Galaxy Clusters Have a Mysterious Motion

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(PhysOrg.com) -- The stars are in motion, and on a much larger scale than can be explained with current theories, according to astronomers at NASA, the University of Hawaii and UC Davis. The finding could improve our understanding of events in the first moments after the birth of the universe.

The researchers found an unexpected motion, or "flow," of galaxy clusters across a wide patch of the sky up to at least a billion light years away.

Local flows of galaxies and galaxy clusters are well-known, said Dale Kocevski, a postdoctoral researcher at UC Davis who was part of the team. For instance, our own Milky Way galaxy is moving toward the Andromeda galaxy, and the galaxy group that includes both Andromeda and the Milky Way is moving at about 600 kilometers a second.

These motions happen because matter -- both stars, dust and gas and the more abundant but invisible "dark matter" -- is distributed in uneven clumps, and gravity pulls galaxy clusters toward those clumps. Astronomers call these clumps "anisotropies."

But the newly detected motion is over far too large an area to be explained in that way, say Kocevski and colleagues Alexander Kashlinsky at NASA's Goddard Space Flight Center in Greenbelt, Md.; Fernando Atrio-Barandela of the University of Salamanca, Spain; and Harald Ebeling of the University of Hawaii.

"It's too big an effect to be due to anisotropies in matter or dark matter," Kocevski said. Because the force of gravity decreases with the inverse square of distance, an effect over such a wide area would require far more mass than can actually exist there, he said.

The astronomers found the effect by using a catalog of 700 galaxy clusters observed with X-ray astronomy, and NASA's Wilkinson Microwave Anisotropy Probe, which shows tiny variations in the microwave background radiation of the universe left over from the Big Bang.

Hot X-ray-emitting gas in a galaxy cluster scatters photons from the cosmic microwave background. The wavelengths of these scattered photons change in a way that reflects each cluster's individual motion. This results in a minute shift of the microwave background's temperature in the cluster's direction. In 2000, Kashlinsky and Atrio-Barandela found a way to amplify this effect and employ it to measure the motion of distant galaxy clusters.

Big Bang models that include a feature called inflation offer a possible explanation for the flow. Inflation is the idea that shortly after the Big Bang, the universe expanded extremely rapidly. If inflation did occur, then the universe we can see is only a small portion of the whole cosmos.

There may have been a "tilt" to the universe, or motion already in progress, before inflation occurred, Kocevski said. Or, the clusters could be responding to the gravitational attraction of matter that was pushed far beyond the observable universe by inflation.

"This measurement may give us a way to explore the state of the cosmos before inflation occurred," Kashlinsky said.

A paper describing the results was published online in the journal

Astrophysical Journal Letters on Sept. 24.

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