THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

8th Wernher von Braun Memorial Symposium
October 27 – 29, 2015

1954 2015 American Astronautical Society

What do Shocks Tell us About Galaxy Clusters?

Sarthak Dasadia, Physics Department

Overview

- Dynamical activities triggered by mergers often produce discontinuities (e.g., shocks & cold fronts) between gas of different entropies that can be seen as surface brightness edges in X-ray observations.
- This provides an excellent opportunity to understand some important aspects of the intracluster medium (ICM) physics, such as gas velocity, thermal conduction, viscosity, self-interaction of dark matter and particle acceleration.

Explanation

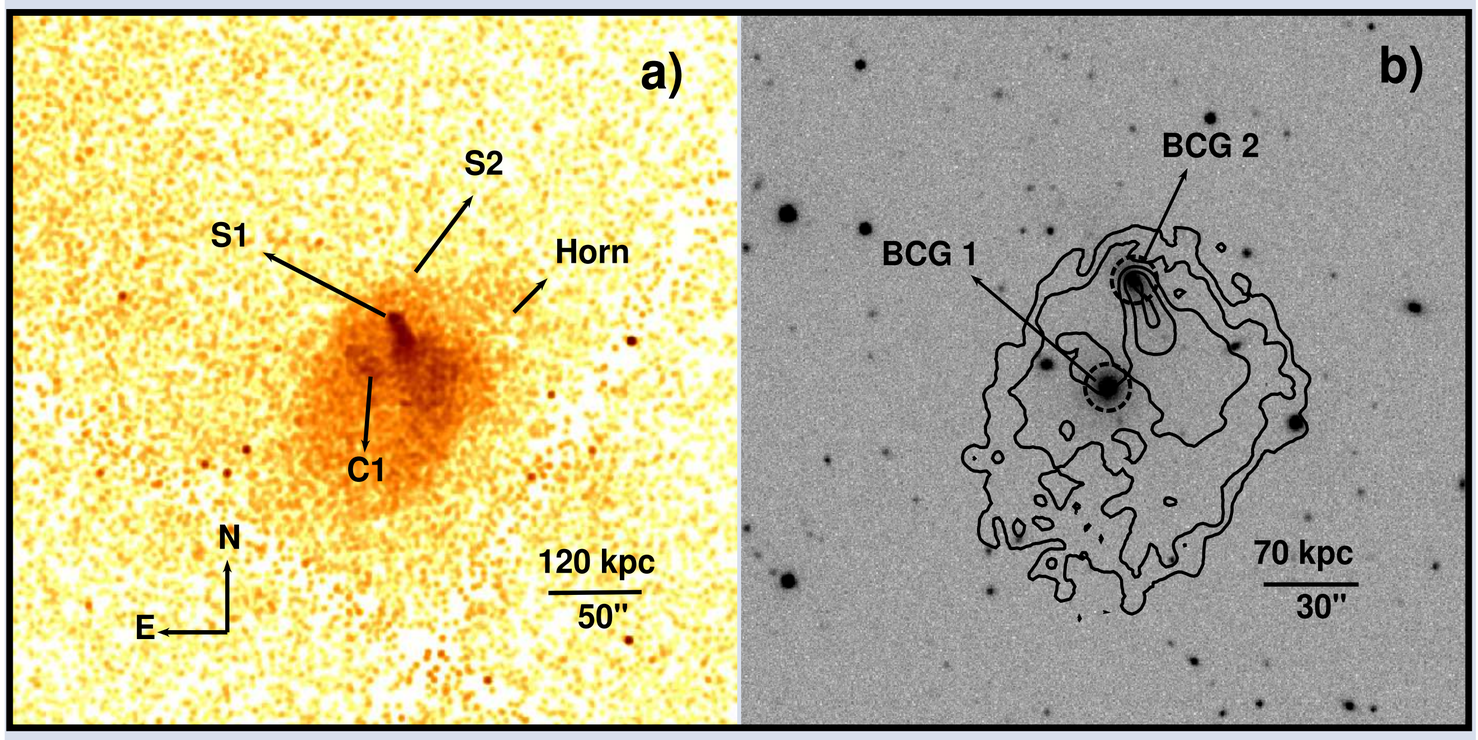
- During a merger, the infalling cool core of the merging subcluster marks a border separating it from the hot cluster atmosphere. This creates a region where the gas on denser, downstream side of the density jump is colder than that on the upstream side, known as “Cold Front”.
- Unlike cold fronts, bow shocks in merging clusters are relatively rare and only a few (~ 7-8) have been discovered so far. The projection effects and other irregularities in the image, such as the presence of substructures, bring observational challenges to detect bow shocks.

