When galaxy clusters collide

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A UC Davis graduate student who is leading a study of the collision of galaxy clusters 5 billion light years away will discuss the team's findings today, Jan. 10, in a press briefing at the annual meeting of the American Astronomical Society in Austin, Texas.

"A galaxy cluster is like a little universe, because it has the same matter composition as the whole universe," said William Dawson, a Ph.D. candidate in physics. "By studying this little universe, we can learn more about our own."

This "little universe" is formally called DLSCL J0916.2+2951 and consists of two clusters of hundreds of galaxies each, in the process of merging into one.

It is nicknamed Perry's Cluster, after team member Perry Gee, a UC Davis research scientist who discovered it. It is similar to another merging cluster — the Bullet Cluster — but relatively further along in its development.

Perry's Cluster comprises about 86 percent dark matter, 12 percent superheated gas and 2 percent actual stars. Those proportions are similar to the distribution of mass in the universe as a whole, Dawson said.

Dark matter is thought to interact very little, if at all, with "regular" matter and does not emit light. But it does exert a gravitational pull on light passing through or near it, distorting the image of distant objects — rather like looking through the bottom of a glass bottle.

Dawson and colleagues mapped the visible galaxies in Perry's Cluster by using the Hubble Space Telescope, the 8-meter Subaru Telescope in Hawaii, the 4-meter Mayall Telescope at the Kitt Peak National Observatory in Arizona and the twin 10-meter telescopes at the W.M. Keck Observatory in Hawaii, and the orbiting Chandra X-ray Observatory for the super-hot gas.

And, with the Hubble, Subaru and Mayall telescopes, the researchers mapped the dark matter by observing distortions in light passing through the cluster from more distant objects — a method called weak gravitational lensing.

The map revealed that the two galaxy clusters within Perry's Cluster had passed through each other — the spaces between the galaxies within the clusters are so vast that actual collisions are unlikely — and that most of the dark matter also had passed through without collision.

Not so with the gas clouds — they had collided and become stuck between the clusters, making a huge cloud of gas a thousand times hotter than the surface of the Sun.

"Because these mergers separate the various matter components of the cluster, they provide astronomers with dissection of the cosmos that would otherwise be impossible," Dawson said.

By comparing and contrasting the behavior of the dark matter to that of the galaxies and gas in the merging cluster, physicists can rule out some theories about dark matter's properties.

The energy of these merging clusters is incomprehensibly large, Dawson said — a million-million times bigger than a supernova. Only a handful have been studied to date.

The cluster is the most advanced of these merging clusters yet seen, Dawson said. Every great advance in our understanding of the physical world is the direct result of understanding how things change with time, so the hope is that by observing clusters at different stages of merging, astronomers can gain insight into the physics involved, he said.

Provided by University of California - Davis