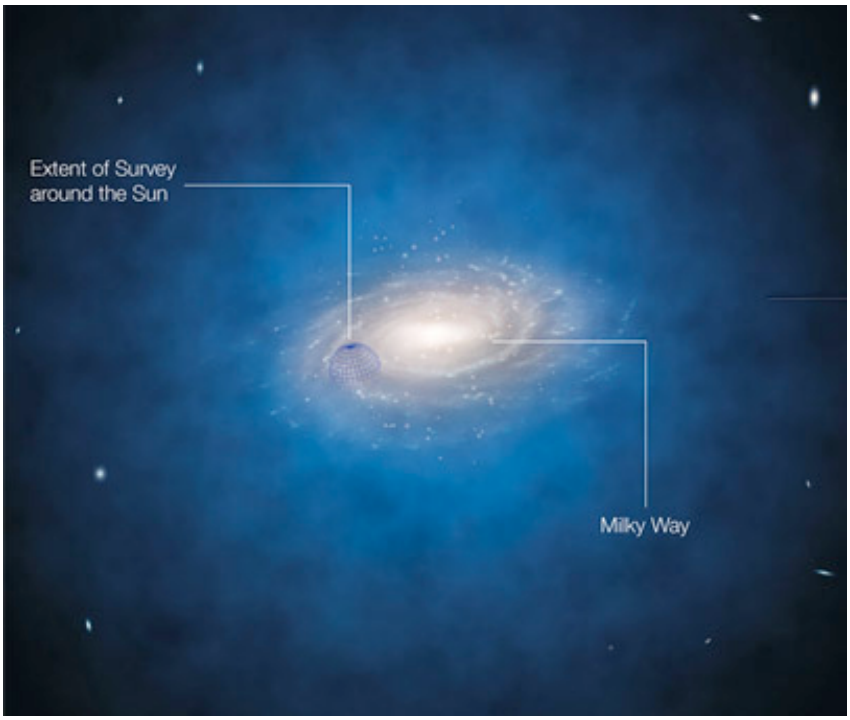
Where's the dark matter? Not here, befuddled astronomers find

April 18, 2012
Courtesy of the European Southern Observatory
and World Science staff

Conventional astronomy holds that there's a mysterious, invisible substance called dark matter, and though we don't know its precise nature, it permeates much of the universe.

Now, conventional astronomy may have a problem.

Dark matter is not here, a new study has concluded. It might be somewhere else, but not in, or even anywhere near, our solar system. And that's a big problem, because it should be all over the galaxy. To make matter worse, dark matter is still sadly very much needed to plug other gaps in astronomical theories.



The diagram shows our Milky Way galaxy and the presumed "halo" of dark matter, shown in fuzzy blue. A new study searched for gravitational evidence of dark matter in a sphere surrounding our solar system, shown as a small round grid.

Dark matter has been previously identified based on what would seem to be gravitational forces exerted by vast blobs of this material, surrounding and filling galaxies.

Yet the new study—the most accurate to date of the motions of stars in the Milky Way—turned up no evidence for dark matter in a large zone around us, researchers said.

Using telescopes including one at the European Southern Observatory's La Silla Observatory in Chile, the scientists mapped the motions of more than 400 stars up to 13,000 light-years from the Sun (a light-year is the distance light travels in a year). From that data they calculated the total mass, or weight, of material in the vicinity of the Sun, in a space four times larger than ever considered before.

"The amount of mass that we derive matches very well with what we see," said team leader Christian Moni Bidin of the Universidad de Concepcion in Chile. "But this leaves no room for the extra material

—dark matter—that we were expecting. Our calculations show that it should have shown up very clearly in our measurements. But it was just not there!"

Dark matter was originally proposed to explain why the outer parts of galaxies, including our own, spin more quickly than they should based on the visible objects and their gravitational interactions. Dark matter now also forms an essential part of theories of how galaxies formed and evolved. It's widely assumed that dark matter constitutes about four-fifths of the mass in the universe. Difficulties in clarifying the nature of dark matter, or in finding it on Earth, have annoyed scientists, but not to the point that most of them would doubt its existence.

Members of Bidin's team measured the motions of many stars, particularly those away from the flat disc of stars that forms the bulk of the visible Milky Way. They then worked backwards using the laws of gravity to deduce how much matter of any type is present.

If dark matter were here, conventional theories hold it should surround our Milky Way galaxy like a halo, as it does other galaxies. The new findings don't utterly rule out such a halo, but it would have to take a very unlikely shape to avoid penetrating our part of the galaxy, so things look awkward for dark matter theory, Bidin and colleagues suggested.

The new results also mean that attempts to detect dark matter on Earth by trying to spot the rare interactions between dark matter particles and "normal" matter are likely to fail, Bidin said.

Meanwhile, the "missing mass" problem that prompted dark matter theory in the first place has not gone away.

"The Milky Way certainly rotates much faster than the visible matter alone can account for," Bidin said. "So if dark matter is not present where we expected it, a new solution for the missing mass problem must be found. Our results contradict the currently accepted models. The mystery of dark matter has just become even more mysterious. Future surveys, such as the (European Space Agency's) Gaia mission, will be crucial to move beyond this point."