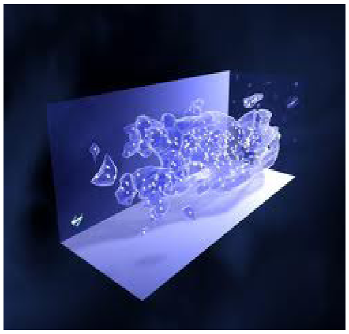
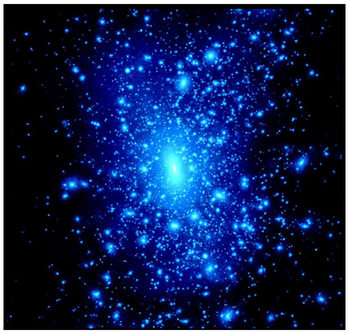
Dark Matter

The invisible stuff.





When the Universe was young, it was nearly smooth and featureless. As it grew older and developed, it developed structure. We know that our solar system is structured into planets (including the Earth!) orbiting around the Sun. On a scale much larger than the solar system (about 100 million times larger!), stars collects themselves into galaxies. Our Sun is an average star in an average galaxy called the Milky Way. The Milky Way contains about 100 billion stars. Yes, that's 100,000,000,000 stars! On still larger scales, individual galaxies are concentrated intro groups, or what astronomers call clusters of galaxies.

The cluster includes the galaxies and any material which is in the space between galaxies. The force, or glue, that holds the cluster together is gravity – the mutual attraction of everything in the Universe for everything else. The space between galaxies in clusters is filled with a hot gas. In fact, the gas is so hot (tens of millions of degrees!) that is shines in X-rays instead of visible light.

By studying the distribution and temperature of the hot gas we can measure how much it is being squeezed by the force of gravity from all the material in the cluster. This allows scientists to determine how much total material (matter) there is in that part of space.

It turns out there is 5 times more material in cluster galaxies than we would expect from the galaxies and hot has we can see. Most of the stuff in clusters of galaxies is invisible and, since these are the largest structures in the Universe held together by gravity, scientists can conclude that most of the matter in the entire Universe is invisible. This invisible stuff is called 'dark matter'. There is currently much ongoing research by scientists attempting to discover exactly what dark matter is, and what effect it may have on the future of the Universe as a whole.

This extra-ordinary Dark Matter is called "non baryonic" (meaning made of one or more particles other than the usual electrons, protons, neutrons, and neutrinos) and makes up about 25% of all the mass in the universe while the ordinary matter that we are made of only comprises about 5% (the remaining 70% of the universe is called "Dark Energy").

Dark Matter is fundamental to the structure and evolution of galaxies including our own. While it appears to have no interactions with ordinary matter that produces light, it does interact with gravity and that gravitational interaction shapes and holds together galaxies and even clusters of galaxies. Nobody knows exactly what Dark Matter particles are. At one point it was thought that they may be neutrinos but we now know that while neutrinos do have mass, they are not heavy enough to explain Dark Matter. A leading candidate for the Dark Matter particle is that it is a WIMP – a "Weakly Interacting Massive Particle" which is a possible particle predicted by a theory called Super Symmetry.

At SNOLAB there are a number of experiments to search for WIMPs:

The PICASSO experiment has been running a number of different detectors at SNOLAB for several years and is searching for spin dependent interactions from WIMPs using fluorine as a target nucleus in the form of Freon droplets suspended in a gel matrix.

The DEAP/CLEAN program is building detectors based around liquid argon and neon and look for WIMPs by examining the scintillation light deposited by interactions in the cryogenic liquid.

SNOLAB

www.snolab.ca