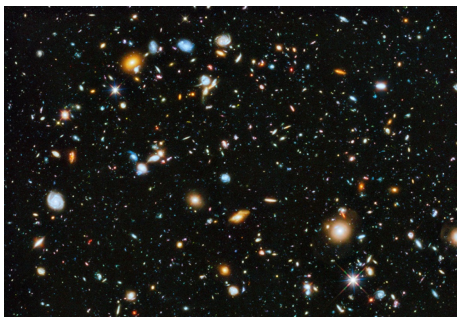
Extragalactics, Cosmology and Relativity

Formation, Evolution and Detection of Galaxies



This meteor introduces the students to the part of extragalactic astronomy dealing with the formation and evolution of galaxies in a ΛCDM cosmology. In order to prepare for state-of-the-art research in that domain, the focus is 1) on the intrinsic and statistical observed properties of the galaxies and clusters of galaxies; 2) on the underlying physical processes; 3) on dedicated detection techniques based on statistical detection theory. The students will detect faint high-redshift galaxies in the data of the MUSE instrument, which is installed since 2014 on one of the 8-meter-telescope at VLT (see image below).

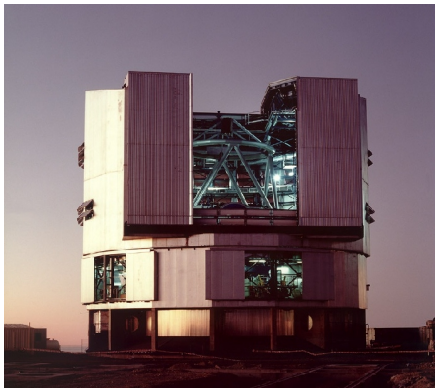
Galaxy formation and evolution

by E.SLEZAK

The study of galaxy formation and evolution is an active and rich research area in astrophysics. It aims to provide us with a clear understanding on how the properties of each individual galaxies result from their formation mechanisms and from the various physical processes playing a role during their evolution. Many factors indeed contribute to the morphological, dynamical and chemical development of a galaxy during its hierarchical build-up from smaller entities and gas infall evidenced by theoretical simulations. This investigation implies first to characterize in great detail the intrinsic properties (luminosity, morphology, color, activity, etc.) of galaxies over a large range in lookback times in relation to their environment (field, group, cluster). One also needs to measure over cosmic time the statistical properties of the galaxy population as a whole in order to link these formation and evolution processes to the underlying evolving cosmological density field and get answers to key questions. For instance, what is the global star-formation history of the Universe or the relationship between the mass assembly of the galaxies, the interaction and merger rates, the build-up of the stellar content and the feedback processes (from stars to supermassive black hole growth) ? In such a cosmological context, galaxy clusters correspond to the largest gravitationally bound overdensities and are thus unique laboratories for studying structure formation, galaxy evolution, thermodynamics of the intracluster medium and plasma physics.

Galaxy detection

by D.MARY



One way to search for the progenitors of the normal nearby galaxies is to detect high-redshift star-forming galaxies through their emission in the Lyman-α line providing little extinction by their dust content. These Lyman-α emitters (LAEs) are extremely faint sources and past surveys based on narrow-band imaging with a spectroscopic follow-up of the candidates for confirmation were poorly efficient. Fortunately, direct spectroscopic studies over a wide range in redshift are now enabled by high-troughput spectrographs with a panoramic field of view, like MUSE at ESO. This instrument provides data cubes composed of images in 3600 spectral channels.

In the detection part of this METEOR, the main characteristics of the MUSE instrument and its specificities with respect to other integral-field spectrographs in astronomy will first be documented. The ability of this instrument to detect faint and distant galaxies and the peculiarities of MUSE datacubes will also be studied. The students will be provided with an advanced course in statistical decision theory (binary vs. multiple hypothesis testing, composite hypotheses, GLR tests and Matched Subspace Detectors). The students will design and apply dedicated detection tests and attempt to unveil the signatures of these ancient galaxies in MUSE data.

See also

MUSE instrument

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