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Column Density Measurements of a Prominence Observed by AIA

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Abstract. We present column density measurements of a polar crown prominence observed on March 9th, 2012 by the Atmospheric Imaging Assembly (AIA) aboard the Solar Dynamics Observatory. The structure was viewed on the east limb by AIA and erupted about 30 hours after the observations shown here. We estimate column density by approximating the obscured background emission to obtain an optical depth. This can then be combined with the absorption cross sections of neutral hydrogen and helium, along with the He:H abundance ratio, to calculate column density. We perform this calculation for the 171, 193, 211, and 335 Å AIA passbands.

Keywords. Sun: prominences – Sun: corona – Sun: coronal mass ejections

1. Observations and Analysis

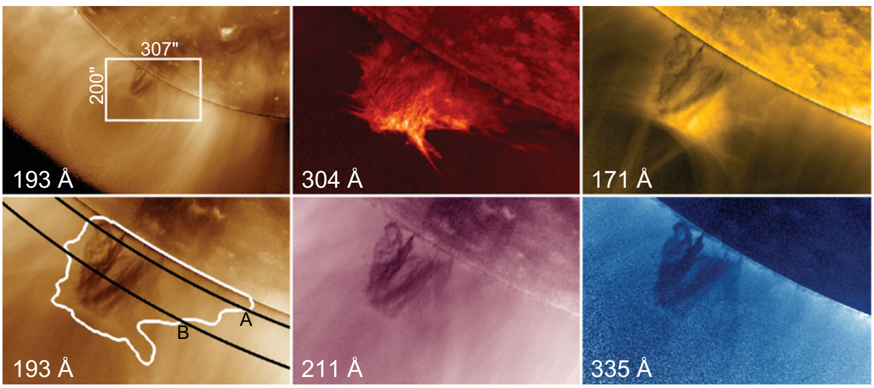

Figure 1. AIA prominence observations taken on 2013/03/09 at 19:35 UT. The white contour on the 193 Å image denotes the 304 Å extent, and the black arcs denote the cuts used in Fig 2.

To estimate neutral hydrogen column density ($N_{\rm HI}$), we employ a simple technique used in several past studies (e.g. Daw *et al.* 1995, Kucera *et al.* 1998, Anzer & Heinzel 2005). Given the observed intensity (I_{obs}) across the EUV absorption features in Fig 1, we approximate the obscured background (I_b) and overlying foreground (I_f) using a linear fit to the emission at the intersections of the white contour and concentric slices shown in the lower-left panel. We take I_f to be 29% of this fit based on the deepest absorption. If a larger portion is attributed to I_f, then I_{obs} is over-subtracted and Eqn 1.1 is NaN at certain positions. This leads to the optical depth (τ), which is combined with the ratio of He:H (r=15%; Del Zanna *et al.* 2004) and their absorption cross sections ($\sigma_{\rm HI}$ & $\sigma_{\rm He\ I}$; Anzer & Heinzel 2005, West & Marr 1976) to yield $N_{\rm HI}$ along the line-of-sight.

$$I_{obs} = I_b e^{-\tau} + I_f \Rightarrow \tau = -\ln \frac{I_{obs} - I_f}{I_b} \tag{1.1}$$

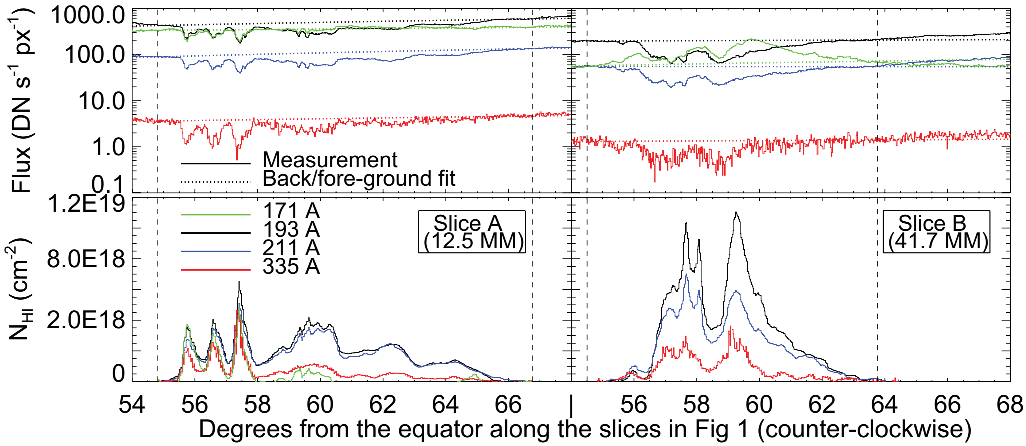

Figure 2. *Upper:* observed flux. *Lower:* estimated column densities. Dashed lines denote intersections of white & black contours in Fig 1, used for linear back/fore-ground fits (dotted).

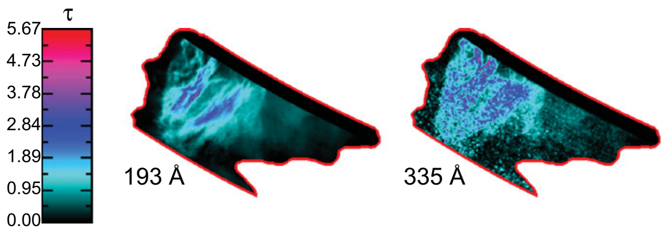

Figure 3. Maps of the optical depth, τ.

$$\tau = \sigma_{\mathrm{HI}} N_{\mathrm{HI}} + \sigma_{\mathrm{He\ I}} N_{\mathrm{He\ I}} + \sigma_{\mathrm{He\ II}} N_{\mathrm{He\ II}} \approx (\sigma_{\mathrm{HI}} + r\sigma_{\mathrm{He\ I}}) N_{\mathrm{HI}} \tag{1.2}$$

$$\Rightarrow N_{\mathrm{HI}} \approx \frac{\tau}{\sigma_{\mathrm{HI}} + r\sigma_{\mathrm{He\ I}}} \tag{1.3}$$

We find N_{HI} to be $\sim 10^{19}$ cm^{-2} for the deepest absorption features, which is consistent with similar work (Labrosse *et al.* 2011). Note that we are sensitive only to the neutral hydrogen, and the ionized fraction likely varies, particularly with height. This, along with a varying filling factor, may explain the discrepancy between the 335 Å channel and the other bands. See Su *et al.* (2013) for additional details on this event.

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