NASA and ESA image

When you look at the sky in a dark, clear night...

Andromeda, our neighbour, 2 million light years away

1 light year = 9.5 trillion kilometres





Mapping the visible Universe

Most of the matter (85%) is invisible





Dark Matter Map in Galaxy Cluster Abell 1689 Hubble Space Telescope ACS/WFC NASA, ESA, and D. Coe (JPL/Caltech and STScI)

Gravitational lensing the gravitational field bends light



Hubble Space Telescope, 1994

Fritz Zwicky: Coma cluster

Fritz Zwicky: Coma cluster



Rotverschiebung extragalaktischer Nebel.

Um, wie beobachtet, einen mittleren Dopplereffekt von 1000 km/sek oder mehr zu erhalten, müsste also die mittlere Dichte im Comasystem mindestens 400 mal grösser sein als die auf Grund von Beobachtungen an leuchtender Materie abgeleitete¹). Falls sich dies bewahrheiten sollte, würde sich also das überraschende Resultat ergeben, dass dunkle Materie in sehr viel grösserer Dichte vorhanden ist als leuchtende Materie.

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Vera Rubin: Galaxies





Dark matter forms structures and galaxies

But: what is it made of?



First: what is normal matter made of?





http://www.symmetrymagazine.org



stars, planets, people, polenta,...



Particles from a very early phase of our Universe

These particles make up the halo of our Milky Way

Visible galactic disk



Dark matter halo

Visible galactic disk

Dark matter halo

How to make them visible?

Look for very rare collisions of such particles with atomic nuclei



How to make them visible?

Look for very rare collisions of such particles with atomic nuclei



Example: neutrinos from the Sun

6500 billions through your hand, every second

Dark matter particles:



~ 10 millions through your hand, every second

Where to detect dark matter particles?

Deep underground: to shield from cosmic rays



How exactly? Build a large, ultrasensitive detector filled with 3.5 tonnes of liquid xenon







3.5 tonnes of liquid xenon? Where from?

Abundance in the Earth atmosphere [Volume, ppm]:

Argon: "the inactive one" (9348), neon: "the new one" (18), krypton: "the hidden one" (1.14), xenon: "the strange one" (0.09)



The XENON1T detector at the Gran Sasso Laboratory



The XENON1T time projection chamber at UZH



The XENON1T time projection chamber at UZH









Xenon1T chasse la matière noire

La découverte de la matière noire est-elle enfin proche? C'est en tout cas le grand espoir des astrophysiciens et physiciens des particules, tant l'instrument inauguré le 11 novembre dans le laboratoire sous-terrain de Gran Sasso, en Italie, paraît prometteur. Plus gros, plus précis, plus isolé que tous ses concurrents, Xenon 1 tonne devrait se lancer dans la grande chasse en février afin de mettre la main sur la fameuse particule fantôme. Voilà en effet trente ans que l'on sait que 80 % de la matière de l'Univers n'est pas «normale». Mais de quoi est-elle faite? Réponse, peut-être, au printemps. LACKNER



Jan 15, 2016, CERN Courier XENON opens a new era for dark-matter searches The recently inaugurated XENON1T detector is designed to be the most sensitive experiment for the direct search of WIMPs

Short movie about the XENON1T construction