

When a Black Hole Fails to do its Job



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Evidence of Runaway Gas Cooling in the Absence of Supermassive Black Hole Feedback at the Epoch of Cluster Formation

The Astrophysical Journal Letters, Volume 898, Issue 2, id.L50

Arxiv: 2007.15660

Press Release:

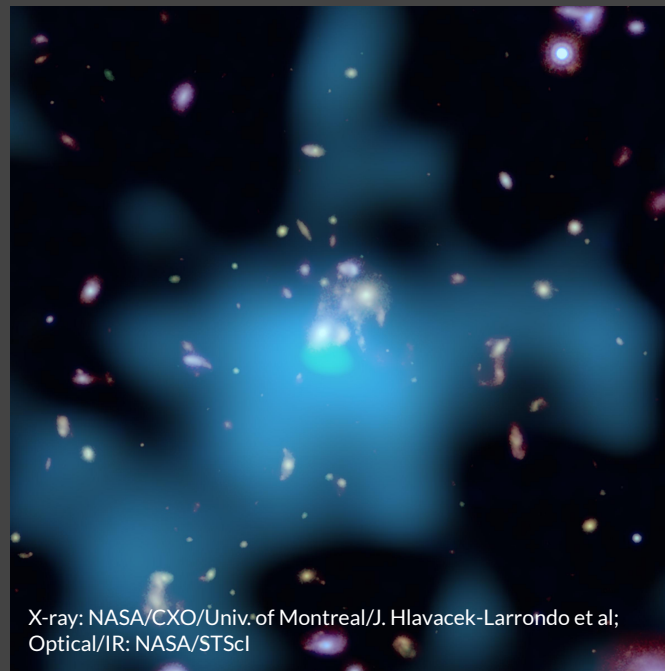
https://chandra.harvard.edu/press/20_releases/press_080320.html

Blog:

<https://chandra.harvard.edu/blog/node/766>



IVADO



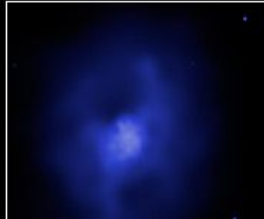
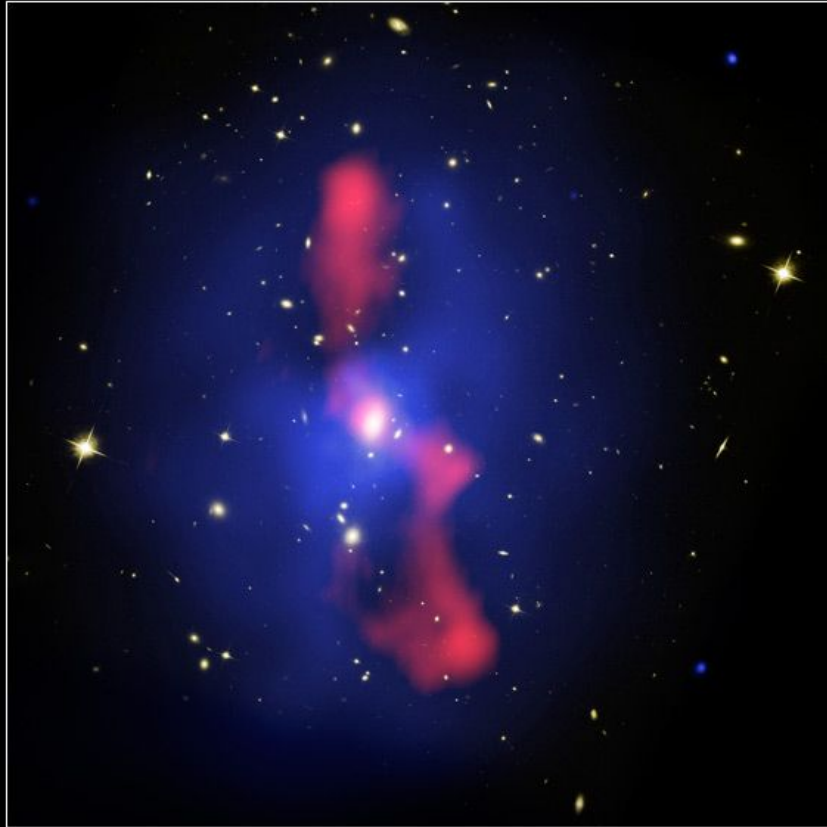
X-ray: NASA/CXO/Univ. of Montreal/J. Hlavacek-Larrondo et al;
Optical/IR: NASA/STScI



