The multiphase circumgalactic medium

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From plasma physics textbooks, we know that more than 90% of the known matter is in a plasma state. Most of this is not in stars but in a very diffuse form around galaxies, known as the intergalactic and circumgalactic medium (IGM & CGM). The IGM filaments feed matter to galaxies, pulled in by the gravity of the halos at the intersection of such filaments. The photoionized ~1e4 K diffuse gas in these filaments can get shock-heated as it becomes a part of the CGM around the central galaxy. Recent observations, mostly based on the interpretation of absorption features in background quasars due to intervening CGM, suggest that the CGM is made up of a multiphase plasma spanning 1e4 K to more than 1e6 K with a large area filling fraction. Galaxy clusters, corresponding to more massive halos, have a denser CGM (known as the intracluster medium or ICM) studied in great detail by interpreting X-ray observations. Some of the key physical processes governing CGM/ICM are radiative cooling, heating due to AGN (active galactic nucleus, powered by accretion on to the central supermassive black hole) feedback, background gravity, turbulence, and the shear layers between dense structures (such as galaxy wakes and IGM filaments) and the diffuse CGM. I shall describe various physical models that we can use to interpret some of the observations. We suggest that the diffuse ICM cannot be denser than an upper limit corresponding to tcool/tff~10 (ratio of the background cooling time and free-fall time). Once this threshold is crossed, the hot gas condenses out in the cold form, which sinks ballistically toward the center powering AGN feedback. We expect cooling and heating cycles governed by periodic cooling/condensation and heating of the inner ICM. Similar processes are expected and seen in other astrophysical "coronae" such as the coronal rain phenomenon in the inner solar corona.