UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Physics of Galaxy Clusters

86R-XXXV-PGC

Aims

Introductory course in the physics of galaxy clusters.
The main objective is to provide an overview of the general properties of galaxy clusters and to provide a starting point for more in-depth studies on individual topics.

Contents

See detailed program

Detailed program

Title: PHYSICS OF GALAXY CLUSTERS

SETTING THE CONTEXT

- The observed Universe:
- Redshift definition and Hubble-Lemaitre law
- Redshift surveys
- Local Large Scale Structure (LSS): from the Milky-Way to Laniakea
- Definition of Group of Galaxies, Cluster of Galaxies, Supercluster, Void
- The primordial Universe and brief Universe's history
- The simulated Universe: simulations of the LSS
- Motivation for the study of galaxy clusters

A MULTI-WAVELENGTH VIEW

- Hubble Diagram and the galactic content in clusters
- Morphology - density relation of galaxies
- Optical Cluster Catalogues and morphological classification from galactic content
- Total mass of clusters from the dynamics of the galaxies (virial theorem)
- Mass-to-light ratio
- Rotation curves in Sp galaxies
- Gravitational lenses: strong and weak lensing effect
- Introduction to the X-Ray Astronomy for galaxy clusters
- Properties of the Intra-Cluster Medium (ICM; cooling, heating)
- X-ray spectra of clusters
- Total mass from the ICM temperature and density profiles
- Matter composition of galaxy clusters
- Baryonic mass fraction
- Clusters mass function
- ICM entropy
- Metal content in the ICM and enrichment mechanisms

COOL-CORE CLUSTERS

- The core properties of dynamically relaxed clusters:
- Cooling time, density, temperature profiles
- Brightest Clusters Galaxies (BCG)
- Cooling flow and gas flow suppression (AGN feedback)
- Spitzer thermal conduction and turbulence
- Fate of the cooling gas

MERGERS IN CLUSTERS

- Properties of the dynamically un-relaxed clusters
- Mergers shocks: the Bullet cluster
- Shock kinematic, Rankine-Hugoniot jump conditions
- Energetic of clusters mergers
- Cold Fronts in un-relaxed clusters: merger cold fronts
- Cold fronts in relaxed clusters: gas sloshing
- Diffuse radio emission in clusters: halos, relics, mini-halos
- Group scale accretion in clusters outskirts
- Missing baryon problem and cluster outskirts

Prerequisites

Teaching form

Pre-recorded video lessons

Textbook and teaching resource

Semester

March-April 2020

Assessment method

Oral examination

Office hours

For any information or question about the course and/or the topics covered, contact the teacher directly at the e-mail address sabrina.degrandi@inaf.it