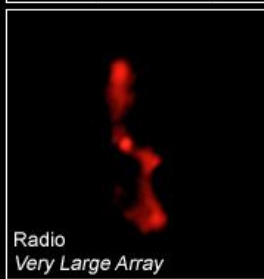
Galaxy Clusters

Galaxy Cluster MS 0735.6+7421

CXO ■ HST ■ VLA



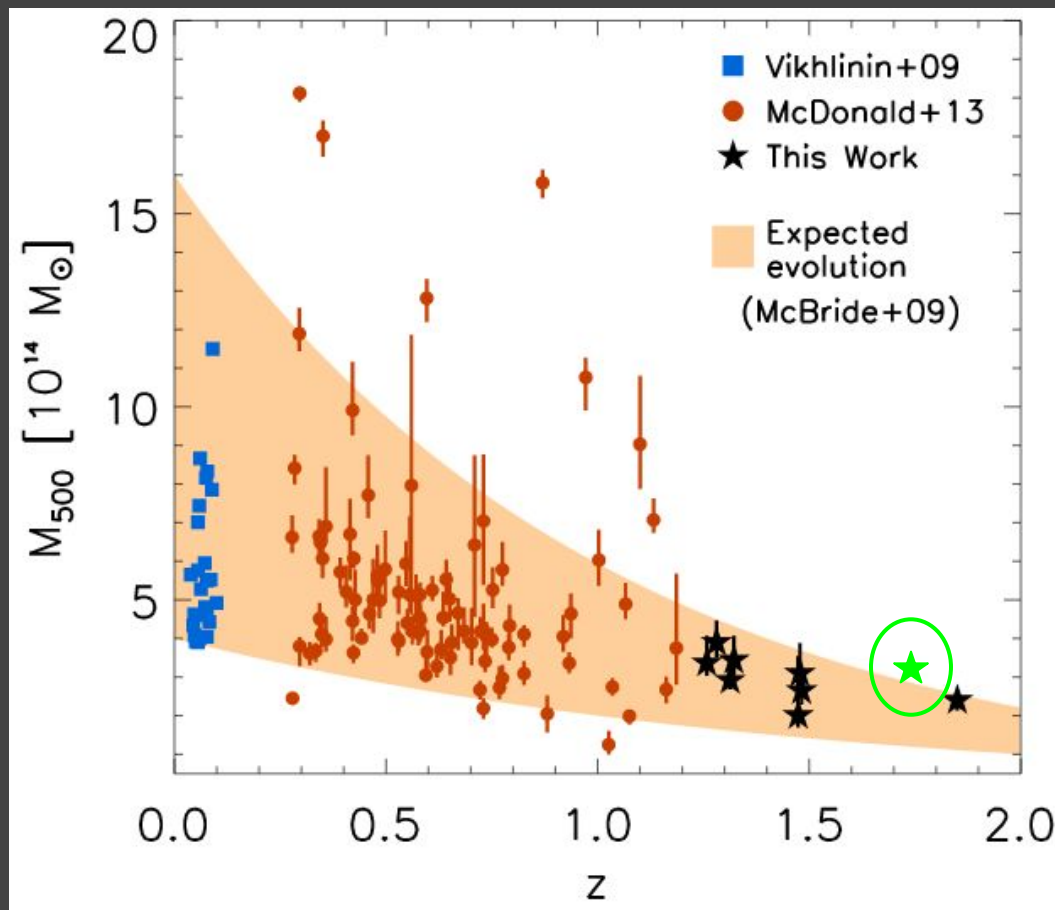
X-ray
Chandra X-Ray Observatory



NASA, ESA, CXC/NRAO/STScI, B. McNamara (University of Waterloo and Ohio University) STScI-PRC06-51

- ★ Galaxy Cluster
 - 100's-1000's of Galaxies
 - 10^{14} - $10^{15} M_{\odot}$
- ★ Cluster Mass Distribution
 - Dark Matter - 84%
 - Intra-cluster Medium - 13%
 - Galaxies - 3%
- ★ Intra-Cluster Medium
 - Hot Ionized Gas
 - 10,000,000-100,000,000 K
- ★ Cooling Flow
 - Collapse of X-ray Emitting Gas
 - Flows toward center
 - Expected Increase in Stellar Formation

