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# NEW PERSPECTIVES ON PROMINENCES AS OBSERVED BY SOHO/SUMER

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**Abstract.** We summarize the results of our prominence and filament studies based on extensive spectral observations with SOHO/SUMER and CDS instruments. During the past decade we have gathered several sets of UV and EUV spectral data, containing various emission lines of different species. Our main objective was to better understand the formation of hydrogen Lyman lines and continuum (using the results of complex non-LTE transfer simulations). However we have also analysed also UV and EUV lines formed under transition-region and coronal conditions. Some highlights of our studies are: reproduction of Lyman-line profiles with partial redistribution, understanding the role of prominence-corona interface in the formation of Lyman-line cores, establishing the effect of the magnetic-field orientation on the shape of Lyman lines, discovery of EUV filament extensions (invisible in the H$\alpha$ line) and their explanation, reconstruction of a 3D topology of the filament using EUV coronal lines, temperature diagnostics based on measurements of the hydrogen Lyman continuum, proper explanation of a prominence darkening detected in coronal lines.

## 1 Introduction

Hydrogen lines are the most prominent lines observed in solar prominences, e.g. the Balmer H$\alpha$ which serves as a standard for prominence imaging. The lines of the resonance Lyman series have been observed since the Skylab ATM experiment and OSO 8 (Vial 1982) and more recently by SOHO/SUMER. Recent codes have been developed using non-LTE approach and the comparison of Lyman lines observations with grids of theoretical profiles allowed us to determine physical models for prominences (Gouttebroze et al. 1993, Heinzel et al. 2001).

## 2 Observations and models

Prominences are observed in Lyman $\alpha$ as structures in emission. The atlas of the spectrum of prominences has been published by Parenti et al. (2004, 2005 a, b) (Fig. 1). From the slope of the Lyman continuum freed from emission lines, an electron temperature of about 8000 K has been derived.

Prominences are observed in absorption in many different coronal lines (Kucera et al. 1998). Using CDS and SUMER data it has been explained by two mechanisms: the absorption by the Lyman continua of H, He, He II and the volume blocking mechanisms (Heinzel et al. 2003). In general the Lyman lines have more reversed profiles in filaments and less reversed profiles in prominences (Fig. 2). However, the SUMER data showed that the Lyman lines in prominences may have either reversed profiles or non reversed profiles (Heinzel et al. 2001b). This behaviour has been explained by using 2D non-LTE radiative transfer simulations (Heinzel and Anzer 2001, Heinzel et al. 2005).

The main conclusions are the following:
* We confirmed the existence of a transition region between the prominence and corona (PCTR),
* The PCTR plays a critical role in radiative transport in the Lyman lines (Schmieder et al. 1998, 1999, 2003; Heinzel et al. 2001 a),
* The orientation of a prominence with respect to the line of sight is important. If the prominence fine structures are observed along the field lines, the profiles are unreversed; if they are observed across the field lines, the profiles are reversed,

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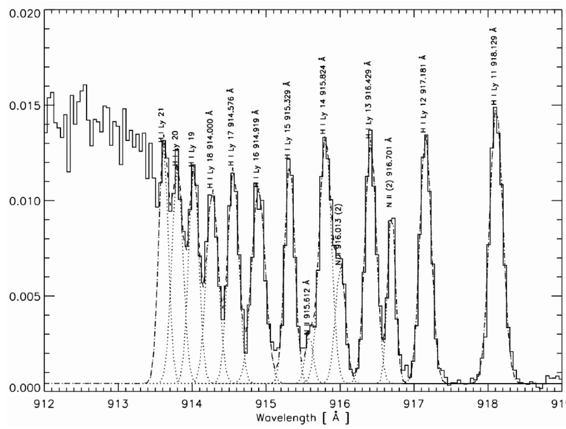


**Fig. 1.** Atlas of the Lyman spectrum of prominences observed with SUMER (L11 to L21)

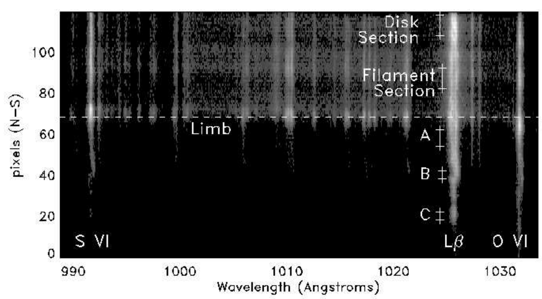


**Fig. 2.** SUMER spectrum of filament and prominence (ABC) on March 23, 1999. Wavelength is along the x-axis and the pixel number from South to North is along the y-axis.

* Large width of EUV filaments compared to H$\alpha$ ones is explained in terms of the Lyman-continuum and H$\alpha$ opacity, respectively (Heinzel et al. 2001a, Schmieder et al. 2003, 2004, Schwartz et al. 2004),
*Opacity of the Lyman continuum is large compared to that of H$\alpha$. Their ratio could reach nearly two orders of magnitude (Schmieder et al. 2003). Cool material does exist in the EUV filament but is optically too thin to be visible in H$\alpha$ images.

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