

# Effects of cosmic rays in cosmological simulations of Milky Way mass galaxies

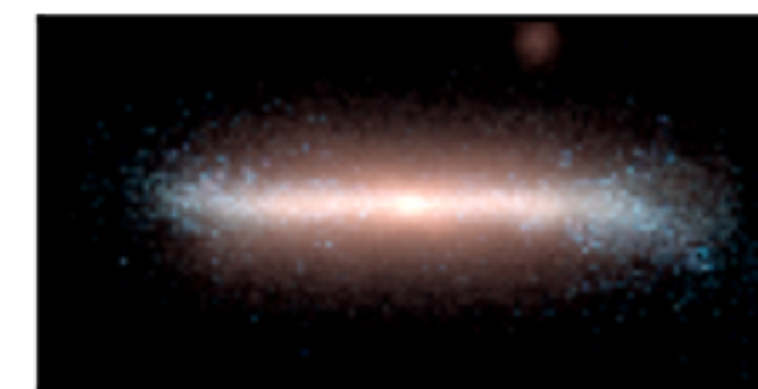
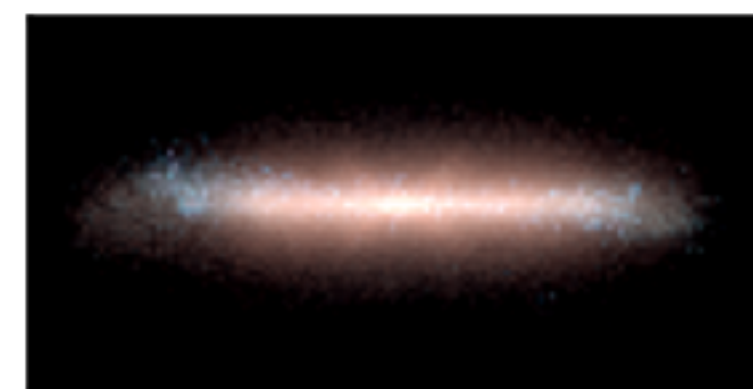
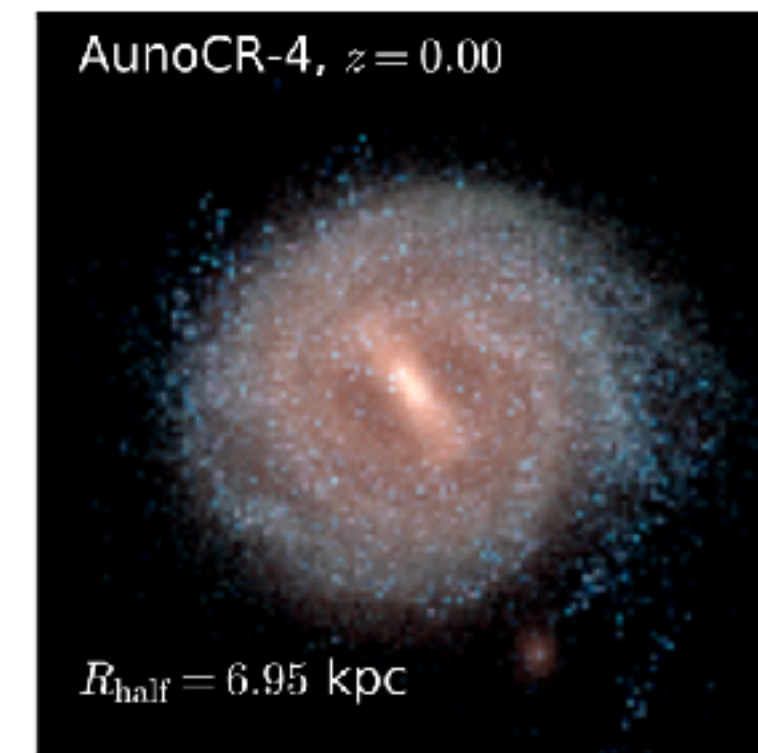