High Redshift Galaxy Clusters

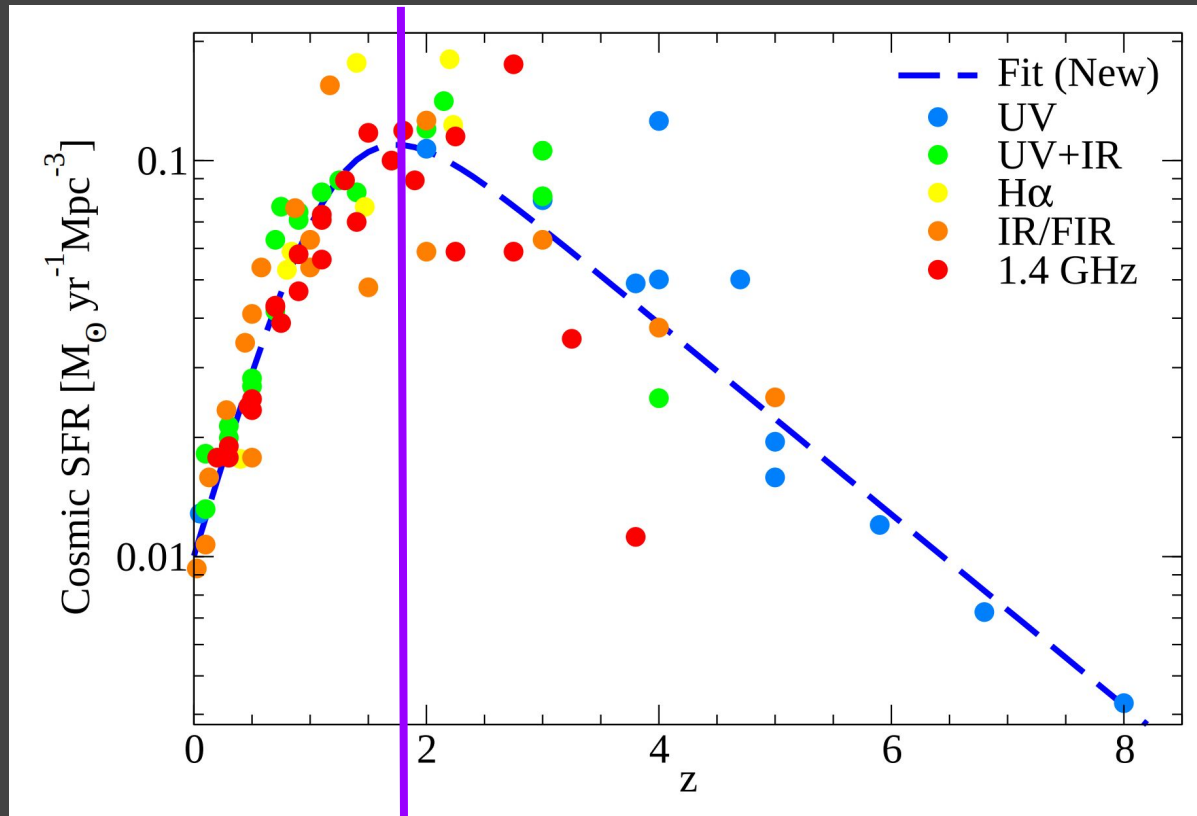


McDonald et al., 2017, ApJ, 843, id.28

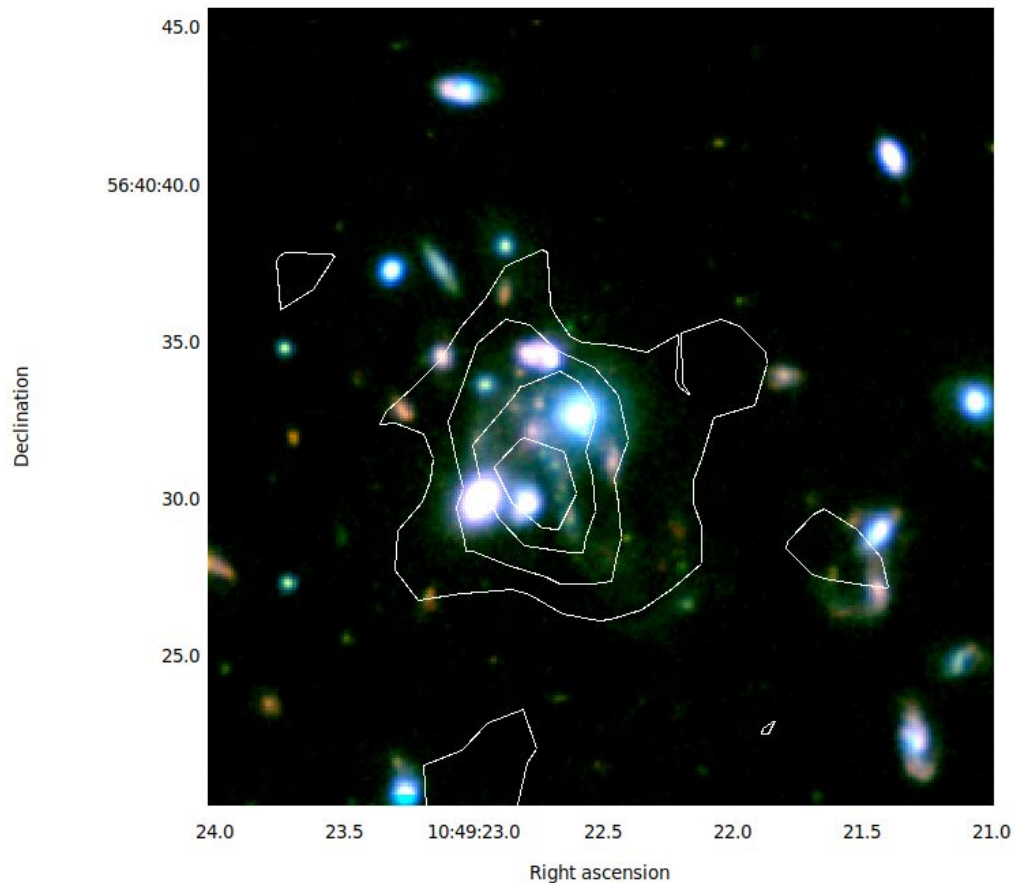
Recent High- z Cluster Surveys

