

**ASTRONOMY 670 – SPRING 2007**  
**“The Interstellar Medium and Gas Dynamics”**

**I. Instructor**

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Office hours: by appointment

**II. Class Meetings**

Tue Thu 2:00-3:15, CSS 0201

**III. Books**

Required texts:

*The Interstellar Medium*, by James Lequeux

*The Physics of Astrophysics II: Gas Dynamics*, by Frank H. Shu

Additional general references, in the Astronomy library:

*Physical Processes in the Interstellar Medium*, by L. Spitzer, Jr.

*Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*, by D.E. Osterbrock

*Interstellar Processes*, eds. D.J. Hollenbach and H.A. Thronson, Jr.

Other readings and references from the astronomical literature will be provided in class.

**IV. Course Grading (approximate)**

Homework	30%
Midterm exam	30%
Final exam	40%

You are encouraged to discuss homework problems and questions with other students, but everyone must work out his or her own solutions or answers, and turn in a personal write-up. There will be one in-class midterm, and an in-class final exam.

**V. Course Outline (tentative)**

**Part I: the Interstellar Medium**

*A. Gaseous phases and diagnostics of the ISM*

**Jan. 25** – History & Modern Overview (Lequeux §§1.1,1.3)

- Jan. 30** – Hot gas: SNR and superbubbles (Lequeux §§5.3,12.1,12.2,15.2)
- Feb. 1** – Warm ionized gas: HII regions (Lequeux §§5.1,8.1.4,8.2)
- Feb. 6** – HII regions *cont.* (Lequeux §§5.1,8.1.4,8.2)
- Feb. 8** – HII regions *cont.*; Diffuse WIM (Lequeux §5.2)
- Feb. 13** – Atomic gas: warm and cold neutral medium (WNM & CNM) (Lequeux §§4.1, 8.1, 8.2)
- Feb. 15** – Atomic gas *cont.* (Lequeux §§4.1, 8.1, 8.2)
- Feb. 20** – Cold molecular gas: dark clouds and GMCs (Lequeux §§4.2, 6.3, 8.3.4,9.2,9.4.2)

*B. Other contents and diagnostics of the ISM*

- Feb. 22** – Dust grains (Lequeux Ch. 7)
- Feb. 27** – Dust, *continued* (Lequeux Ch. 7)
- Mar. 1** – Magnetic fields and cosmic rays (Lequeux §§2.2, 6.1)

*C. Global models of the ISM*

- Mar. 6** – Two-phase model of the ISM: Field, Goldsmith, & Habing (Lequeux §8.3)
- Mar. 8** – Three-phase models of the ISM: Cox & Smith; McKee & Ostriker (Lequeux §§12.1, 15.2)
- Mar. 13** – *Catch-up day*
- Mar. 15** – *Midterm exam*
- Mar. 19-23** – *Spring break*

**Part II: Gas dynamics**

*D. Hydrodynamics*

- Mar. 27** – Equations of hydrodynamics; conservation laws (*Shu Ch. 4*)
- Mar. 29** – Equations of hydrodynamics, *cont.*
- Apr. 3** – Hydrostatic equilibria and steady flow solutions (*Shu Ch. 5,6*)
- Apr. 5** – Fluid instabilities and waves: buoyancy (Rayleigh-Taylor), shear (Kelvin-Helmholtz), rotational (Rayleigh's criterion), gravitational (Jeans), thermal instability, sound waves, density waves (*Shu Ch. 8, 11*)
- Apr. 10** – Instabilities and waves *cont.*
- Apr. 12** – Instabilities and waves *cont.*
- Apr. 17** – Shocks: jump conditions for non-radiative and radiative flows (*Shu Ch. 15,16*)
- Apr. 19** – Supernovae and blast waves (*Shu Ch. 17*)

*E. Magnetohydrodynamics*

**Apr. 24** – MHD equations of motion (*Shu Ch. 21*)

**Apr. 26** – MHD waves: Alfvén, fast, slow (*Shu Ch. 22*)

**May 1** – MHD instabilities: Parker, pinch, kink, Balbus-Hawley (*Shu Ch. 23*)

**May 3** – MHD shocks (*Shu Ch. 25*)

*F. Diffusion, dissipation, etc.*

**May 8** – Nonideal effects: viscosity, resistivity, ambipolar diffusion (*Shu Ch. 1,27*)

**May 10** – Turbulence (*Shu Ch. 9*)

**May 16** – *Final exam, 10:30 AM - 12:30 PM*