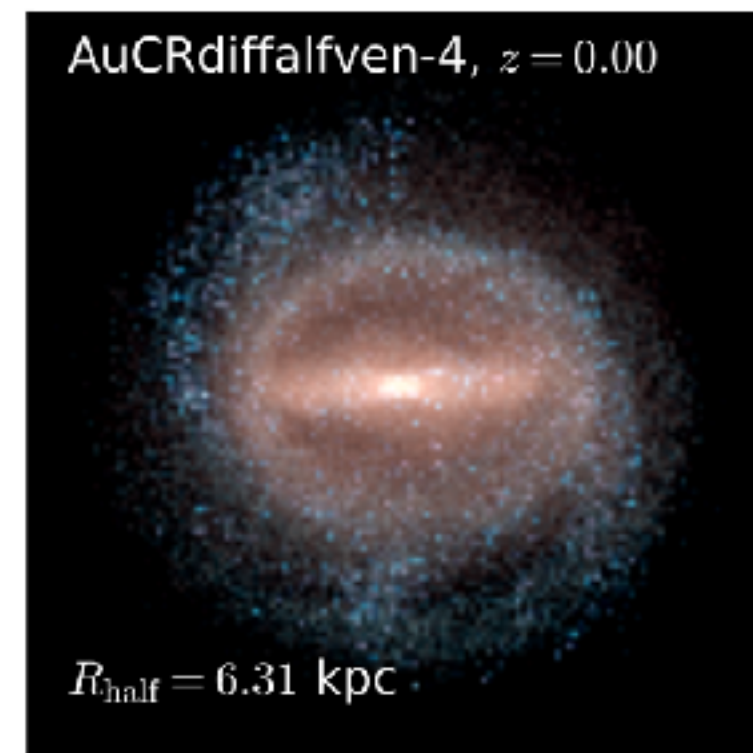
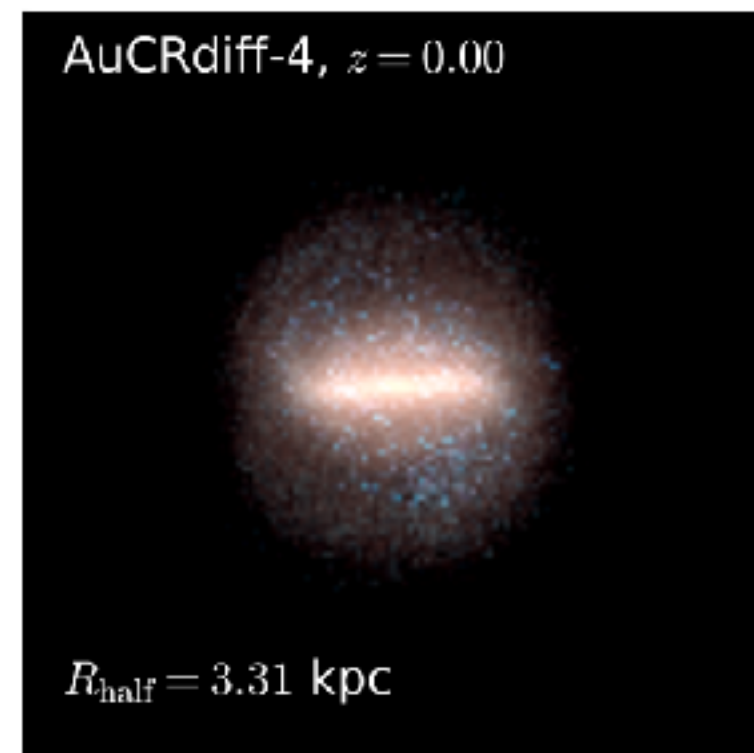
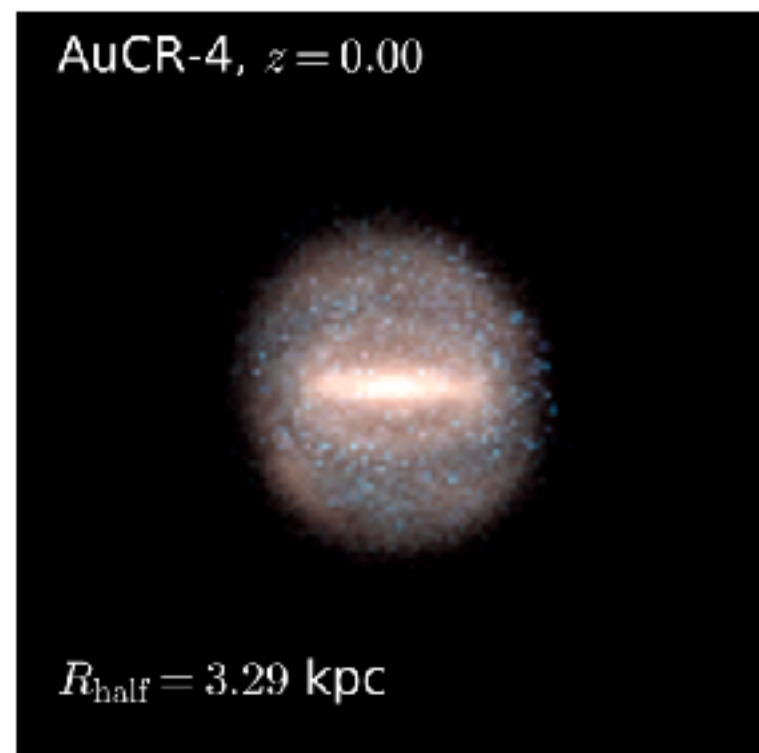
Tobias Buck<sup>1</sup>, Christoph Pfrommer<sup>1</sup>, Rüdiger Pakmor<sup>2</sup>, Robert Grand<sup>2</sup>

