ASTRONOMY 670 – SPRING 2011

"The Interstellar Medium and Gas Dynamics"

I. Instructor

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Office hours: open door policy for short consultations, else by appointment

II. Class Meetings

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

III. Books

Required texts:

Physics of the Interstellar and Intergalactic Medium, by Bruce T. Draine

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

Additional general references, in the Astronomy library:

The Interstellar Medium, by James Lequeux

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	20%
Midterm exam	40%
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

Part I: the Interstellar Medium

A. Gaseous phases and diagnostics of the ISM

Jan. 25 – Overview (Power Point slides; Draine §§1; Lequeux §§1.1,1.3)

Jan. 27 – Hot gas: SNR & superbubbles (Draine §§34,38,39,25.7; Lequeux §§5.3,12.1-2,15.2)

Feb. 1* – Hot gas: SNR & superbubbles *cont.*

Feb. 3 – Warm ionized gas: HII regions (Draine §§10,13,14,15,18,27,28,32.6; Lequeux §§5.1,8.1.4,8.2)

Feb. 8 – HII regions *cont.*

Feb. 10 – HII regions *cont.*

Feb. 15 – HII regions *cont.*

Feb. 17 – Diffuse WIM (Lequeux §5.2)

Feb. 22 – Atomic gas: warm and cold neutral medium (WNM & CNM) (Draine §§16,29,30; Lequeux §§4.1, 8.1, 8.2)

Feb. 24 – Atomic gas *cont.*

Mar. 1* – Cold molecular gas: dark clouds and GMCs (Draine §§31,32,33; Lequeux §§4.2, 6.3, 8.3.4,9.2,9.4.2)

B. Other contents and diagnostics of the ISM

Mar. 3 – Dust grains (Draine §§21–26; Lequeux §§7)

Mar. 8 – Photodissociation regions (Draine §§31; Lequeux §§10)

Mar. 10 – Magnetic fields and cosmic rays (Draine §§4.7,11,12.1,26.3,40; Lequeux §§2.2, 6.1)

C. Global models of the ISM

Mar. 15 – Two-phase model of the ISM: Field, Goldsmith, & Habing (Lequeux §8.3). Three-phase models of the ISM: Cox & Smith; McKee & Ostriker (Lequeux §§12.1, 15.2)

Mar. 17 – *Midterm exam*

Mar. 20-27 – *Spring break*

Part II: Gas dynamics

D. Hydrodynamics

Mar. 29 – Equations of hydrodynamics; conservation laws (Shu §§4)

Mar. 31 – Equations of hydrodynamics, *cont.*

Apr. 5 – Hydrostatic equilibria and steady flow solutions (Shu §§5,6)

Apr. 7 – Fluid instabilities and waves: buoyancy (Rayleigh-Taylor), shear (Kelvin-Helmholtz), rotational (Rayleigh's criterion), gravitational (Jeans), thermal instability, sound waves, density waves (Draine §§41; Shu §§8, 11)

Apr. 12 – Instabilities and waves *cont.*

Apr. 14 – Instabilities and waves *cont.*

Apr. 19 – Shocks: jump conditions for non-radiative and radiative flows (Shu §§15,16)

Apr. 21 – Supernovae and blast waves (Shu §§17)

E. Magnetohydrodynamics

Apr. 26 – MHD equations of motion (Shu §§21)

Apr. 28 – MHD waves: Alfvén, fast, slow (Shu §§22)

May 3 – MHD instabilities and shocks: Parker, pinch, kink, Balbus-Hawley (Shu §§23,25)

F. Diffusion, dissipation, etc.

May 5 – Nonideal effects: viscosity, resistivity, ambipolar diffusion (Shu §§1,27)

May 10 – Turbulence (Shu §§9)

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