KSETA Course

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KIT Campus North, building 401, seminar room 410

Dark Matter and Dark Energy

Abstract:

Dark matter was discovered 1933 by F. Zwicky in clusters of galaxies; the term is due to J.Oort 1932. Today we know that dark matter is most of the matter in the universe, but we do not know what it is. Particle Physics suggests that it could be a heavy particle, and it could be produced in the right quantity. Astronomy suggests that it is a light particle, from simple phase space arguments of old compact galaxies. If the first approach is correct, then the particle ought to be visible in some strange interaction, producing odd positrons, neutrinos, etc. Many unexpected photons, positrons, anti-protons and other particles have been detected, but none of them securely point to anything unusual. All can be quantitatively explained with normal star explosions. If the second approach is correct, then of course things are even more difficult: One particle physics candidate for the second approach is a sterile neutrino of about 2 - 8 keV mass. We may have a chance to detect it via a decay yielding an X-ray photons: such X-ray photons greatly enhance the formation of molecular Hydrogen in the early universe. The relative motion between baryonic matter and dark matter is super-sonic right from recombination; shocks ensue. With a sterile neutrino these shocks have a much larger cooling efficiency due to much larger fraction of molecular Hydrogen; this process is a great amplifier, since the density jump of baryonic matter may reach order 10, while the density disturbance of dark matter is still << 1. In the post-shock region this allows the formation of clumps, and they also allow strong star formation in the early universe. In the combination they may support the formation of the first super-massive black holes. Since disturbances give rise to an expanding spherical shell, we might expect gigantic arcs of super-massive black holes in projection - we do observe this at the > 50 Mpc scale. We speculate on the role of these first super-massive black holes: could they be connected to dark energy? What are the critical tests of all such ideas about dark matter?