

Stellar Spectra A. Basic Line Formation

Andreas Ellefsen¹

¹ Institute of theoretical astrophysics

Abstract. We learned how to write nice reports ...

1. Introduction

This is the first of three numerical exercises in the course on Radiative processes in astrophysics (AST4310) at the University of Oslo. In this exercise we are to follow the steps of Annie Cannon, Cecilia Payne, and Marcel Minnaert. By doing this we hope to learn how to write better reports using LaTeX, and also how to solve some problems using IDL.

2. Spectral Classification

The first part of this section deals with learning a little about how IDL functions. You also make a function that adds all the numbers in an array together and gives you the result. This function already exists in IDL, and is called TOTAL, but we make our own function anyway. The function is called ADDUP, and looks exactly like the function written in the exercise text. The function has been tested, and it passes all the test I've tried throwing at it (except of course those it will clearly fail, like strings).

The second part of this section deals with LaTeX and gives instructions on how to write a good report. Basically one is given a template and told a long list of things that are useful to know when writing reports, and then you use this knowledge for the rest of the exercise.

3. Saha-Boltzmann calibration of the Harvard sequence

Here we want to explain the spectral-type sequence that was studied in the two first parts of the last section (which we ignored). To start of we study figures 5 and 7 in the exercise text. Starting from the right of figure 5 one sees that the $H\beta$ line lies between 4762\AA and 4954\AA . If one looks at figure 7 one sees that the only line between these two wavelengths is the Balmer β line at 4861\AA . The Balmer β line is the transition between $n = 4$ and $n = 2$. Considering that the spectrum we're looking at in figure 5 ranges between 3900\AA and 5000\AA , which is in the visual part of the spectrum, the rest of the lines corresponding to hydrogen should all be in the Balmer series as well. This means that none of the lines share the same upper level, and that they all share the same lower level, namely $n = 2$. This is the case for all of these named series. Sharing of the upper levels is a bit more complicated. If one looks at figure 7 one sees that Lyman α shares no upper level with anything. But Lyman β shares the same upper level as Balmer α . Figure 7 skips some of the transitions. But Lyman γ shares upper level with Balmer β and Paschen α . It keeps going in this way for the rest of the transitions.

At this point Payne made the assumption that the strength of the absorption lines observed in stellar spectra scaled with the population density of the lower level of the corresponding

transition. This seems logical if one also assumes that most of the hydrogen was in the ground state to begin with.

4. Fraunhofer line strengths and the curve of growth

The modeling of ...

5. Conclusions

The answer is 42.

Acknowledgements. We are much indebted to Rob Rutten for exemplary instruction. Our research made much use of NASA's Astrophysics Data System.