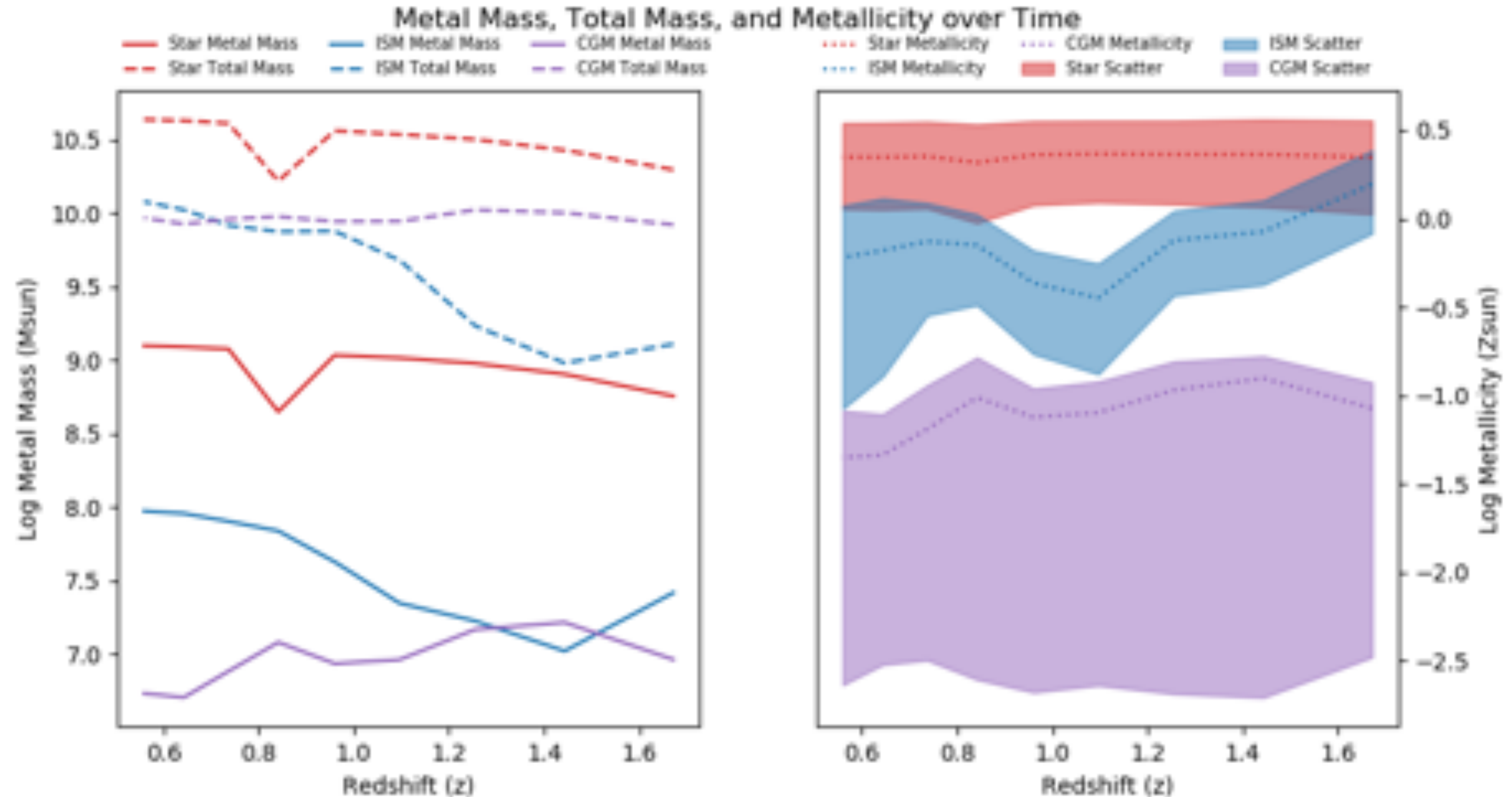


Galactic density and metal mass are directly linked to stellar evolution and galaxy-wide gas flows.



