Cosmology

In cosmology, individual stars are rarely considered. Instead, the smallest preferred unit is the conglomerations of stars known as...

Galaxies: our Solar System lies some way off-centre, in a giant disk (disc?) structure, known as the Milky Way galaxy. It contains $\sim 10^{11}$ stars, with masses ranging from $0.1\ M_\odot$ to tens of times more massive.

It consists of a central bulge, with a disk of radius 12.5 kpc and a thickness of $\sim 0.3 \longrightarrow 1$ kpc. The Sun is located in the disk, about 8 kpc from the centre. The disk rotates slowly (and differentially, with the outer edges moving more slowly). At the region of the Sun, the Galaxy rotates with a period of $\sim$ 200 million years. Because we are within it, we cannot obtain an image of our own galaxy.

The Galaxy is surrounded by smaller collections of stars known as globular clusters. These are distributed roughly symmetrically about the bulge, at distances of $5 \longrightarrow 30$ kpc. Typically containing 10^6 stars, they are thought to be remnants of the formation of the Galaxy. It is believed that the entire disk and globular cluster system might be embedded in a larger spherical structure, known as the galactic halo.

Galaxies are the most visually striking and beautiful objects in the Universe. However, in Cosmology, structure of a galaxy is usually irrelevant: galaxies are normally thought of as point-like objects emitting light, often broken into sub-classes according to colours, luminosities and morphologies.

The Local Group: The Galaxy resides within a small, concentrated group of galaxies known as the Local Group. The nearest is a small, irregular galaxy, known as the Large Magellanic Cloud (LMC), which is 50 kpc from the Sun. The nearest galaxy of similar size to our own is the Andromeda Galaxy, at a distance of 770 kpc. The Milky Way is one of the largest galaxies in the Local Group (of the order of around one hundred galaxies). A typical galaxy group occupies a volume of a few cubic megaparsecs. →

The megaparsec, denoted Mpc, equal to one million parsecs, is the cosmologists' favourite unit for measuring distances, because it is roughly the separation between neighbouring galaxies. It is $3{\cdot}086 \times 10^{22}$ m. Remember, from a distance of 1 Mpc, the radius of the orbit of the Earth around the Sun would subtend an angle of $0{\cdot}000001''$. You would subtend an even smaller angle from that distance!

Clusters of galaxies, superclusters and voids: Surveying larger regions of the Universe, say, on a scale of 100 Mpc, one sees a a variety of large-scale structures. In some places, galaxies are grouped into clusters. A famous example is the Coma cluster, containing ~ 10000 (sic) galaxies, orbitting (orbiting?) in their common gravitational field. Many galaxies are not part of a cluster. Galaxy clusters are the largest gravitationally-collapsed objects in the Universe and they, themselves, are grouped into superclusters, perhaps joined by filaments. In between this foam-like structure lie large voids, some as large as 50 Mpc across.

Large-scale smoothness: Only once we get to larger scales, hundreds of mega parsecs or more, does the Universe appear smooth. The belief that the Universe does indeed become smooth on the largest scales, the so-called Cosmological Principle*, is the underpinning of modern Cosmology. It is interesting that, while the "smoothness" of the matter distribution on large scales has been a key assumption for decades now, it is only fairly recently that it has been possible to provide a convincing observational demonstration.

* The belief that the place which we occupy in the Universe is in no way special — a powerful and simple idea. We know that it does not hold perfectly. The nearby Universe is highly inhomogeneous, consisting of stars, planets and galaxies, rather than the smoothly-distributed fluid of mass density, d. You are more likely to find a galaxy near another galaxy.