Chandra Science Highlight

Galaxy Clusters Used to Test Einstein's General Theory of Relativity

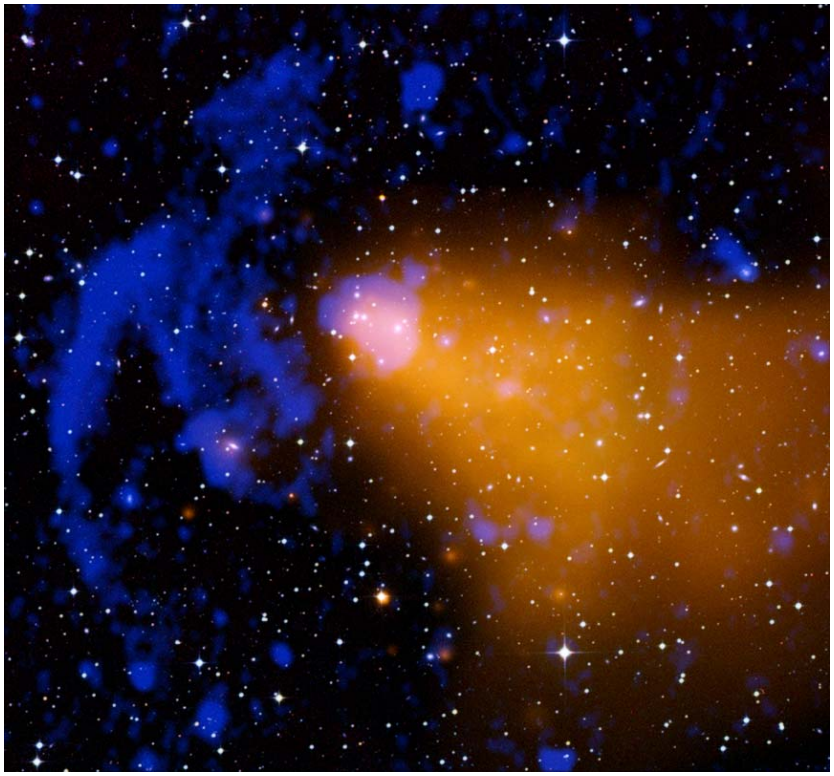

Image is 29 arc min (about 5 million light years) across

Distance Estimate: About 614 million light years (z=0.046)

Credits: X-ray: NASA/CXC/SAO/A.Vikhlinin; ROSAT), Optical (DSS), Radio (NSF/NRAO/VLA/IUCAA/J.Bagchi)

This composite image of the galaxy cluster Abell 3376 shows X-ray data from the Chandra X-ray Observatory and the ROSAT telescope in gold, an optical image from the Digitized Sky Survey in red, green and blue, and a radio image from the VLA in blue. The "bullet-like" appearance of the X-ray data is caused by a merger, as material flows into the galaxy cluster from the right side. The giant radio arcs on the left side of the image may be caused by shock waves generated by this merger.

- Mass estimates of 49 galaxy clusters, derived from Chandra observations, have been used to test an alternate to General Relativity in which the observed acceleration of the expansion of the universe comes not from an exotic form of energy but from a modification of the gravitational force.
- The modified force in the alternate theory, known as f(R) gravity, also affects the rate at which small enhancements of matter can grow over the eons to become massive clusters of galaxies. This makes possible a sensitive test of the theory because of the greatly enhanced gravitational forces acting in clusters.
- The research showed that there is no evidence that gravity is different from General Relativity on scales larger than 130 million light years, a hundred-fold improvement on the bounds of the modified gravitational force's range that can be set without using the cluster data.

References: Schmidt, F. Et al. 2009, Phys Rev D, 80, 083505

CXC operated for NASA by the Smithsonian Astrophysical Observatory

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