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Total mass loading of prominences estimated from their multi-spectral observations

Pavol Schwartz[1,2], Peter Heinzel[2], Pavel Kotrč[2], František Fárník[2], Yurij A. Kupryakov[2,3], Edward E. DeLuca[4] and Leon Golub[4]

[1]Astronomical Institute of Solvak Academy of Sciences, 05960 Tatranská Lomnica
email: pschwartz@ta3.sk

[2]Astronomical Institute, Academy of Sciences of the Czech Republic, 25165 Ondřejov
email: pheinzel pkotrc ffarnik kupry @asu.cas.cz

[3]Sternberg Astronomical Institute, 119899 Moscow, Russia

[4]Harvard-Smithsonia Center for Astrphysics, Cambridge, MA 02138, USA
email: edeluca lgolub @cfa.harvard.edu

Abstract. The total mass of several quiescent prominences observed in EUV by the AIA instrument on board SDO, in soft X-rays by XRT on Hinode and in Hα and CaII H by the SLS and HSFA spectrographs of the Ondřejov observatory, was estimated. Values of asymmetry of coronal emissivity obtained during the mass computations are compared with those estimated from 193 Å intensities measured at the disk edge and just above the limb.

Keywords. solar prominences, spectroscopy, EUV coronal radiation, X-rays

1. Introduction

Total mass of a prominence can be estimated from amount of EUV coronal radiation that it absorbs (see works of Kucera *et al.* (1998); Gilbert *et al.* (2005, 2006); Williams *et al.* (2013). In these works only absorption in resonance continua of hydrogen and helium was taken, but decrease of intensities of hot coronal lines due to lack of coronal emission from cool prominence or low-dense cavity, was not taken into account. Moreover, interpolations in time or space were used to estimate background coronal radiation. In this work we take into account the blocking and fraction of emissivity behind a prominence is estimated from simultaneous coronal EUV observations at three different wavelengths.

2. Observations

More than 30 quiescent prominences were observed during a campaign held from April through June 2011. Prominences were observed from space in EUV by the AIA instrument on board the SDO , in soft X-rays by *X-ray Telescope* (XRT) (Golub *et al.* 2007) on Hinode and by ground-based spectrographs *Solar Laboratory Spectrograph* (SLS) (http://radegast.asu.cas.cz/MFS/prominence_archiv/sls.html) and *Horizontal-Sonnen-Forschung-Anlage* (HSFA) (Kotrč 2009) in Hα and CaII H, respectively. Example of prominence observations in EUV at 304 Å and 193 Å X rays and Hα from 18 May 2011 is shown in Fig. 1. In this work we chose from the campaign six prominence observations made between 19 April and 18 May 2011. More about these observations can be found in Schwartz *et al.* (2013).

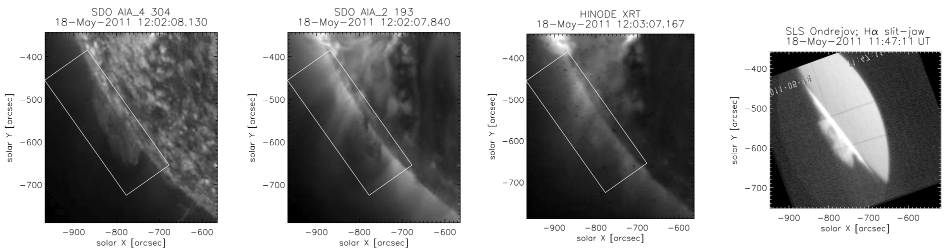

Figure 1. Multi-spectral observations of prominence on 18 May 2011. Panels from left to right: images in the 304 Å and 193 Å AIA channels, X-ray image by XRT and Hα slit-jaw image of the SLS spectrograph.

3. Method

For estimation of the optical thickness at wavelength below 912 Å we used improved method of Heinzel *et al.* (2008). The method is based on the fact that both X-ray and EUV intensities are decreased only by the emissivity blocking in the cavity and in a prominence the EUV intensity is lowered by both absorption and blocking while X-ray emission is not absorbed by the prominence plasma. More details about the method can be found in Schwartz *et al.* (2013).

4. Results and discussion

The total mass ranges from 2.9×10^{11} up to 1.7×10^{12} kg that is close to values estimated by other authors (Gilbert *et al.* 2005, 2006; Williams *et al.* 2013). The α values are varying for each prominence from zero to almost unity. Such wide intervals of α variations shows that emissivity of the corona is rather inhomogeneous. This fact is supported also by the indirect α measurements: When a radial cut is made close to a prominence partly crossing the disk and partly going off limb, interpolation to disk edge of quiet--Sun (outside brightenings) 193 Å intensities along disk part of the cut, gives at least rough estimation of foreground intensity. An intensity from the whole line of sight at the limb close to a prominence is estimated by fitting off-limb intensities along the cut by exponential function. Then α is calculated simply by subtraction from the unity of ratio of the foreground to the whole line-of-sight intensity. Such value of α is strongly sensitive to position in which the radial cut is made. Thus, background coronal emission obtained by interpolation from prominence vicinity, cannot be reliable. More detailed discussions about the method and results can be found in Schwartz *et al.* (2013).

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