## Astro 201 Course Reader

## Table of Contents

1. "Rereading Einstein on Radiation". Commentary by Dan Kleppner on the revolutionary import of Einstein's A and B coefficients. Fun to read and think about (pp. 1-16)

2. Selections from Mihalas's textbook "Stellar Atmospheres." No shortage of words here for those who don't like Rybicki & Lightman's terseness. Thorough and somewhat formal discussions of the equation of transfer (pp. 17–24); absorption cross sections including Einstein coefficients, classical electron-on-a-spring model, photoionization,  $H^-$  absorption, Thomson and Rayleigh scattering (pp. 25–39). I find the words more useful than the equations whose functional dependencies, although complete, distract from the main ideas, which are actually fairly simple.

3. Absorption efficiencies for various models of grains, from the UV to the radio, showing solid-state absorption features, computed by Chiang et al. 2001 (p. 40)

4. Selections from Bohren & Huffman's textbook "Absorption and Scattering of Light by Small Particles." A must-read textbook for anyone interested in how light interacts with dust (pp. 41–61).

5. A concise and readable review article on the optical properties of dust in the diffuse interstellar medium by Bruce Draine (pp. 62-76)

6. Selections from Osterbrock's "Astrophysics of Gaseous Nebulae and Active Galactic Nuclei," first edition. This textbook is the go-to reference for the interpretation of emission lines from ionized gas. I copy these pages to show you some collisional rate coefficients (pp. 77–88).

7. A page from Spitzer's "Physical Processes in the Interstellar Medium." This textbook is a concise guide to the ISM. It's an oldie but a goodie. This page gives de-excitation rate coefficients for H and  $H_2$  colliding with other atoms and molecules (p. 88).

8. "On the Opacity of the Interstellar Medium to Ultrasoft X-rays and Extreme-Ultraviolet Radiation," by Cruddace et al. 1974. I especially like Figure 1 which shows the various ionization edges (pp. 89–96).

9. "Interstellar Absorption of Cosmic X-rays," by Brown and Gould 1970. Same data as the Cruddace et al. article in (8) above, but plotted differently (pp. 97–101).

10. "Interstellar Photoelectric Absorption Cross Sections, 0.03–10 keV," by Morrison & McCammon 1983. Same data as (8) and (9) above but I like Figure 1 which shows the effects of depletion of elements into grains (pp. 102–105).

11. More of Mihalas's "Stellar Atmospheres" (see 2 above). This time it's Chapter 5 on "The Equations of Statistical Equilibrium": what it specifically means to be in "LTE" or "non-LTE" (pp. 106–124).

12. More from Osterbrock's "Astrophysics of Gaseous Nebulae and AGN" (see 6 above). Radiative recombination coefficients (pp. 125–127), plus a clear derivation of Milne's relation between recombination and photoionization cross sections (pp. 128–129).

13. Shu's "Synchrotron Theory: Simple Version" from his textbook, "Physics of Astrophysics, Volume I". Probably my favorite chapter from this textbook. Even includes inverse Compton effects. This will be on the exam (pp. 130–144).

14. A readable introduction to cosmic rays by Mewaldt (pp. 145–147).

15. The cosmic-ray (high-energy proton) energy spectrum (p. 148).

16. A brief introduction to cosmic rays, by Nilsen and Zager who detect them using balloons in the Antarctic. Separate data for protons and He nuclei are given (pp. 149–161).

17. "Physical Processes in Active Galactic Nuclei," by Roger Blandford. Lecture notes from the Saas-Fee school. A self-contained and insightful introduction to synchrotron emission, including a nice bit on polarization; Burbidge's minimum energy argument for synchrotron sources; and Compton and inverse Compton scattering (especially well treated). There is also a fun paragraph for people who don't believe in black holes (pp. 162–193, with the most useful pages 167–179).

18. "A Jet Model for the Broadband Spectrum of XTE J1118+480," by Markoff et al. 2001. Having understood synchrotron radiation, and having gotten the hang of "thinking logarithmically," you should be able to understand how Figure 1 was computed (pp. 194–197).

19. A plot that demonstrates synchrotron-self-Compton scattering from Band & Grindlay 1985 (p. 198).

20. A discussion of the importance of relativistic beaming, the inverse Compton limit, and fast time variability of active galactic nuclei and quasars, by Kellermann (pp. 199–205).

21. Selections from Chamberlain & Hunten's textbook "Theory of Planetary Atmospheres," a lucid introduction to the subject, relevant for disk and stellar atmospheres as well. From the selections photocopied here, I learned Eddington's simple and powerful radiative transfer methods (two-stream and N-stream) for radiative atmospheres in LTE (pp. 205–215), and Chandrasekhar's elegant solution of a scattering atmosphere (pp. 216–230; page 230 I computed using the equations from the book).

22. "Interstellar Masers," lecture notes by Peter Goldreich. The first paragraph should be read by aspiring theorists (pp. 231–285).