- South Pole Telescope
- Spitzer Adaptation of the Red-Sequence Cluster Survey

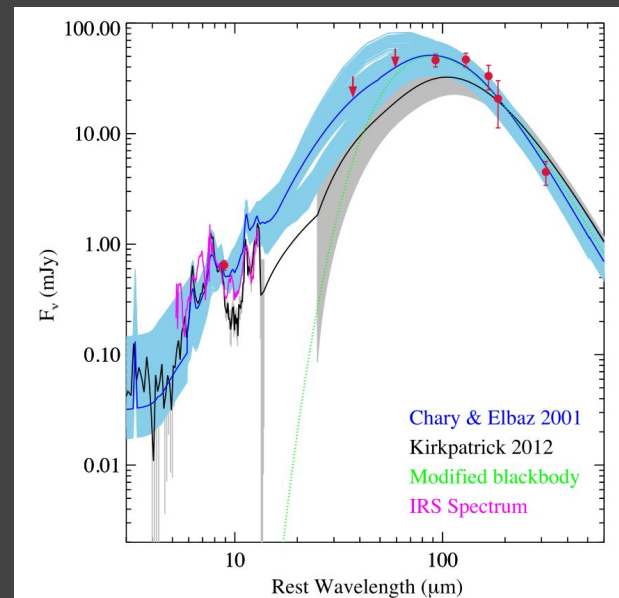
Galaxy Formation History