## CR advection

## CR diffusion

## CR streaming

## AURIGA



## Effects of cosmic rays in cosmological simulations of Milky Way mass galaxies

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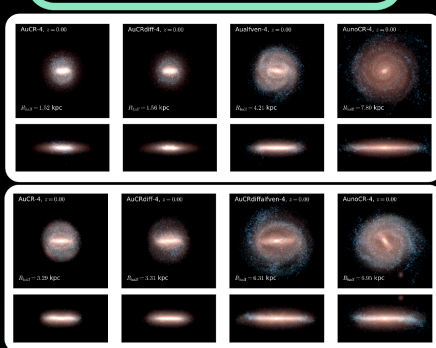


### Introduction and Goals

**The Simulations:**  
We study the impact of cosmic rays (CR) in fully cosmological magneto-hydrodynamical simulations of Milky Way (MW) mass galaxies taken from the AURIGA project [1]. We focus on the differences between different implementations of the cosmic ray physics, cosmic ray advection, diffusion and a streaming approximation [2,3].

**Results:** CR feedback does not strongly effect the global properties of MW like galaxies like e.g. stellar mass or SFR. However, the additional non-thermal pressure of the CRs changes the structure of the CGM making it smoother and slightly hotter. CRs alter the gas accretion onto the central galaxy. The lagrangian region of accreted gas is smaller and the specific gas angular momentum is lower. Thus galaxy sizes are slightly smaller in the CR runs compared to the standard AURIGA runs.

### The Simulation Suite...

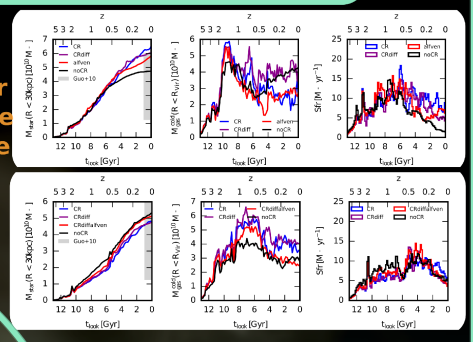


8 simulations,  
4 physics  
setups,  
2 halos

The most realistic implementation of CR physics, the Alfvén run, agrees well with the fiducial AURIGA model

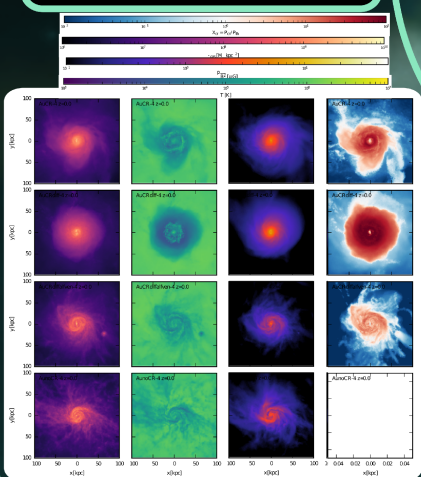
### Global Galaxy Properties...

Stellar mass, cold gas mass and star formation rate do not change much.



Differences are within halo to halo variance.

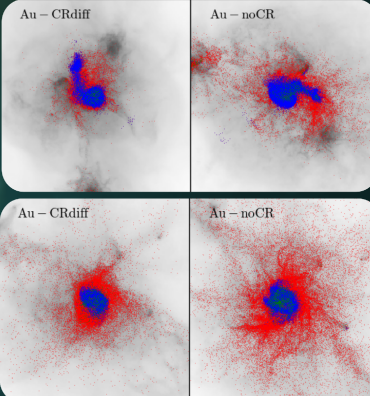
### CGM Properties



Density, temperature, B-field and ratio of cosmic ray pressure to thermal pressure

### Origin of Differences

Accretion from a smaller lagrangian region and of



lower angular momentum gas

### Conclusion and follow-up research

The current implementation of supernova feedback and cosmic ray feedback in the AREPO code does not have a huge impact on global galaxy properties like stellar mass or SFR of Milky Way mass galaxies.

The additional non-thermal pressure of the CRs effects the structure and properties of the CGM. The lagrangian accretion region of galactic baryons is much smaller in the cosmic ray runs and the specific angular momentum of baryons is lower.

### References

- [1] Grand, R. J. J., Gómez, F. A., Marinacci, F. et al. 2017, MNRAS, 467, 179
- [2] Pfrommer, C., Pakmor, R., Schaal, K., Simpson, C. M., & Springel, V. 2017, MNRAS, 465, 4500
- [3] Pakmor, R., Pfrommer, C., Simpson, C. M., Kannan, R., & Springel, V. 2016, MNRAS, 462, 2603

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