AA-472/672: Galactic and Extra-galactic Astronomy

(Approximately 13 weeks ~ 25 Lectures, 4 Tutorials, 4 for project presentation)

1. Basic Preliminaries (2-3 Lectures)

Stellar Magnitude, Co-ordinate systems (galactic co-ordinate), Physical scales and Distance Ladder, Radiative Transfer Equation, Black body, Seeing, Extinction and Reddening, Overiew of multi-wavelength emission of our own galaxy.

2. Galaxy: Structure and Components (3-4 Lectures)

What is a galaxy and how is it different from star cluster, Galactic disk composition and density distribution, Concept of velocity dispersion, mass to light ratio, metallicity. Composition of Galactic bulge, de Vaucouleurs profile and sersic index. Stellar halo – Globular cluster, Tidal distruption

3. Milky Way Galaxy: Kinematics and Properties (3-4 Lectures)

Velocity of Sun wrt to Earth – LSR, Asymmetric drift ; Rotation curve of the galaxy – Oort's Constant, Trangent point method ; Flat rotation curve, observing with 21cm line Doppler shift and implications to dark matter.
Galactic Center – Mass Estimate, Proper motion of Sgr A*.
Near MW : Satellite galaxies, Our Local Group.

4. Galaxy Zoo (6 Lectures)

Classification – Tuning fork diagram, Color-Color (Red and Blue sequence)
Eliptical Galaxy: Stellar Dynamics, Relaxation time scale, Gravitational Potential Density distribution pair for spherical distribution (NFW, Plummer, Jaffe etc), Collisionless systems – Boltzmann Equation, Jeans and Virial Theorem,
Spiral Galaxy: Sprial density wave theory, Lindbald Resonances, Surface brightness and Freeman's Law
Starburst galaxies: Star formation history, spectra of galaxies.
Scaling Relations: Tully Fisher, Faber Jackson, M-sigma, Dn-sigma, Kenicut-Schmidt Law, Initial Mass function,
Press-Schechter Luminosity functions of Galaxies,
Brief introduction to Gravitational Lensing (No math)

----------MID-SEMESTER EXAM----------

5. AGNs (5-6 Lectures)

Difference between normal and active galaxies, Components of AGNs : Torus, BLR, NLR, jets etc,. Unification model.
Properties of Accretion disk: Optically Thick radiative efficient disk, ADAF, Super Eddington Accretion rates

Properties of Jets: Jet launching, superluminal motion, relativistic beaming and boosting, FRI and FRII galaxies. Variability and Flares
Spectra of AGNs and radiation mechanisms: Synchrotron emission, Inverse Compton

6. Galaxy Cluster (2-3 Lectures)

Properties of Galaxy cluster: Temperature, scale, Relaxation time scale, Mass estimate using Virial Theorem
Multi-wavelength emission maps, radio relics and Free-free emission and SZ Effect (Brief intro as application of IC effect, No Math).
Kompaneets Equation and Y-parameter (In case you have time for Math of SZ effect and less BTech students)