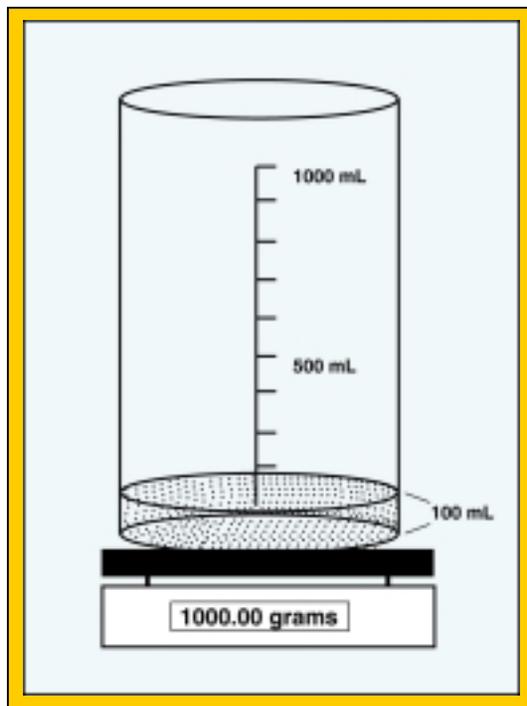




Cosmic Chemistry: Cosmogony

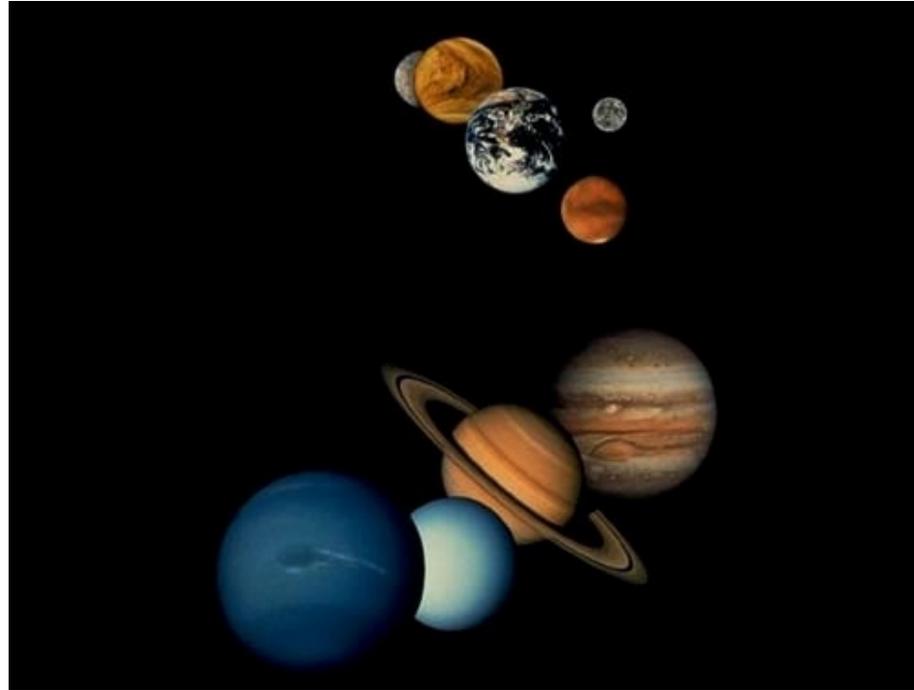
Dark Matter—More Than Meets the Eye

Student Text Supplement



Beaker containing 100 mL of water on a balance.

If a beaker contains 100 mL of water, we expect the water to have a mass of 100 grams, since the density of water is 1 g/1 mL. Let's say the balance showed the contents of the beaker to have a mass of 1000.00 grams. Ah, there must be more to this situation than "meets the eye."



In our solar system, the inner planets revolve more rapidly in orbit than do those farther out. Why do you think this is so?

Most astronomers thought that rotating galaxies should show the same characteristics as our solar system.



