The Life and Death of Galaxies (L24)

Professor V. Belokurov

This course will provide the observational perspective on the evolution of galaxies. A large variety of the currently available data will be discussed as well as the theoretical and numerical tools necessary to interpret it.

The course will cover a selection of topics including:

- **Dynamics.** Dynamics of elliptical galaxies. Distribution Functions. Collisionless Boltzman Equation (CBE). Integrals of CBE. Jeans Equations. Mass-anisotropy-density degeneracy. Virial Theorem. Poisson Equation. Slow and Fast rotators. Dynamical Friction. Fundamental and Mass planes. Relaxation and phase mixing. Violent relaxation. Dynamics of spiral galaxies. Rotation curves. Dark matter. Navarro-Freak-White density profiles. Galactic halos. Dark matter structure and sub-structure in the Local Group. Dwarf galaxies as dark matter laboratories.
- **Structure and evolution.** Structure of galaxies. Two types of galaxies: dead and alive. Light distribution. Density de-projection. Sersic profile and its modifications. Detailed structure of elliptical galaxies. Cusp scouring. 3D shapes of ellipticals. Galaxy luminosity function. Schechter function. Connection between galaxy type/structure and environment. Mergers. Tides. Stellar streams. Accretion signatures in the Local Group. Formation and evolution of elliptical galaxies.
- **Spectral Energy Distribution.** Panchromatic view of galaxies. Dependance of the galactic structure on wavelength. Components of the galactic SED. Stars. Dust. Nebular emission. Stromgren sphere. Spectral lines. Initial mass function: its shape and observational constraints. Links between SEDs (continuum, absorption and emission lines) and star-formation history, the current (recent) star-formation, stellar and gas contents. Age-metallicity degeneracy.
- **Star-formation.** Star-formation rates. Metal-enrichment. Galactic chemical evolution modes. Yields. Closed box, instantaneous one-zone mixing. G-dwarf problem. Inflows and Outflows. Mass-metallicity relation. Star-Formation Law. Cloud collapse and fragmentation. Star formation on sub-galactic scales. Quenching. Star-formation history of the Universe. Integrated light: Look back vs Archaeology. Halo and galaxy assembly in the Cold Dark Matter Universe. Galaxy formation efficiency as a function of galaxy mass. SFH with resolved stellar populations. Stellar Feedback. Dwarf galaxies and early star formation.
- **Active Galactic Nuclei and Quasars.** Evidence for (S)MBHs in the centres of galaxies. Energy production. BH growth. Co-evolution of central BHs and galaxies. M-sigma relation. AGN feedback.

Prerequisites

Knowledge of Galactic Dynamics (e.g. Part II Astrophysics Course "Stellar dynamics and Structure of Galaxies") would come in handy. Some facts from Part II's "Structure and Evolution of Stars" will also be used.

Literature

1. Binney, J., and Tremaine, S. *Galactic Dynamics* Second Edition. Princeton University Press, 2008.

2. Mo, H., van den Bosch, F., and White, S. *Galaxy Formation and Evolution* Cambridge University Press, 2010.

3. Sparke, L., and Gallagher, J. *Galaxies in the Universe* Second Edition. Cambridge University Press, 2007.

4. Longair, M. *Galaxy Formation* Second Edition. Springer, 2008.

Additional support

Four examples sheets will be provided and four associated examples classes will be given. There will be a one-hour revision class in the Easter Term.