INFLUENCE OF ROTATION AND EXPANSION ON INTENSITY OF LINES OF THE IONIZED CALCIUM IN CYLINDRICAL PROMINENCIES

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Radiation in lines of the ionized calcium of a prominence simulated by the infinite cylinder which axis is perpendicular to the Sun's surface is calculated. The prominence may expand or rotate with velocity linearly dependent on radius. In calculations the Monte-Carlo method for problems of radiation transfer in the (Bernes, 1979) formulation is used, adapted for a cylindrical prominence in (Kalinin, Sobolev 1988) and supplemented by a method of acceleration of convergence according to (Kalinin, 2000).

Ca II atom model includes 5 low levels. The radiation in lines K, H and infrared triplet X, Y, Z ($\lambda\lambda$ 3934, 3968, 8498, 8542, 8662 accordingly) is calculated, for continua radiation temperatures are specified. The rates of collision processes, photoionization and photorecombination (including induced) are determined by subprograms and radiation temperatures from a known program complex MULTI (version 2.2). The incident radiation from the Sun in lines with corresponding limb darkening is fully taken into account.

Input parameters are an optical thickness in line K along diameter of the cylinder τ_{0K} (for motionless medium), electronic temperature T_e and concentration n_e , rotation (V_{rot}) or expansion (V_r) at $R = R_{max}$ (R - radius). After setting them the solution of non-LTE problem gives Ca II level populations depending on R, that allows to calculate profiles of emission lines for different distances (impact parameters) from a cylinder axis and corresponding integral intensities, or full energies (FE). The profiles and FE can be calculated also for a flux from the cylinder as a whole (if the diameter of the prominence image in the focus of a telescope is less than spectrograph slit width).

For an expanding prominence the Doppler-effect lead to two consequences. At first the ingoing into prominence solar radiation is shifted into wings of Fraunhofer lines, and secondly it penetrates inside more freely because of decreasing optical depth. Whether both of these effects result in increase of FE (Doppler Brightening Effect - DBE) or to decreasing of FE (Doppler Dimming Effect - DDE) for a particular line of explored atom, it depends on a situation. In our case for lines H and K the DBE is observed, and for an infrared triplet - weak DDE.

For a rotated prominence DBE (DDE) exists, but is rather small. The enlightenment of medium does not happen. Such effect is stipulated by the adopted (rigid-body) law of rotation.

The most striking feature of these calculations is absolutely different spectra in rotating prominences for the center of prominence (which correspond roughly to spectra in slab geometry) and spectra from prominence as a whole (flux). This difference takes place also for expanding prominences (but effect is not so big). It means that though source functions in slab and cylinder may be quantitatively close, profiles must be calculated in the suitable geometry. Fig. 1 illustrates this observation.

The work is executed with support of a program Astronomy, code of the project 1.5.4.5.

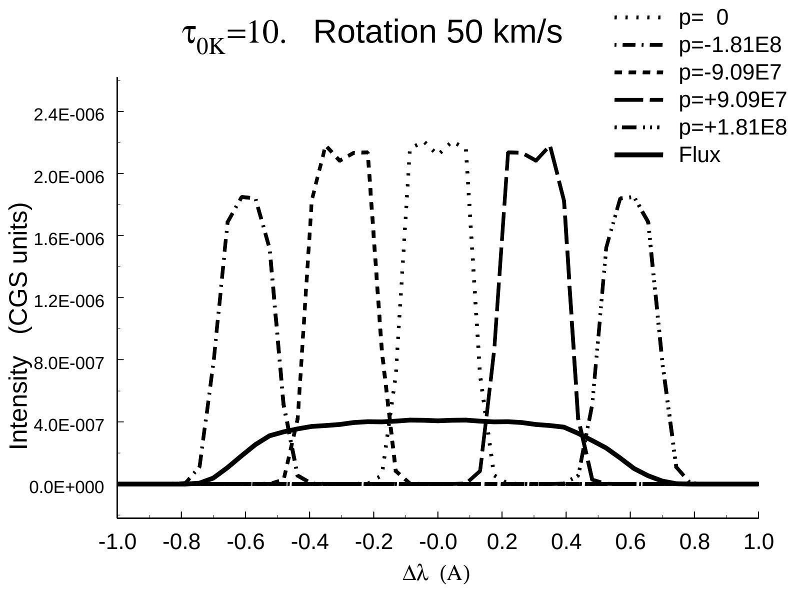

Fig.1. Ca II K line profiles for τ_{0K}=10 in the rotating prominence. Note difference for profile at p=0 (center) and flux profile.

References

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