Impact

- ✓ **A unique bow shock system associated with a wide angle tail (WAT) radio galaxy.**
- ✓ **Active Galactic Nucleus (AGN) feedback can displace X-ray gas to form a cavity.**
- ✓ **Clusters without diffuse radio emission (DRE) tend to have lower system temperature and weather shocks than clusters with diffuse radio emission.**

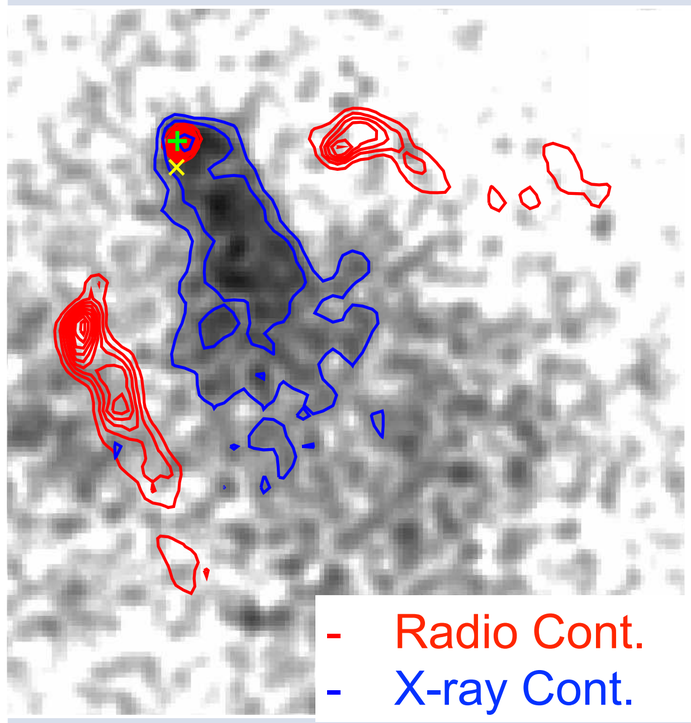
Key Findings

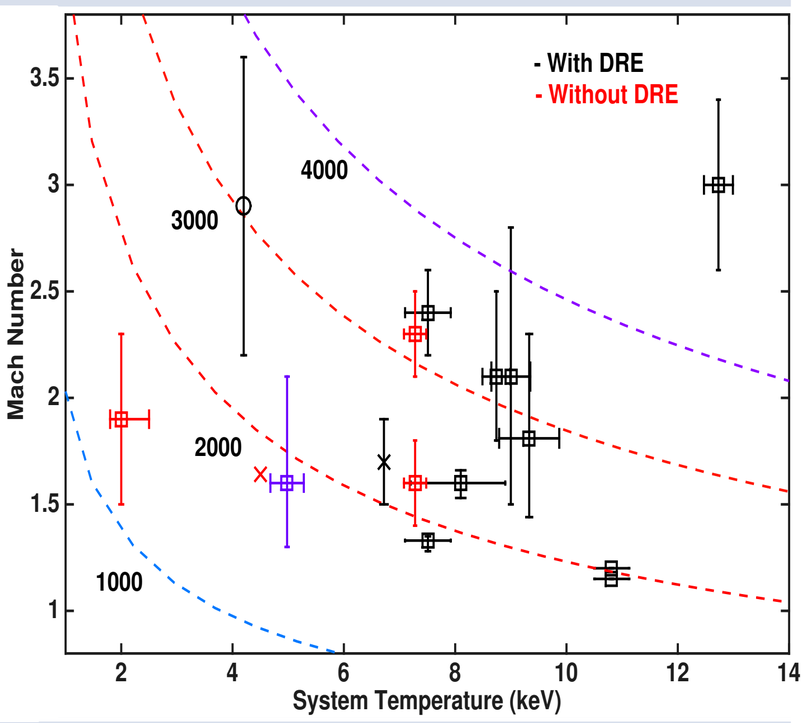
Discovery of a new bow shock (M = 1.6) in 3C89



Chandra X-ray Image — Optical Image (i-band)

- Merger between two clusters. The brightest galaxies of both clusters are marked by BCG 1 & 2.
- Text-book example of bow-shock (S2) ahead of infalling cluster core (S1).
- Shock Velocity: 1600 km/s.
- Temperature Jump = 1.5 & Density Jump = 1.8





- Radio jets are bent probably due to ICM pressure.
- Evidence of X-ray plasma being displaced by radio plasma (Horn).
- No diffuse radio emission is observed! (Probably due to the lower mass of the cluster).

Acknowledgements

Advisor: Dr. Ming Sun

Support for this work was provided by the National Aeronautics and Space Administration (NASA) through Chandra Award GO2-13160A.
Office of the Vice President for Research and Economic Development

CHANDRA X-RAY OBSERVATORY

COLLEGE OF SCIENCE
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

NASA