A View from the Optical/Infrared

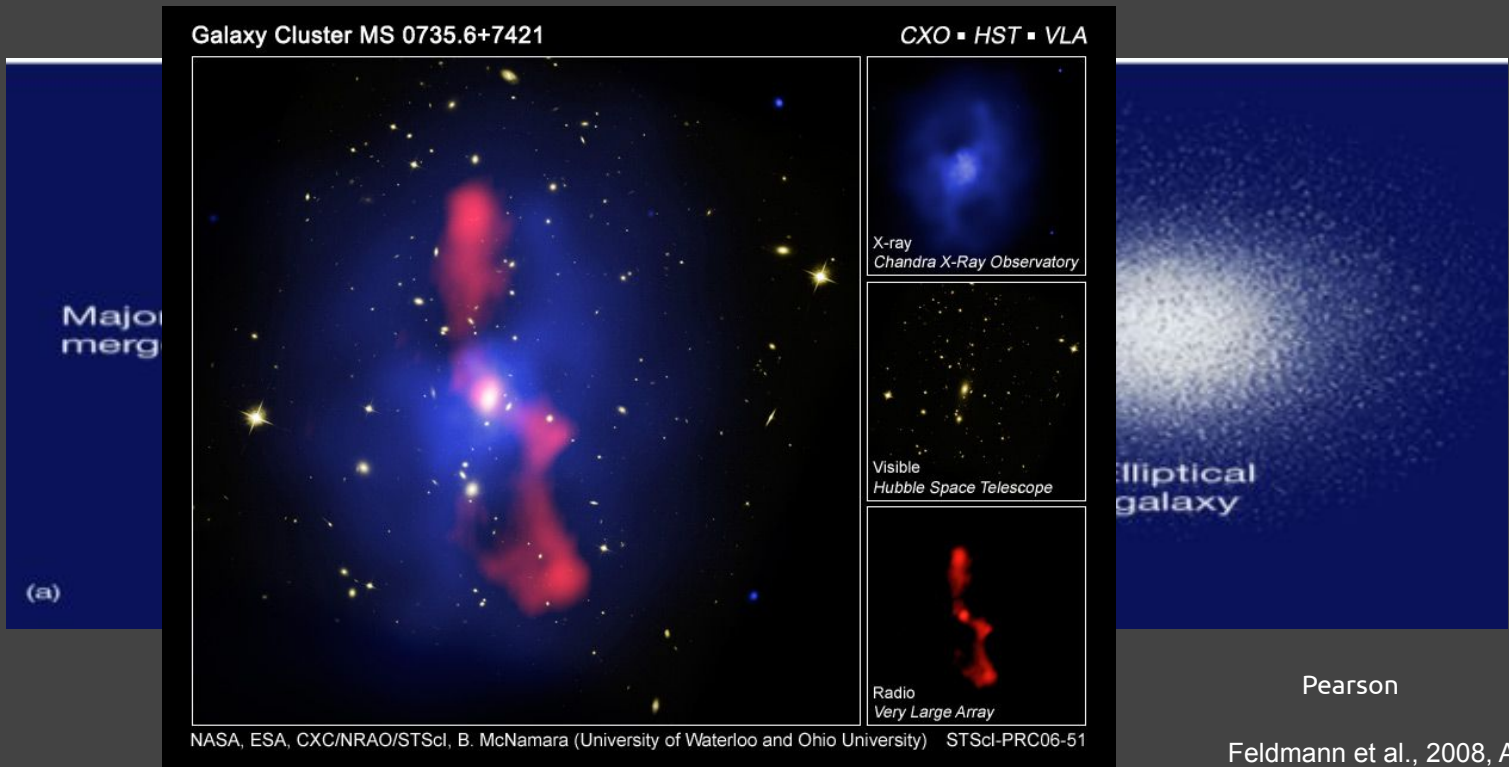


- Hubble Space Telescope:
 - F160W ~ 9000s
 - F105W ~ 8500s
- Spitzer Space Telescope:
 - 24, 70, 160 micron