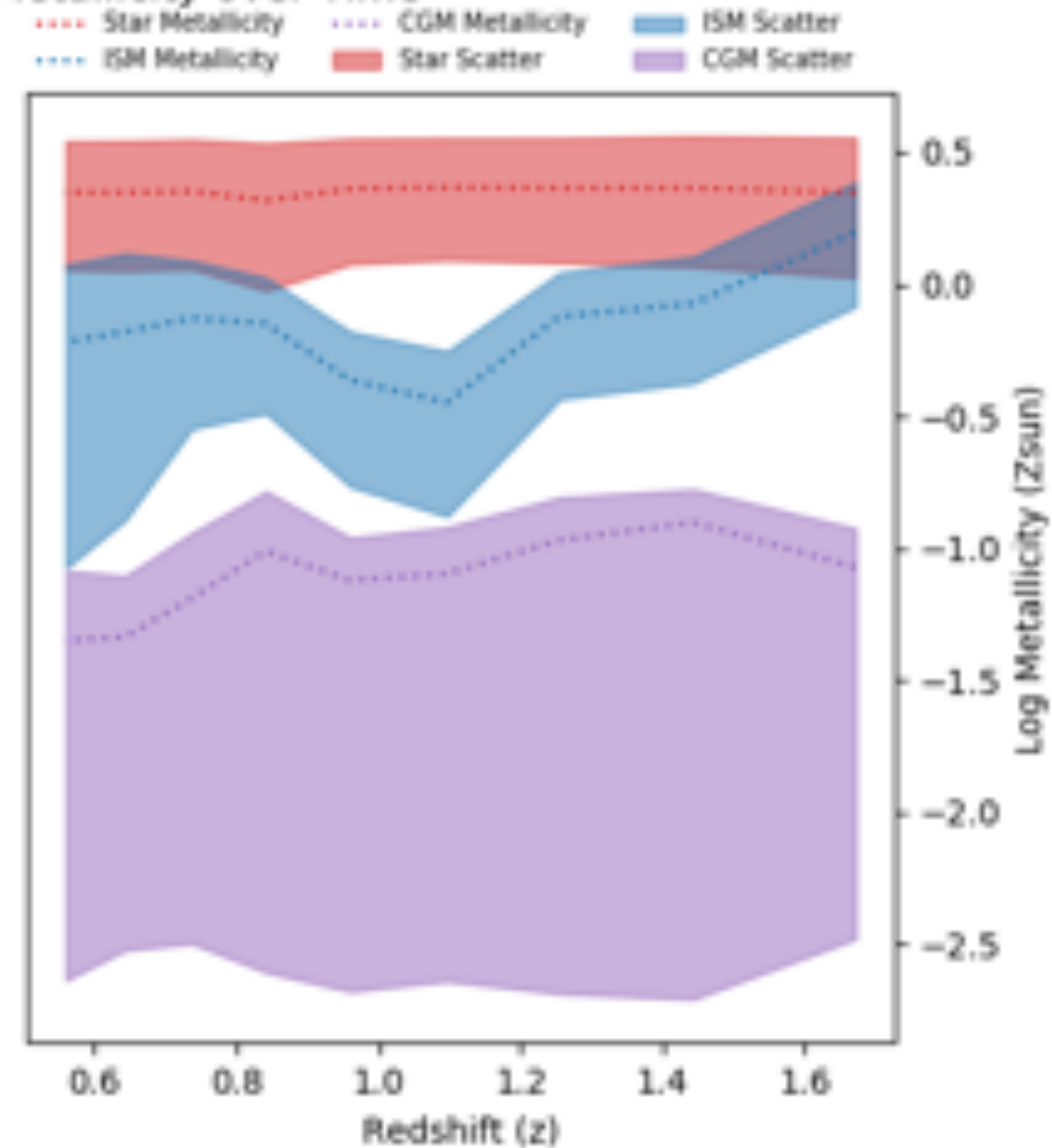
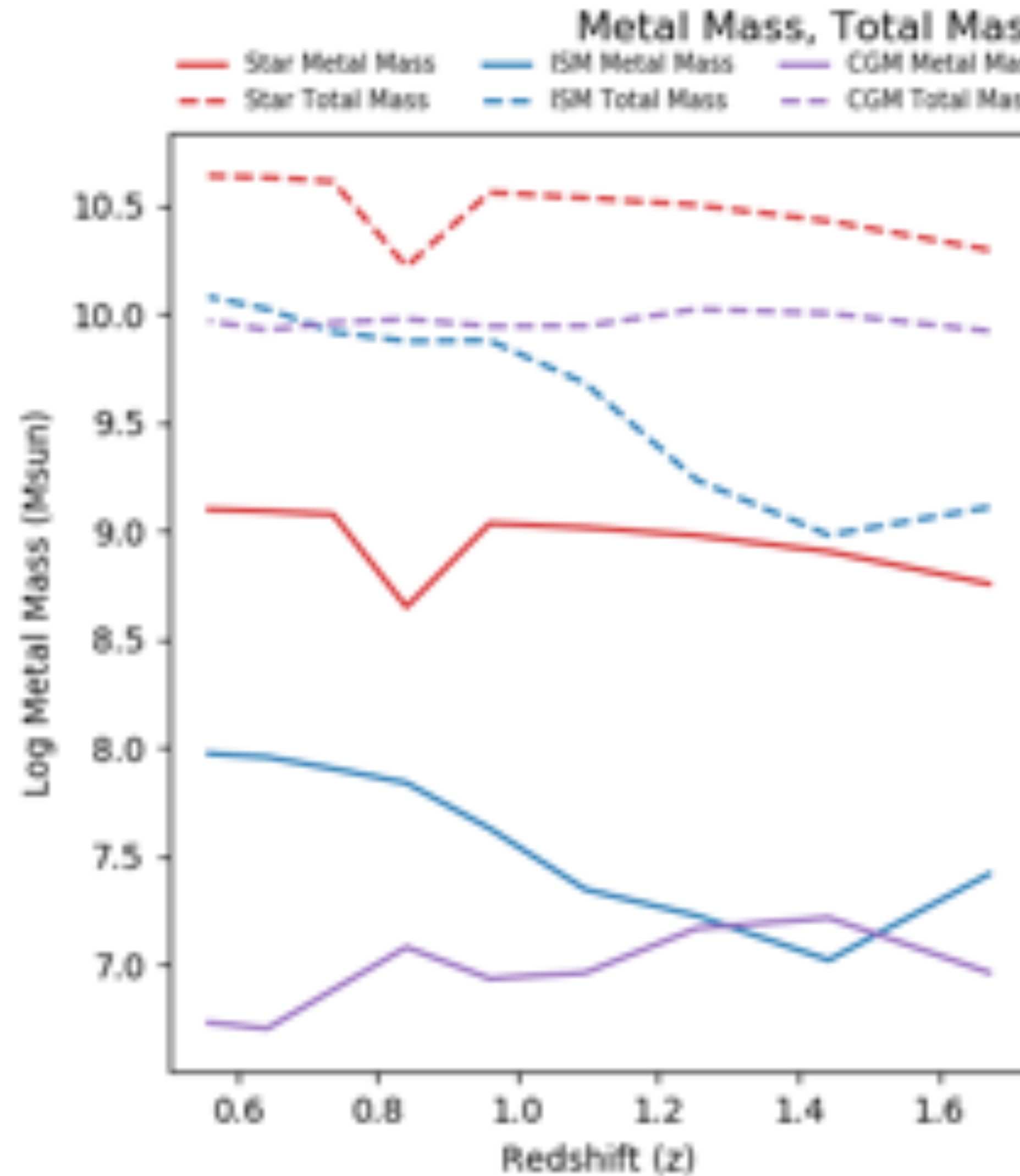
