

International Centre for Radio Astronomy Research

Observations and Theoretical Study of Colliding Galaxies and the Effects on their Star Formation

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Off-centre collision --> Ring of star formation --> Disturbed/Warped HI morphology





Credit:ESA/NASA



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Collisional Ring Galaxies

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The ISM in Ring Galaxies



Excess amount of gas at fixed mass; different ISM gas phase slower consumption rate (Elagali+2018a).

Rings are H2 deficient galaxies (Higdon & Higdon 2010), despite their high gas fraction.



why rings are HI rich yet Poor in H2:

a) Insufficient ISM gas phase pressure: low ISM pressure ---> high HI to H2 ratio (Elmegreen 1993; Blitz & Rosolowsky 2006)

b) Photodissociation of molecular gas: ultraviolet photons (0.05-0.22 μm) ---> destruction of H2 molecules (Higdon 2011, 2015)





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The need to escape the observational domain to hydrodynamical Simulations:-

- ***** Lack of statistically large sample of rings in the local Universe!
- * The need for coherent galaxy formation model to study the gas and stellar content in a resolved manner.



The EAGLE Simulations



Large number of subgrid physics module:

- → Metal-dependent cooling
- → Reionisation
- \rightarrow Star formation (metallicity-dependent)
- → Stellar recycling
- → SNe feedback
- → AGN feedback
- (~700pc resolution, $10^6 M_{\rm o}$,100Mpc box size)

Image Credit: Schaye et al (2015)



The simulation reproduces many low redshift observables(Trayford+2015;Schaye+2015;Lagos+2015;Crain+2017).



Ring Galaxies in EAGLE Simulations



Elagali+2018b in press (arXiv:1807.08251)

Rings in EAGLE are very similar to the observed systems:

- The number density agrees with observations
- Located in massive concentrated groups



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Ring galaxies are characterised by inefficient conversion of the HI gas to stars (Elagali+2018b in press arXiv:1807.08251)



Rings at z=0.5

··- Ring Progenitors at z=0.7

SF Progenitors at z=0.7

----- Star-forming galaxies at z=0.5



The relatively low pressure and metallicity in rings give an interpretation for the inefficient HI to SFR conversions which can lead to the excess HI gas fraction found in observations/simulations of rings (Elagali+2018b in press arXiv:1807.08251)



Formation Mechanisms of Rings in EAGLE





Summary

- ***** Ring galaxies are HI rich but H2 deficient galaxies.
- * Except at the ring, EAGLE ring galaxies have an ISM with much lower gas phase-pressure and metallicity than galaxies with similar stellar/HI masses.
- ***** The collision is responsible for decreasing the ISM pressure by causing the ISM gas to flow from the inner regions to the outer disk.

References: Elagali et al 2018a (arXiv:1804.07037) Elagali et al 2018b (arXiv:1807.08251)



Thank You



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Kinematics of Rings in EAGLE



The kinematics of EAGLE collisional ring galaxies are similar to those predicted by the analytic caustic theory & non-cosmological interaction simulations (Elagali+2018b in press arXiv:1807.08251)



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