The dark side of the Universe

Dark matter: the known and the unknown

Jonathan Freundlich

We are all made of the same building blocks: particles such as protons, neutrons and electrons. All the matter we can see is made of these particles. But what if they were only a small portion of all the matter in the Universe? What if there were other forms of matter? As strange as it may seem, the current model describing the Universe assumes the existence of an unseen type of matter.

Cosmic whirling dances

Gravity is the invisible bound that makes apples fall towards the ground and satellites like the Moon orbit around the Earth instead of flying away. The Moon is indeed always falling towards us, but its velocity makes it drift sideways and circle instead of falling straight down. It will always continue to circle and its velocity is set by the mass of the Earth and by the distance between the two celestial bodies. If the Earth was more massive, the Moon would spin faster around us!

On bigger scales, galaxies are also held by gravity. Galaxies often look like magnificent whirlpools, in which billions of stars and huge amounts of gas orbit around a central black hole. As for the Moon, the speed at which these stars rotate should be set by the mass of the galaxy and by the distance from its center. The more massive a galaxy is, the faster its stars rotate.

Some mass is missing!

But stars actually orbit faster than they should, as if galaxies were much more massive than observations suggest. Could there be some matter we can't see? Is our theory of gravitation wrong? The easiest answer is to assume that there is some additional invisible matter in all galaxies: dark matter. This assumption is not necessarily strange, as our perception of the Universe is always limited: for example, our eyes can't see ultraviolet or infrared light, although we know it exists.

STILL IN THE DARK *The Whirlpool Galaxy is a typical spiral galaxy with stars and gas rotating around its center.* CREDITS: NASA/HUBBLE

The current model describing the Universe used by most astrophysicists assumes the existence of a dark matter that is fundamentally different from all other types of matter. It wouldn't be made of protons, neutrons and electrons as we are. Indeed, the amount of ordinary matter was set once and for all at the beginning of our Universe, and it can't account for the large amount of dark matter that is needed to explain the velocities of stars in galaxies. There should be more than five times more dark matter than ordinary matter!

In search for dark matter

Uncovering dark matter is one of the big challenges of physics today. But as dark matter shouldn't emit or absorb any light, nor interact much with ordinary matter, it should be totally invisible and almost impossible to detect directly. Hundreds of dark matter particles may be just crossing your body right now, without you noticing anything! We can just observe its gravitational influence on the visible matter at large scales, or hope to detect compatible new particles in colliders such as the ones at CERN, in Switzerland. Much is expected from particle colliders in the next few years.

It might also be possible to explain the velocities of stars in galaxies without dark matter. That would require to change our models drastically! Notably, we would have to change our conception of gravitation itself. Dark matter is still one of the great mysteries of the Universe, but the next few years might be crucial for our understanding of it. Stay tuned!

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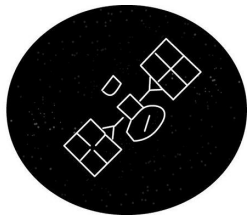
Did you know?

- The Swiss astronomer Fritz Zwicky first used the term "dark matter" in the 1930s to explain the velocities inside a cluster of galaxies and the apparent missing mass, but the idea became much more popular in the 1970s with U.S. astronomer Vera Rubin and her observations of the velocities of stars in galaxies.
- The Israeli physicist Mordehai Milgrom proposed a serious alternative theory to dark matter in 1983, which modifies Newton's law of gravitation.
- Collisions of highly energetic particles can sometimes produce new types of particles. The Large Hadron Collider (LHC) at CERN is the largest and most powerful particle collider in the world.



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