M100: A Grand Design

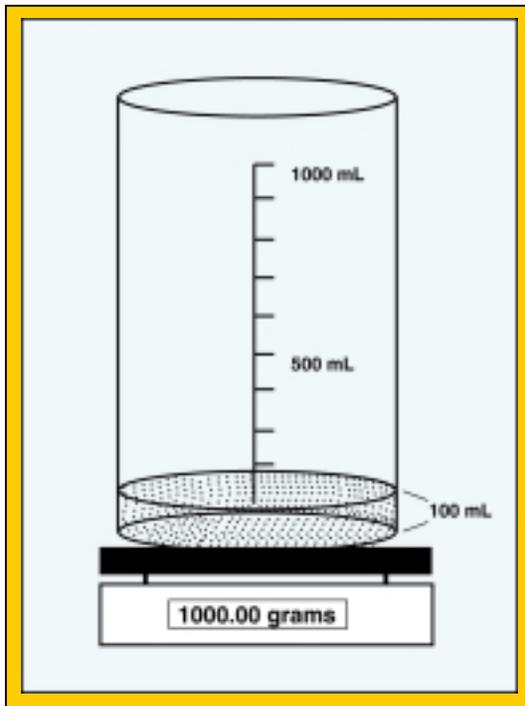
NASA



Milky Way Galaxy in Infrared

NASA

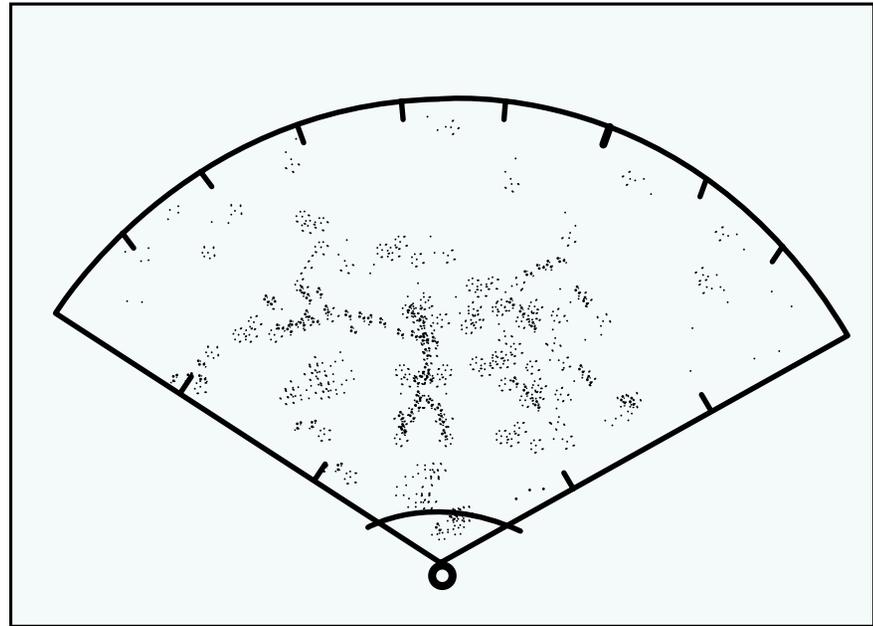
Scientists were surprised to find that there are stars in our galaxy at a **greater** distance from the center of the galaxy than our sun that revolve **faster** than our sun!



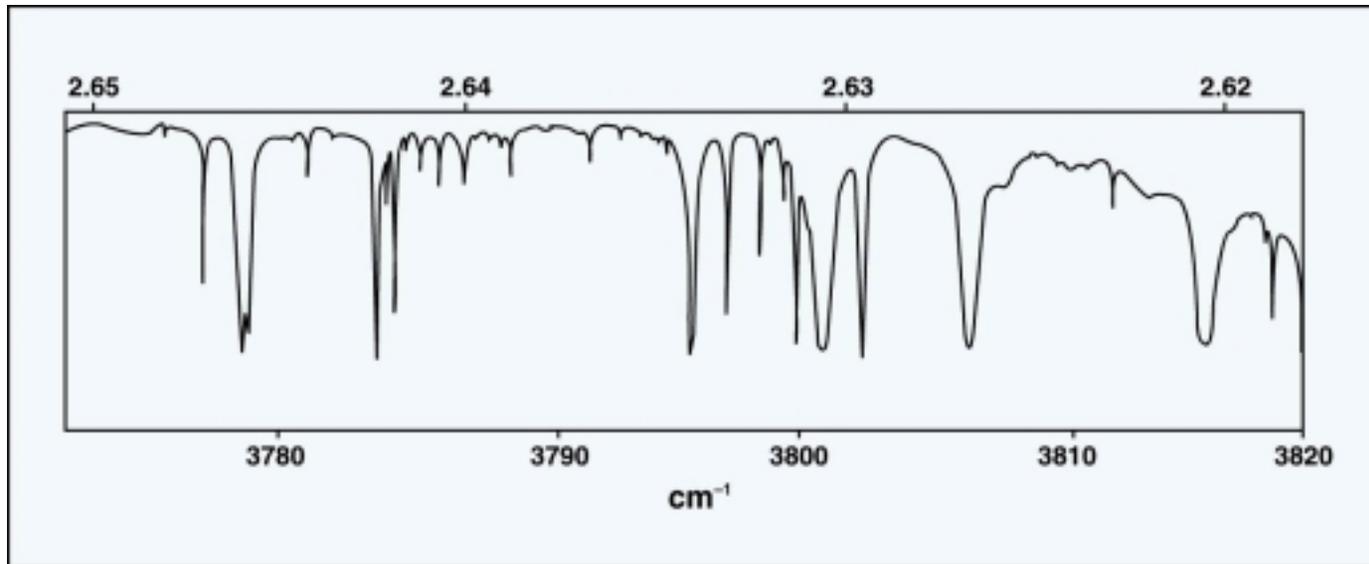
Beaker containing 100 mL of water on a balance.

Could one answer to our beaker “discrepant event” be that 90% of its contents are dark matter?

Dark matter may be clumped around galaxies, in much the same way that we found matter clumped around voids in “The Spongy Universe.”



A map of a slice through the universe, where the Earth is at the point of the wedge and the distance from the Earth increases as one moves away from the point.

