

ASTR 556: Interstellar Matter

Course Syllabus

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Course Description

Interstellar Matter (ISM) is one of the graduate-level course that examines the physical processes, chemistry, and chemical evolution of the interstellar medium within galaxies. The course introduces the distribution and multi-phase structure of interstellar gas and dust, emphasizing thermal balance, radiation processes, shocks, turbulence, and star formation. It prepares students for advanced study and research in galactic structure, star formation, and astrochemistry.

Table 1: Assessment Methods and Weighting (Total = 100 Marks)

Assessment Component	Description	Marks
Midterm Exam 1	Written exam covering Weeks 1–4	15
Midterm Exam 2	Written exam covering Weeks 5–8	15
Course Project	Research-based or computational ISM project	20
In-class Activities	Quizzes, problem-solving activities, and participation	10
Total		60
Final Exam		40

Course Contents

- Distribution of the interstellar medium in galaxies, including atomic, molecular, ionized gas, and dust components, and their multi-wavelength observational tracers.
- Physical processes in the ISM, including thermal balance, heating and cooling mechanisms, radiation fields, shocks, turbulence, magnetic fields, and cosmic rays.
- Multi-phase structure of the ISM, pressure equilibrium, phase transitions, and stability of interstellar clouds.
- Chemistry of the ISM, including gas-phase reactions, ion–molecule chemistry, grain-surface reactions, molecule formation (e.g., H₂, CO), and photodissociation processes.
- Chemical evolution of the ISM, stellar nucleosynthesis, enrichment from supernovae and stellar winds, metallicity evolution, and gas inflow/outflow in galaxies.
- Star formation processes, including gravitational collapse, Jeans instability, cloud fragmentation, protostellar evolution, star formation efficiency, and stellar feedback.
- Observational diagnostics of ISM physical conditions, including emission and absorption lines, molecular tracers, dust continuum emission, and comparison with theoretical models.

References

- Linsky, J. L., *The Interstellar Medium*, Cambridge Astrophysics Series.
- Hollenbach, D. J., & Salpeter, E. E., *Interstellar Matter and the Evolution of Galaxies* (chapter-specific readings).
- Werner, M. K., *Principles of Astrophysics* (advanced methods in radiative transfer).
- Selected research articles from recent journals such as *The Astrophysical Journal* and *Monthly Notices of the Royal Astronomical Society*.