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COMPARING OBSERVED PROMINENCE SPECTRA WITH SIMPLE MODELS COMPUTED USING GHV CODE

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Abstract. Emission spectra in seven lines have been computed for 980 prominence models using code originally developed by Gouttebrose, Heinzel and Vial. Prominence is treated as isothermal, isobaric, 1-D slab, with five input parameters determining outgoing radiation. Computed emission spectra in $H\alpha$ have been compared with observations from the Ondřejov large solar spectrograph and some of the results are discussed.

1. INTRODUCTION

There are two basic approaches used to infer plasma parameters from spectra of a quiescent prominence. One is a direct inversion of observed data, which can be used if emitting plasma is optically thin, and therefore it is not necessary to use rigid solution of radiative transfer equations. For example, temperature can be estimated from width of some optically thin line. In this work, however, we were interested in using $H\alpha$ and $H\beta$ emission lines to estimate magnitude of temperature and density of the emitting plasma. Prominences cannot be often regarded as optically thin in those two spectral lines as their optical thickness in $H\alpha$ and $H\beta$ is of order of unity. One of cases where we cannot use simple method of direct inversion is if we are dealing with emission profile with self-absorption. Here we used *forward method*, that is non-LTE modeling of prominence. By solving radiative transfer problem, using coupled equations of radiative transfer and statistical equlibrium, synthetic spectra can be obtained and compared to observed one. Here we used already existing code written by Gouttebrose, Heinzel and Vial (1990), further in text, GHV code.

2. METHOD

Prominences were treated as 1D isothermal, isobaric slabs standing vertically above solar surface. Outgoing radiation in seven hydrogen spectral lines is obtained by solving coupled equations of radiative transfer and statistical equilibrium. This Code is based on IAS code, where equations of statistical equilibrium are solved by iterations and equations of radiative transfer are solved by using Feautrier method. Partial redistribution (PRD) is also considered and included in the computation.

Table 1: Values for three input parameters, Temperature T [K], column density m [g cm^{-2}] and pressure p [dyn cm^{-2}]

Input Parameter	Minimum valuve	Maximum value	Step
T	4 000	23 000	1 000
log m	-7	-4	0.5
log p	-2	-0.2	0.3

Outgoing radiation depends on five input parameters. Those are temperature, pressure, column density (which can be used to compute average density or density in center of the slab), turbulent velocity and height above solar limb. In this work we kept turbulent velocity and height above the limb as constants (5 km s^{-1} and 10000 km, respectively), and computed a grid of models for 7 different values of pressure, 7 different values of column density and 20 different values of temperature, which brings us to a grid of 980 models. Values for input parameters are given in Table 1. Outgoing data includes emission profiles in first three Lyman and Balmer lines and Pashen-α line, as well and some parameters describing outgoing radiation as intensity in nearby continuum, optical thickness in center of the line, etc.

3. RESULTS

We compared some spectral data obtained by large optical spectrograph in Ondřejov, Czech Republic (Kotrč, 2009) in last several years with this computed grid. Prominences are observed in five different emission lines, those are $H\alpha$, $H\beta$, $D3$, $CaIIH$ and CaI 8542 Angstroms. $H\alpha$ and $H\beta$ emission line profiles have been compared with models from the grid by using simple least-square method. Observed data was undergone full reduction by procedure developed by Maciej Zapior in 2009. Best fits for total of 30 profiles have been found. An example of those fits is given in Fig. 1. By this fitting we found temperature of observed prominences to be between 12000 K and 18000 K, pressure $0.1 - 0.4$ dyn cm^{-2} and column density $1 - 3 \cdot 10^{-5}$ g cm^{-2}.

4. DISCUSSION

This method can be used for simple and rough estimation of plasma paramteres in quiescent prominence. It will be more useful and accurate if data in other hydrogen lines becomes avaiable (for example Lyman emission lines). We also plan to use this method with bigger grid and some high-spatial resolution observations in order to get idea about temperature distribution in a prominence in the plane of sky.

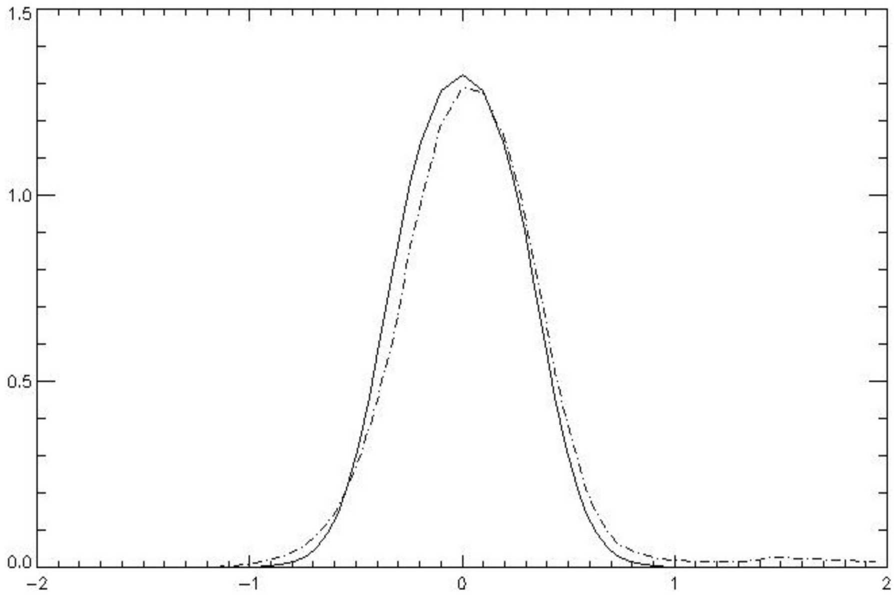

Figure 1: Example fit of an observed $H\alpha$ line, x axis in angstoms, relative to line center, and y axis in arbitrary units of intensity

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