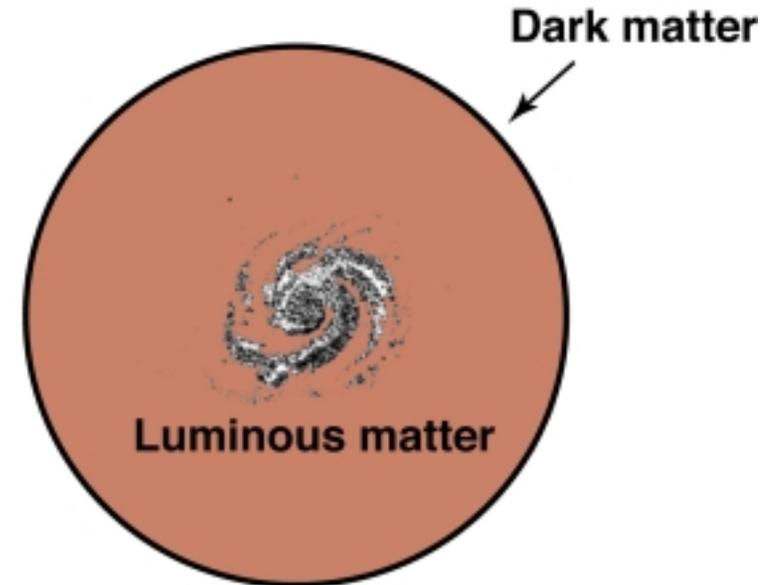


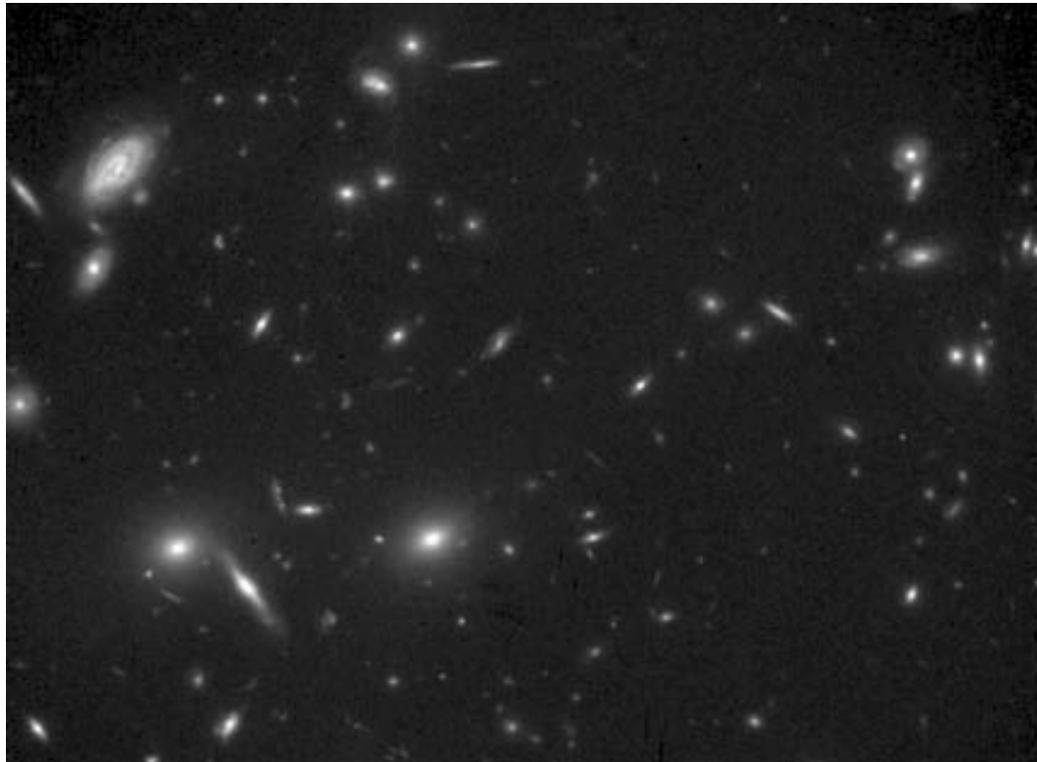
A **spectroscope** can be used to detect composite radiation spectra of individual stars and gas in a particular location of a spiral galaxy.



Gravitational lensing is a technique for measuring distance that takes advantage of the fact that matter distorts the space surrounding it.

Across the visible part of a galaxy, the luminous disk is matched by an equal *nonluminous halo* mass of dark matter.





A Distant Cluster of Galaxies

NASA

Clusters of galaxies are at least nine-tenths dark matter.

ELEMENTARY PARTICLES THAT MIGHT MAKE UP DARK MATTER	
<u>Baryons (MACHOs)</u>	<u>Leptons (WIMPs)</u>
protons	electrons
neutrons	neutrinos

MACHOs stands for **Massive Compact Halo Objects**.
MACHOs are made of **baryons**.

WIMPs are **leptons**, an abbreviation for **Weakly Interacting Massive Particles**.



Where does that leave us?