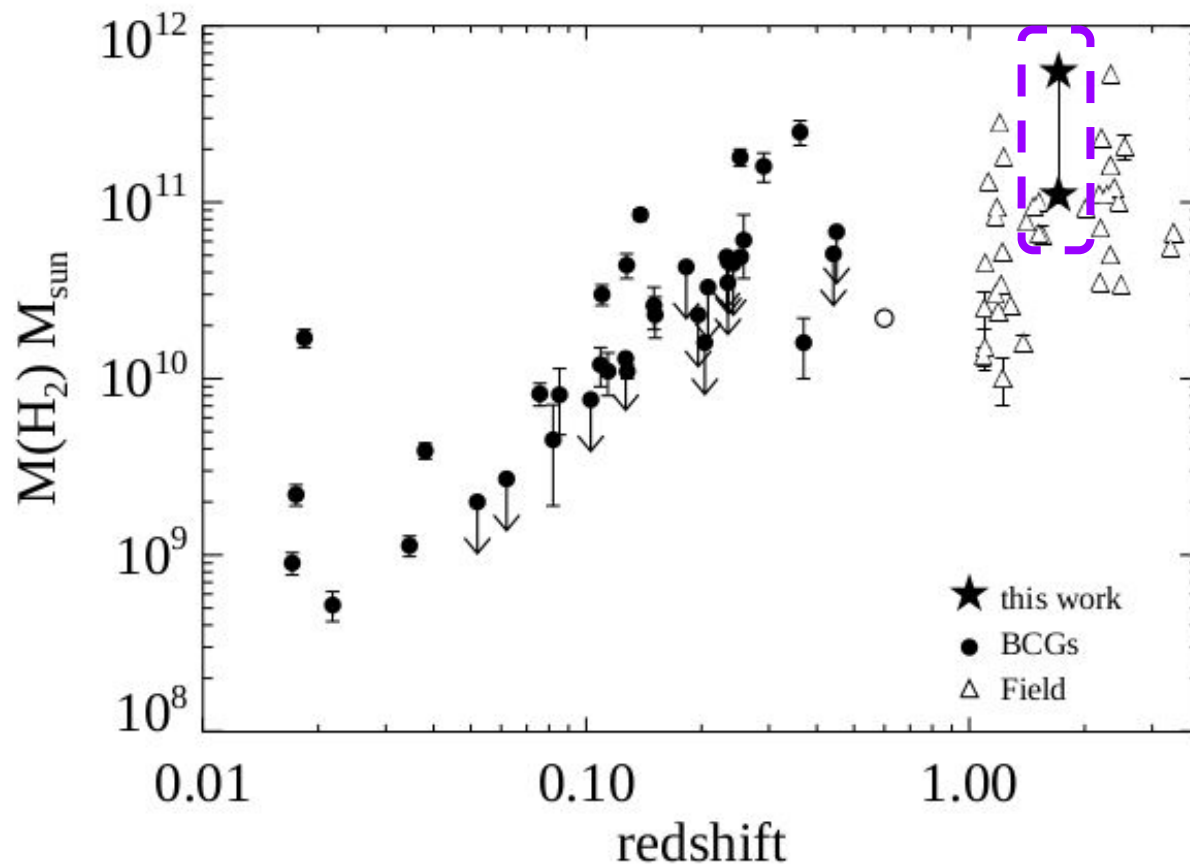


Potential Explanations for High Stellar Formation Rate

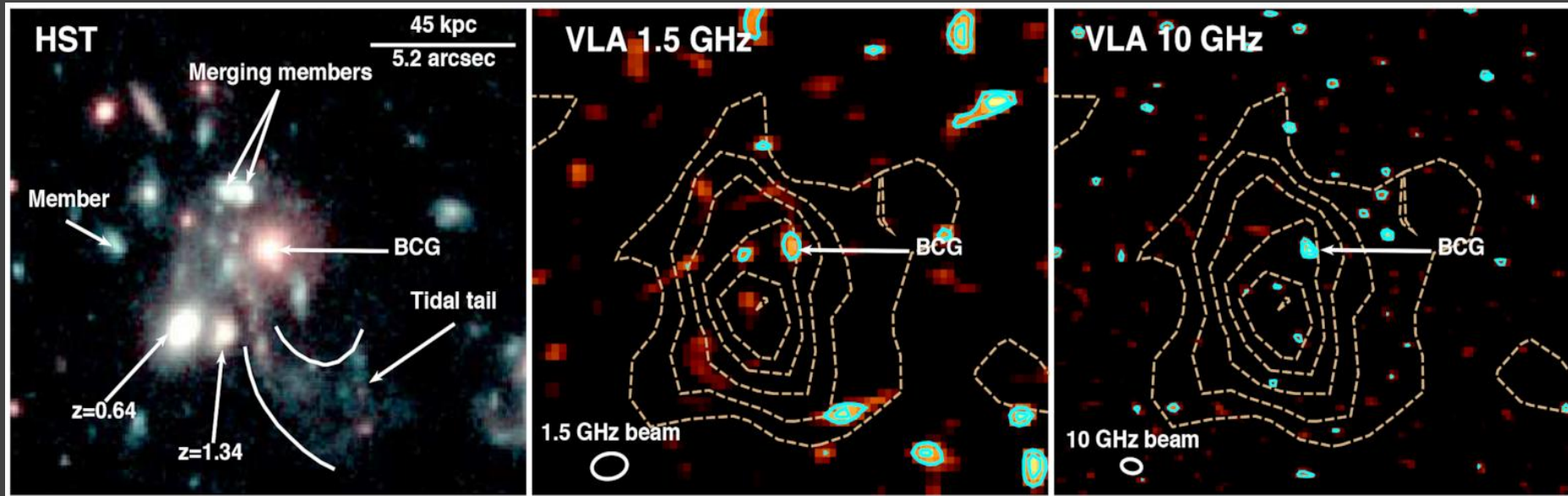
★ Gas-Rich Galaxy Merger



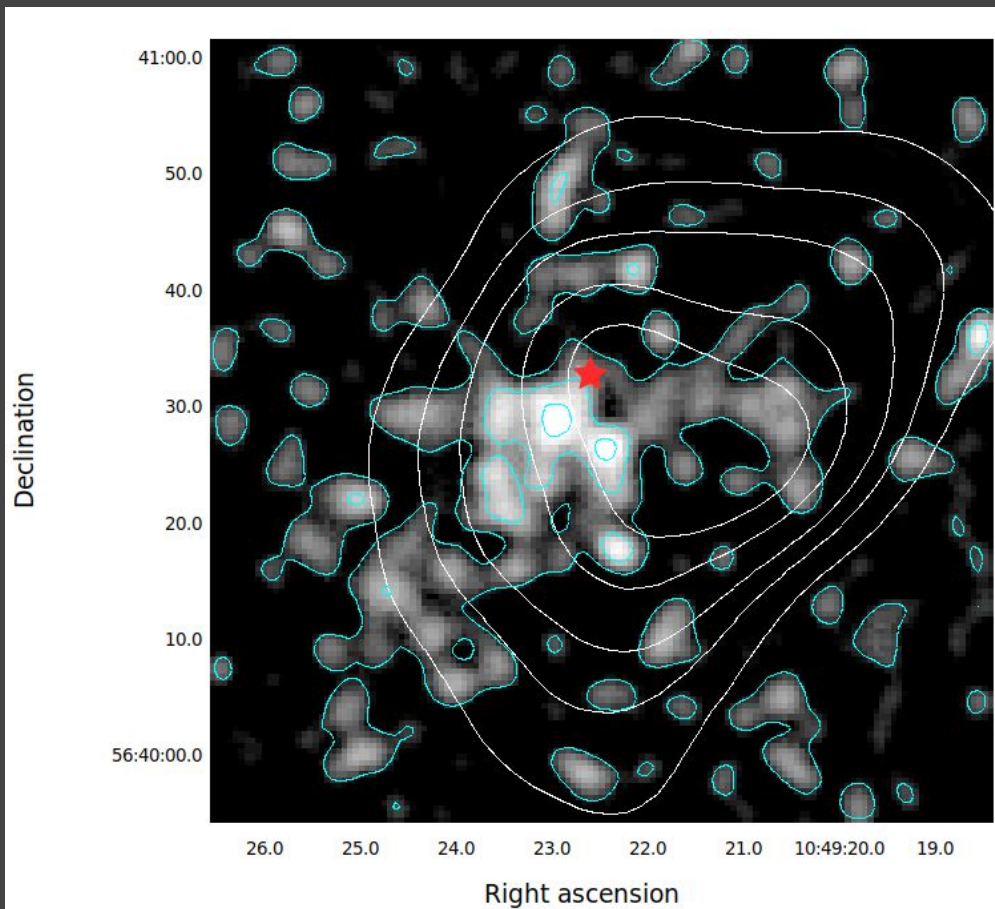
Gas-Wet Merger? No



A Radio View



X-rays with Chandra

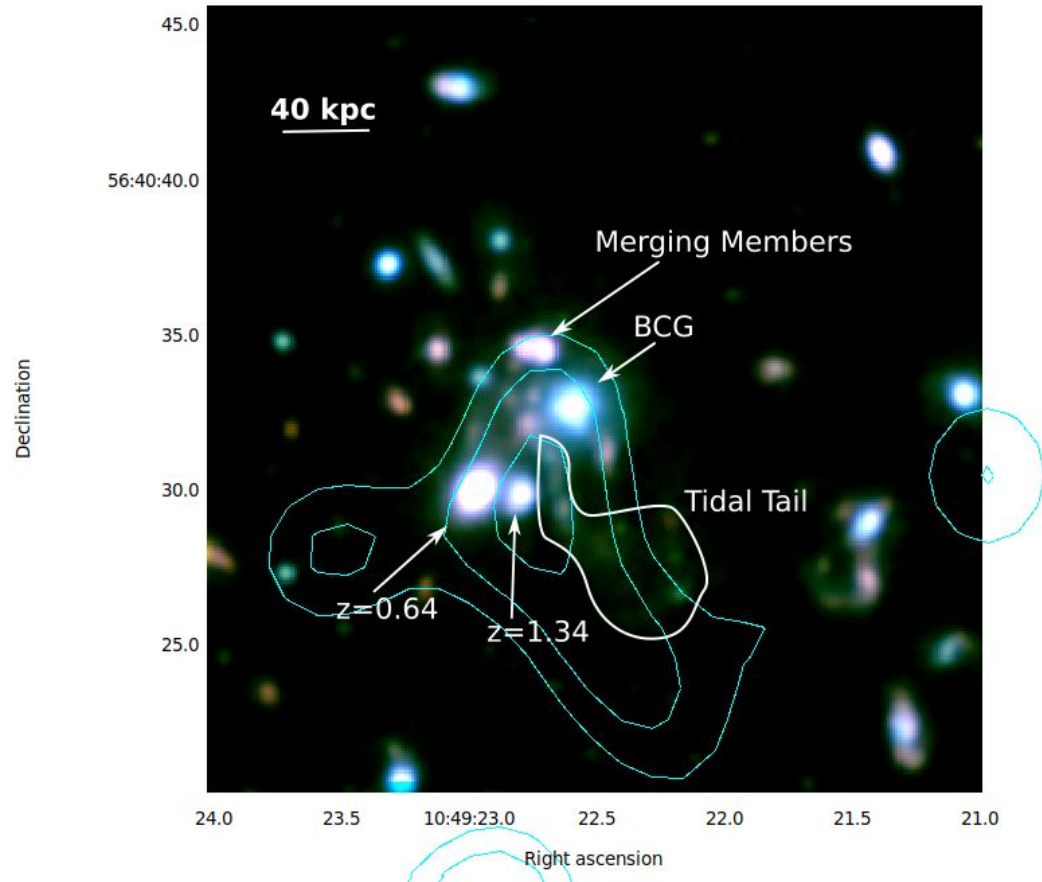


