Interstellar Medium --- Syllabus

NCUIA 2025 Spring

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Office hours: M 3 to 5 pm; Tu 3 to 5 pm; or by appointment

The course consists of two main parts:

(1) the morphological and physical characteristics of various **material components** found in the interstellar space, from extremely cold molecular gas and dust, to diffuse atomic hydrogen nebulae, to hot ionized gases around luminous stars; some of these are relevant to intergalactic media as well.

(2) interactions between stars and their environments, i.e., **between matter and radiation**.

We will discuss what has been observed, and the theories to interpret these results. The course will end by the onset within molecular clouds of formation of stars and planets. There is no prerequisite; knowledge of radiative transfer and matter-radiation interplay will be covered in the course though prior exposure should help.

* ***Textbook***: ***Physics of the Interstellar and Intergalactic Medium***,
by Bruce T. Draine (2011, Princeton U Press)

https://www.astro.princeton.edu/~draine/

https://press.princeton.edu/books/paperback/9780691122144/physics-of-the-interstellar-and-intergalactic-medium

NCU library carries an online version of this book,
https://ebookcentral.proquest.com/lib/ncutw/reader.action?docID=664587&query=&ppg=1

**** Subjects:*** gaseous nebulae and dust clouds; radiative processes; radiative transfer, photoionization; Strömgren spheres; stellar winds; circumstellar disks and star formation; galactic magnetic fields: Zeeman effects; polarization

Primary reference: *Interstellar Processes* by D.J. Hollenbach & H. A. Thronson, Jr. (Reidel) --- A close look at our Milky Way Galaxy, including its morphology, stellar content, stellar population, kinematics and dynamics.

**** Subjects:*** 21-cm line observations; giant molecular clouds; stellar population; initial mass function; galactic kinematics and dynamics; the Galactic center

Primary reference: *Galactic Astronomy* by D. Mihalas & J. Binney (Freeman)

There will be homework assignments, and perhaps term projects. This is a fast growing subject. In addition to "standard" textbook problems, there may be questions for which I do not know the answers myself (hardly surprising). For these, you will need to consult research literature.

Grading is based on homework (~40%), the mid-term (~30%) and final (~30%) exams.

The following references are potentially useful:

- ✓ *Physics of the Interstellar Medium*, by Dyson & Williams (eBook)
- ✓ *The Milky Way as a Galaxy*, by Gilmore, King, & van der Kruit
- ✓ *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*, by Osterbrock
- ✓ *The Galactic Interstellar Medium*, by Pfenniger & Bartholdi
- ✓ *The Interstellar Medium in Galaxies*, ed. By Thronson & Shull
- ✓ *Gaseous Nebulae*, by Aller
- ✓ *The Galactic Interstellar Medium*, by Burton, Elmegreen, & Genzel
- ✓ *Physics of the Galaxy and Interstellar Matter*, by Scheffler & Elsässer
- ✓ *Physical Processes in the Interstellar Medium*, by Spitzer (eBook);
  New 2008 version https://onlinelibrary.wiley.com/doi/epdf/10.1002/9783527617722
- ✓ *The Physics and Chemistry of the Interstellar Medium*, by Tielens
- ✓ *Physics and Chemistry of the Interstellar Medium*, by Kwok
- ✓ *Interstellar Matters*, by Verschuur
- ✓ *Galactic Nebulae and Interstellar Matter*, by Dufay
- ✓ *Physics of Interstellar Dust*, by Krügel (eBook)
- ✓ *Dust in the Galactic Environment*, by Whittet
- ✓ *The Dusty Universe*, by Field & Cameron

The following are useful general references, not necessarily specific to ISM/MW:

- ✓ *Astrophysics II*, by Bowers & Deeming
- ✓ *Stars, Nebulae, and the Interstellar Medium*, by Kitchin
- ✓ *Atoms, Stars, and Nebulae*, by Aller
- ✓ *The New Cosmos*, by Unsöld & Baschek