

A clash of clusters provides another clue to dark matter

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This astounding view of galaxy cluster MACSJ0025 demonstrates how ordinary matter and mysterious dark matter interact. The blue cloud-shaped parts flanking the centre show the position of dark matter, mapped by the Advanced Camera for Surveys onboard the NASA/ESA Hubble Space Telescope. The pink middle indicates ordinary matter, charted by NASA's Chandra X-Ray Observatory. The position of the two matter types shown in the image are explained by MACSJ0025's origin. It was formed when a pair of large galaxy clusters collided. Ordinary matter in the form of hot gas slowed down and pooled at the centre but ghostly dark matter passed straight through. Hubble used a technique known as gravitational lensing to obtain its data. The light observed was bent by the gravitationally massive galaxy cluster, resulting in an incredibly detailed image. This technique was originally predicted by Einstein. MACSJ0025 is located in the constellation Cetus, the Whale. Credit: NASA, ESA, CXC, M. Bradac (University of California, Santa Barbara, USA), and S. Allen (Stanford University, USA).

New Hubble and Chandra observations of the cluster known as MACSJ0025.4-1222 indicate that a titanic collision has separated dark from ordinary matter. This provides independent confirmation of a similar effect detected previously in a target dubbed the Bullet Cluster, showing that the Bullet Cluster is not an anomalous case.

A powerful collision of galaxy clusters has been captured with NASA's Chandra X-ray Observatory and Hubble Space Telescope. Like its famous cousin, the so-called Bullet Cluster, this clash of clusters provides striking evidence for dark matter and insight into its properties.

Like the Bullet Cluster, this newly studied cluster, officially known as MACSJ0025.4-1222, shows a clear separation between dark and ordinary matter. This helps answer a crucial question about whether dark matter interacts with itself in ways other than via gravitational forces.

This finding is important because it independently verifies the results found for the Bullet Cluster in 2006. The new results show the Bullet Cluster is not an exception and that the earlier results were not the product of some unknown error.

Just like the original Bullet Cluster, MACSJ0025 formed after an incredibly energetic collision between two large clusters in almost the plane of the sky. In some ways, MACSJ0025 can be thought of as a prequel to the Bullet Cluster. At its much larger distance of 5.7 billion light years, astronomers are witnessing a collision that occurred long before the Bullet Cluster's.

Using optical images from Hubble, the team was able to infer the distribution of the total mass (colored in blue) -- dark and ordinary matter -- using a technique known as gravitational lensing. The Chandra

data enabled the astronomers to accurately map the position of the ordinary matter, mostly in the form of hot gas, which glows brightly in X-rays (pink).

An important difference between the Bullet Cluster and the new system is that MACSJ0025 does not actually contain a "bullet". This feature is a dense, X-ray bright core of gas that can be seen moving through the Bullet Cluster. Nonetheless, the amount of energy involved in this mammoth collision is nearly as extreme as that found in the Bullet Cluster.

As the two clusters that formed MACSJ0025 (each almost a whopping million billion times the mass of the Sun) merged at speeds of millions of miles per hour, the hot gas in each cluster collided and slowed down, but the dark matter did not. The separation between the material shown in pink and blue therefore provides direct evidence for dark matter and supports the view that dark matter particles interact with each other only very weakly or not at all, apart from the pull of gravity.

One of the great accomplishments of modern astronomy has been to establish a complete inventory of the matter and energy content of the Universe. The so-called dark matter makes up approximately 23% of this content, five times more than the ordinary matter that can be detected by telescopes. The latest results with MACSJ0025 once again confirm these findings.

The results will appear in an upcoming issue of *The Astrophysical Journal*.

Source: Hubble Information Centre

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