

Discovery of the Musket Ball Cluster

April 12 2012



This composite image shows Chandra (red) and Hubble (yellow and white) data of the galaxy cluster system that has been nicknamed the "Musket Ball" cluster. Astronomers call it this because the newly discovered cluster is older and slower than the Bullet Cluster, a famous system in which "normal" matter has been wrenched apart from dark matter. Chandra detects the normal matter as hot gas, while optical emission reveals the presence of dark matter through the effect of gravitational lensing (blue). DLSC1 J0916.2+2951 is further along in its evolution than the Bullet Cluster, giving scientists valuable insight into a different phase of how galaxy clusters -- the largest known objects held together by gravity -- grow and change after major collisions. Credit: X-ray: NASA/CXC/UCDavis/W.Dawson et al; Optical: NASA/STScI/UCDavis/W.Dawson et al.

(Phys.org) -- Using a combination of powerful observatories in space and on the ground, astronomers have observed a violent collision

between two galaxy clusters in which so-called normal matter has been wrenched apart from dark matter through a violent collision between two galaxy clusters.

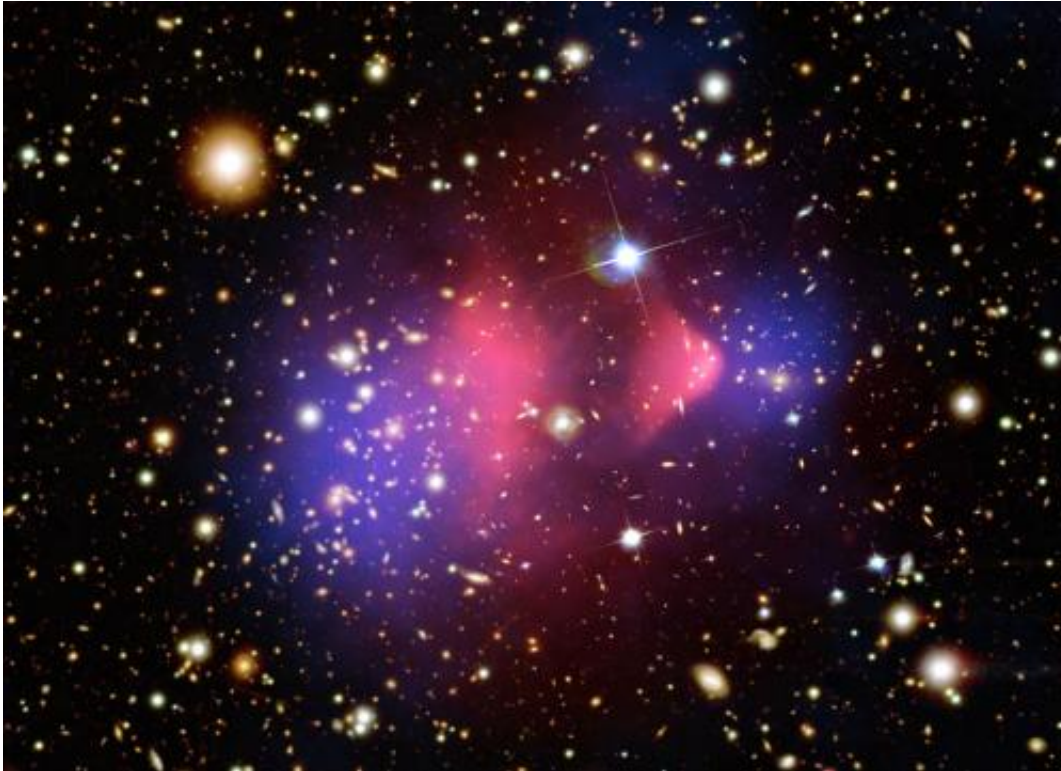
The newly discovered galaxy cluster is called DLSCL J0916.2+2951. It is similar to the Bullet Cluster, the first system in which the separation of dark and normal matter was observed, but with some important differences. The newly discovered system has been nicknamed the "Musket Ball Cluster" because the cluster collision is older and slower than the Bullet Cluster.

Finding another system that is further along in its evolution than the Bullet Cluster gives scientists valuable insight into a different phase of how [galaxy clusters](#) - the largest known objects held together by gravity - grow and change after major collisions. Researchers used observations from NASA's Chandra X-ray Observatory and Hubble Space Telescope as well as the Keck, Subaru and Kitt Peak Mayall telescopes to show that hot, X-ray bright gas in the Musket Ball Cluster has been clearly separated from dark matter and galaxies.

In this composite image, the hot gas observed with Chandra is colored red, and the galaxies in the optical image from Hubble appear as mostly white and yellow. The location of the majority of the matter in the cluster (dominated by dark matter) is colored blue. When the red and the blue regions overlap, the result is purple as seen in the image. The matter distribution is determined by using data from Subaru, Hubble and the Mayall telescope that reveal the effects of gravitational lensing, an effect predicted by Einstein where large masses can distort the light from distant objects.

In addition to the Bullet Cluster, five other similar examples of merging clusters with separation between normal and dark matter and varying levels of complexity, have previously been found. In these six systems,

the collision is estimated to have occurred between 170 million and 250 million years earlier.



This composite image shows the galaxy cluster 1E 0657-56, also known as the "bullet cluster." This cluster was formed after the collision of two large clusters of galaxies, the most energetic event known in the universe since the Big Bang. Credit: X-ray: 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.

In the Musket Ball Cluster, the system is observed about 700 million years after the collision. Taking into account the uncertainties in the age estimate, the merger that has formed the Musket Ball Cluster is two to five times further along than in previously observed systems. Also, the relative speed of the two clusters that collided to form the Musket Ball

cluster was lower than most of the other Bullet Cluster-like objects.

The special environment of galaxy clusters, including the effects of frequent collisions with other clusters or groups of galaxies and the presence of large amounts of hot, intergalactic gas, is likely to play an important role in the evolution of their member galaxies. However, it is still unclear whether cluster mergers trigger star formation, suppress it, or have little immediate effect. The Musket Ball Cluster holds promise for deciding between these alternatives.

The Musket Ball Cluster also allows an independent study of whether dark matter can interact with itself. This information is important for narrowing down the type of particle that may be responsible for [dark matter](#). No evidence is reported for self-interaction in the Musket Ball Cluster, consistent with the results for the Bullet Cluster and the other similar clusters.

The Musket Ball Cluster is located about 5.2 billion light years away from Earth. Findings on the Musket Ball Cluster were presented at the American Astronomical Society meeting in Austin, TX in January by Will Dawson from the University of California, Davis.

More information: A paper describing these results led by Dawson was published in the March 10, 2012 issue of *The Astrophysical Journal Letters*.

Provided by Chandra X-ray Center

Citation: Discovery of the Musket Ball Cluster (2012, April 12) retrieved 6 May 2024 from <https://phys.org/news/2012-04-discovery-musket-ball-cluster.html>

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