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Astrophysical dark matter

Dr. Mofiz Uddin Ahmed



CERN Axion Solar Telescope

The 'dark' matter is called 'dark' as it does not radiate or absorb light. It has only gravitation and weak interactions. There are two types of dark matters: the hot dark matter (HDM) and the cold dark matter (CDM). Hot dark matter occurred during the earlier stage of the universe while the cold dark matter occurred later. Examples of cold dark matter may be neutron stars, black holes and brown dwarfs. These objects are not directly observables as they do not emit. But their presence can be detectable due to their strong gravitational effects on the surroundings.

Neutrinos are the hot dark matter. They have extremely low mass and go only the weak interaction. There are many sources of neutrinos in our universe. Our sun is one of the best sources. There are other particles called WIMP also are examples of hot dark matter. WIMP means weakly interacting massive particles. Intensive research is being going on to detect neutrinos and WIMPs. Through CERN Axion Solar Telescope in Switzerland, solar neutrinos are being detected and WIMPs are being detected in Italy through CRESST (Cryogenic Rare Event Search with Superconducting Thermometers).

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First evidence for dark matter was formed by Zwicky in galaxy clusters in 1933. In the later 1940s, Gamow, Alpher and Herman predicted cosmic radiation background with temperature of a few Kelvin. Penzias and Wilson in 1965 discovered the cosmic microwave background (CMB). It was later realized through numerical simulations that cosmological structure formation could be explained with the paradigm of cold dark matter (CDM). This is further confirmed by the cosmic background explorer (COBE) satellite in 1992.

Initially, our universe was smooth and featureless. Then gradually it becomes more and more organized with the formation stars, galaxies and cluster of galaxies. The space between the galaxies is filled with hot gas. This hot gas emits radiations in the x-ray region. By studying the temperature distribution in the hot gas scientists measured how much materials are squeezed due to strong gravity.

It was turn out through this measurement that five time more materials are in the cluster than that predicted by other means. Scientists then concluded that most of the materials in the universe are invisible. This invisible stuff is called 'dark matter'- a term initially coined by Fritz Zwicky who discovered evidence for missing mass in galaxies in the 1930s. There is currently much ongoing research by scientists attempting to discover exactly what this dark matter is, how much there is, and what effect it may have on the future of the Universe as a whole.

The author is a Plasma Physicist and Professor at BRAC University.