PHY305: Stellar Atmospheres

Objectives

At the end of the course, the student should:

1. Understand what is meant by the atmosphere or photosphere, and appreciate, in terms of the relevant equations the similarities and differences between this region and the stellar interior;
2. Appreciate the key differences between the main spectral types, plus the significance of luminosity class;
3. Understand the relation between flux and temperature for a black body emitter, and be familiar with Wien's displacement law;
4. Understand the definitions of specific and mean intensity, flux and the K-integral;
5. Be able to derive and use the equation of radiative transfer, and be familiar with related concepts like optical depth and source function;
6. Describe the assumptions inherent in Local Thermodynamical Equilibrium, and to realise then that the source function is given by the Planck function;
7. Be able to use (but not derive) the Boltzmann and Saha equations to describe the degree of excitation and ionization for an element;
8. Be able to apply the radiative transfer equation for the parallel ray and plane-parallel cases to calculate the surface intensity from a given source function, and to use this approach on Solar data to obtain the depth dependence of the source function and the wavelength dependence of the absorption coefficient;
9. Be able to calculate the surface flux, and hence obtain the Eddington-Barbier relation involving effective temperature;
10. Know what is meant by a grey atmosphere, appreciate why it is a useful approximation and be able to calculate the depth dependence of the source function in this case;
11. Be able to compare quantitatively different sources of continuous opacity in stellar photospheres using the Saha-Boltzmann equations, and to calculate electron pressures including metal species;
12. Appreciate the contribution of scattering processes to the continous absorption;
13. Discuss how stellar temperatures are derived from direct and indirect techniques, including the sensitivity of the Balmer jump to temperature and pressure;
14. Appreciate the sensitivity of gas pressure to depth in stellar atmospheres, and determine the radiation pressure in a grey, LTE atmosphere, plus be familiar with the Eddington parameter and limits;
15. Understand the definitions of equivalent width and line depth for spectral lines;
16. Understand the origins of absortion lines and the appearance of Gaussian and Lorenzian line shapes under various temperature and pressure broadening mechanisms, and be able to estimate associated line widths;

17. Appreciate the differences between permitted and forbidden spectral lines, and be familiar with the terminology used for spectroscopic notation;

18. Understand the mapping from absorption line coefficient to flux, determine the sensitivity of optically thin lines, and describe the appearance of thin and thick lines;

19. Understand the form of the curve of growth, and be able to explain how abundances are determined from spectral lines;

20. Be able to describe cases in which Local Thermodynamic Equilibrium is invalid;

21. Appreciate the main components of the solar atmosphere, and origin of the solar wind

22. Be able to describe diagnostics and possible driving mechanisms of winds from late-type giants and supergiants

23. Understand the means by which early-type stars lose stellar winds, and be able to describe their observational diagnostics.

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