- 170 ks of Chandra Observations (50 hrs)
- Compact Morphology
- Coefficient of Surface Brightness indicates strong Cool Core (~ 0.19)



Chandra X-ray Observatory

An Uninhibited Cooling Flow



Conclusions



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Machine Learning Approach to Integral Field Unit Spectroscopy Observations: I. HII Region Kinematics

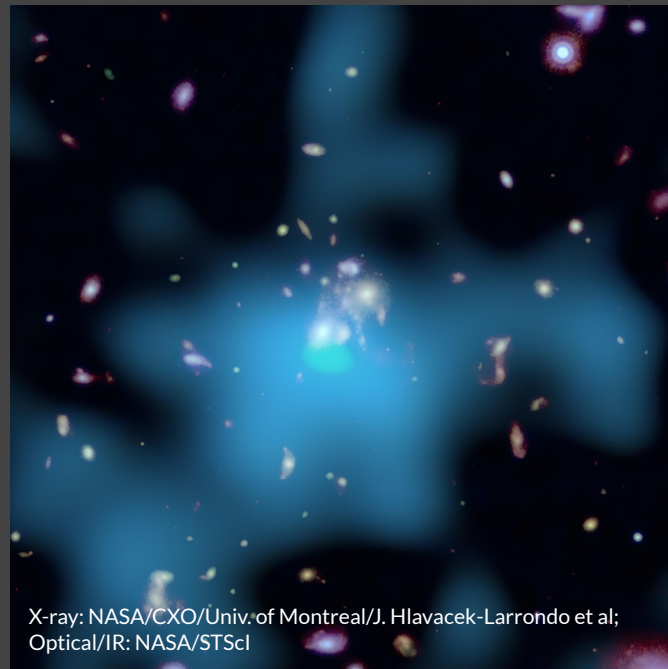
Arxiv: 2008.08093

A Novel Machine Learning Approach to Disentangle Multi-Temperature Regions in Galaxy Clusters

Arxiv: 2009.00643



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Optical/IR: NASA/STScI

