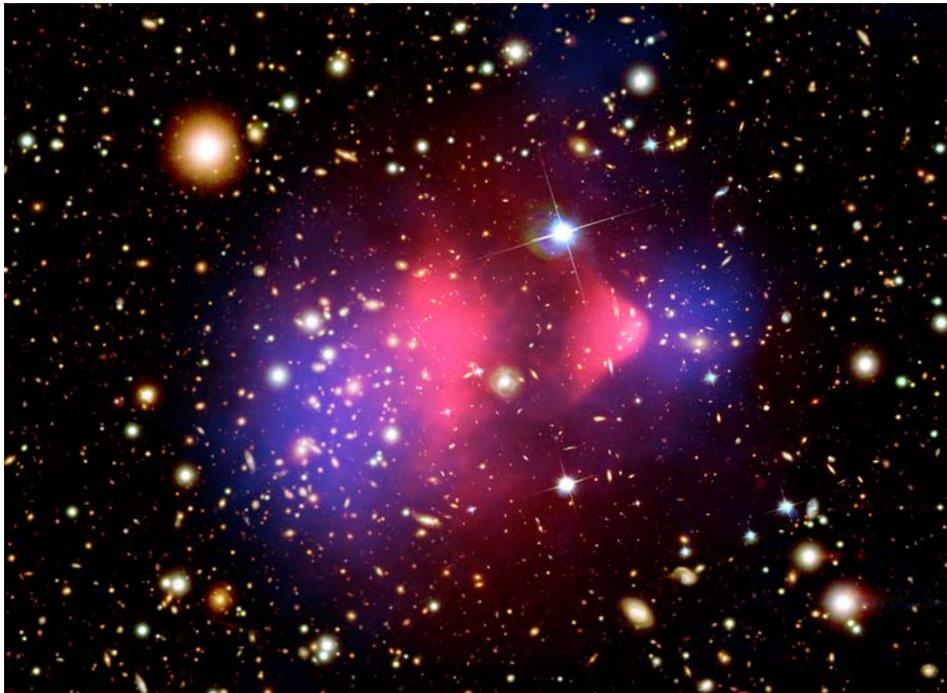




Chandra Science Highlight

1E 0567-56: NASA Finds Direct Proof of Dark Matter



Chandra X-ray Observatory ACIS image.

This composite image shows the galaxy cluster 1E 0657-56, also known as the “bullet cluster,” the site of an extremely energetic collision of a sub-cluster of galaxies (right) with the core of the main cluster (center). The image shows hot, X-ray producing gas (pink), and optical light from stars in the galaxies (orange and white). Using a technique known as gravitational lensing, astronomers have mapped peaks in the total mass surface density (blue).

- The image shows that the X-ray emitting plasma, which contains most of the normal, or baryonic mass of the cluster, is offset from the galaxies and peaks in total mass surface density.
- The prominent bow shock facing to the right in the X-ray gas indicates that the sub-cluster is currently moving away from the main cluster core at 4700 km/s.
- Drag forces due to the high speed collision pulled the hot gas away from the dark matter in both the cluster core and the sub-cluster. Neither dark matter nor the galaxies experience the drag force, so they moved ahead of the hot gas clouds.
- No non-standard gravitational theory that scales with baryonic mass can explain the separation of baryonic matter from dark matter. These observations therefore demonstrate that approximately 90% of the matter in the cluster is dark matter.

Reference: D. Clowe et al., 2006 *Astrophys. J.* 648, L109-L113

Credit: NASA/CXC/CfA/M.Markevitch et al.;
Optical: NASA/STScI; Magellan/U.Arizona/D.Clowe et al.;
Lensing Map: NASA/STScI; ESO WFI; Magellan/
U.Arizona/D.Clowe et al.