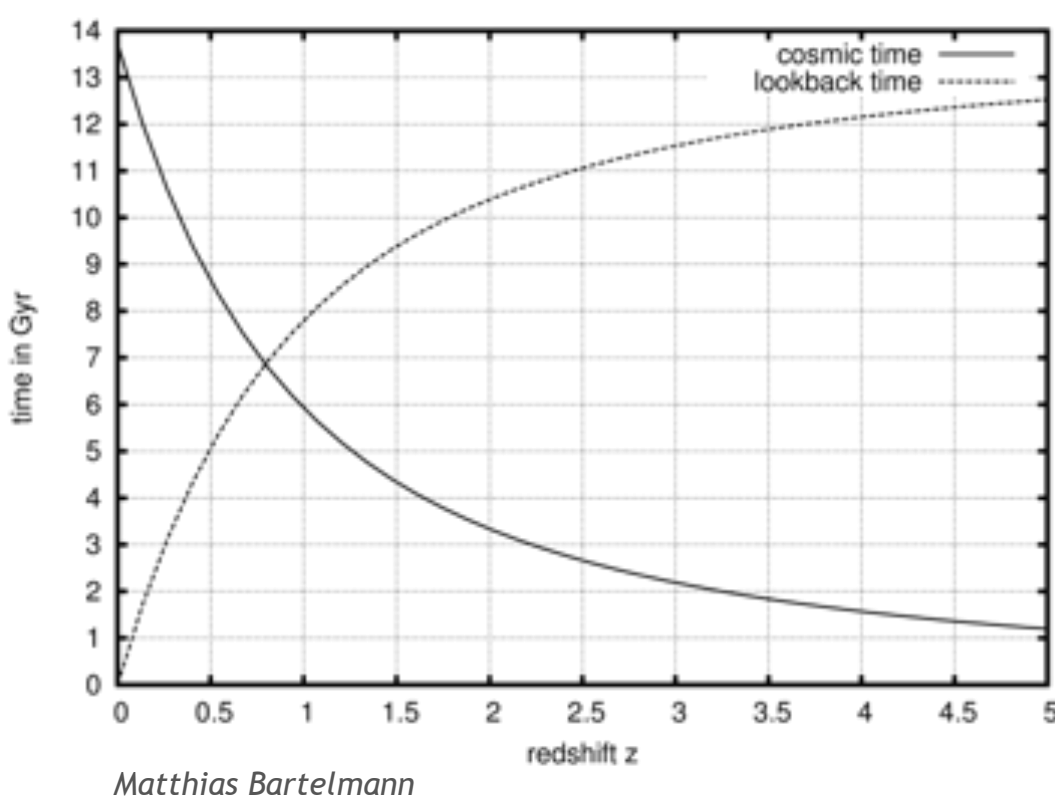


