Stellar Physics:
Stellar Atmospheres (13)
Stellar Structure & Interiors (11)

Kenneth Wood, Room 316
kw25@st-andrews.ac.uk
http://www-star.st-and.ac.uk/~kw25

Course Texts

- Radiative Transfer in Stellar Atmospheres (Rutten) On web and in library
- Stellar Structure & Evolution (Prialnik)

- Stellar Atmospheres (Mihalas)
- Observation & Analysis of Stellar Photospheres (Gray)

Lectures, Tutorials, & Exam

- 27 scheduled lectures
- Coursework: 24 lectures (including today)
- 2 Tutorial sheets. Do you want more?

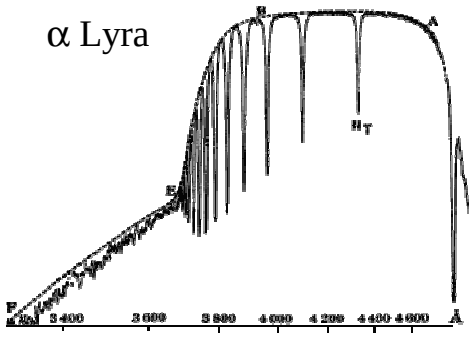
- Lecture notes on web

- Degree Exam in January
- 3 long questions: answer 2
- 5 short questions: answer all

What is a Stellar Atmosphere?

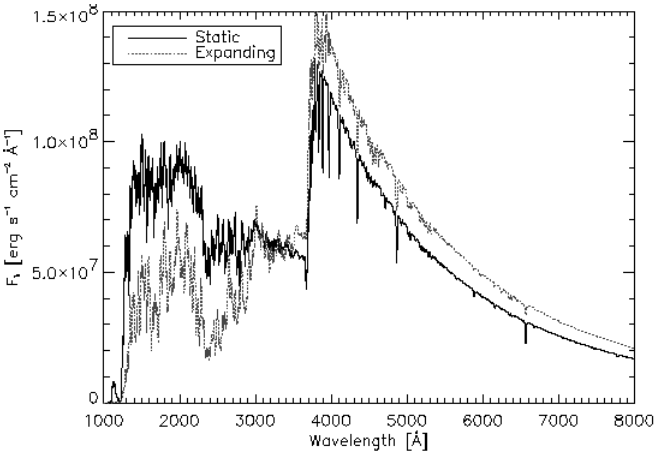
- Transition from dense stellar interior to interstellar medium.
- Region that produces the stellar spectrum. The physical depths in the atmosphere where the spectral features form depend on the atmospheric conditions: temperature, density, level populations, optical depth…
- We see radiation from the "optical depth one surface"
- Goal: From analysis of spectral lines and continua, determine physical conditions, chemical abundances, mass loss rates…

Balmer Lines & Balmer Jump



- H-opacity ~ λ^3
- Jump at Balmer "series limit"
- Size of jump: estimate temperature & pressure

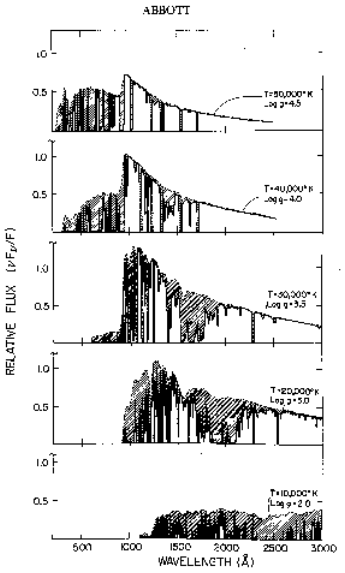
Model Atmosphere



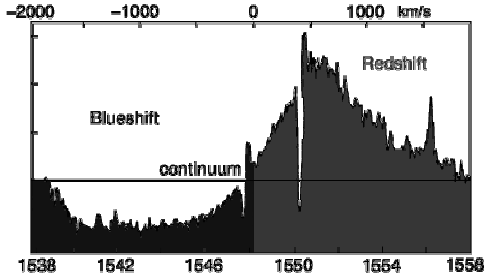
- Expect "saw tooth" due to H opacity
- Line blanketing…

Line Blanketing

- UV opacity from metals
- Blocks flux: blanketing
- Fe, Al,…
- Temperature diagnostic



P-Cygni Line Profiles

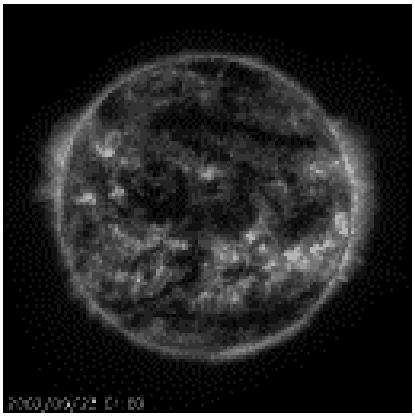


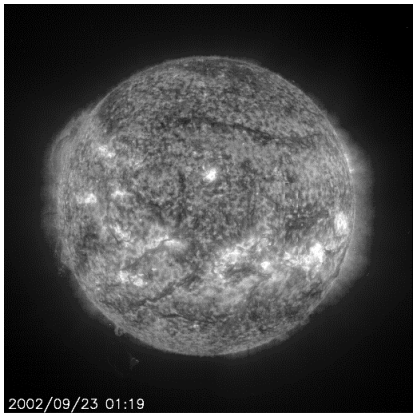
- Expanding atmosphere or stellar wind
- Wind speed from blue edge
- UV space astronomy (1960s): wind theories

Simplifications, but not simple…

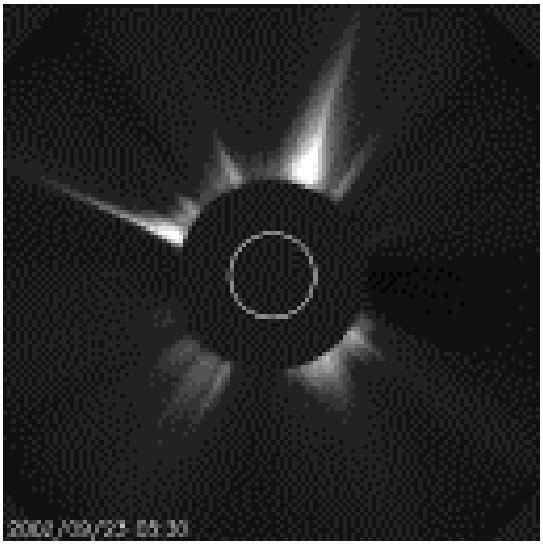
- Plane parallel
- Time independent
- Hydrostatic equilibrium
- No magnetic fields

The Sun





The Solar Corona



What happens physically?

- Photons emitted, travel some distance, interact with atmospheric material
- Scattered, absorbed, re-emitted
- Photon interactions heat atmosphere, change level populations, ionization balance
- Hydrostatic equilibrium: density structure related to temperature structure
- Atmospheric structure depends on radiation field and vice versa
- Atmosphere model requires detailed study of radiation transfer: bulk of this course

Stellar Atmospheres & Radiation Transfer: 13 Lectures

- Radiation transfer recap: equations, definitions (2)
- Opacity sources & LTE (2)
- Formal, approximate & analytic solutions (3)
- Model atmospheres (1)
- Spectral lines (2)
- Circumstellar material: Monte Carlo (3)

2. Radiation Field Basics I

- Rutten: 2.1
- Basic definitions of intensity, flux
- Energy density, radiation pressure