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
Arxiv: 2007.15660

Press Release:
Blog:
https://chandra.harvard.edu/blog/node/766
Galaxy Clusters

★ 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

★ Galaxy Cluster
  ○ 100’s-1000’s of Galaxies
  ○ $10^{14}$-$10^{15}$ M☉
High Redshift Galaxy Clusters

Recent High-z Cluster Surveys
- South Pole Telescope
- Spitzer Adaptation of the Red-Sequence Cluster Survey

Galaxy Formation History

Behroozi, P.S., Wechsler, R.H., Conroy, C.
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