We can look at the metal mass, total mass, and metallicity of the stars, ISM, and CGM over time.





We can look at the metal mass, total mass, and metallicity of the stars, ISM, and CGM over time.





Galaxies are dynamic, and tracing metals through time and space reveals their histories.

Acknowledgements

Thanks to the Space Telescope Science Institute's Space Astronomy Summer Program for hosting me, the FOGGIE collaboration for letting me join the team, and the Maryland Space Grant Consortium for inviting me to share my research today!



Space Telescope Science Institute



FOGGIE Collaboration



Maryland Space Grant Consortium

Bibliography

Bartelmann, M.(2010). "The Dark Universe." In: *Reviews of Modern Physics* **82** (331), pp. 331-382. DOI: 10.1103/RevModPhys.82.331

Christensen, C. R., R. Davé, A. Brooks, T. Quinn, and S. Shen (2018). "Tracing Outflowing Metals in Simulations of Dwarf and Spiral Galaxies". In: *The Astrophysical Journal* 867 (142), pp. 1–19. DOI: 10.3847/1538-4357/aae374

Peeples, M. S., J. K. Werk, J. Tumlinson, B. D. Oppenheimer, J. X. Prochaska, N. Katz, and D. H. Weinberg (2014). "A Budget and Accounting of Metals at $z \sim 0$: Results from the COS-Halos Survey". In: *The Astrophysical Journal* 786 (54), pp. 1–17. DOI: 10.1088/0004-637X/786/1/54

Tumlinson, J., M. S. Peeples, and J. K. Werk (2017). "The Circumgalactic Medium". In: *Annual Review of Astronomy and Astrophysics* 55, pp. 389–432. DOI: 10.1146/annurev-astro-091916-055240