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THE HELIUM SHELLS OF HEI AND HEII AT SOLAR MINIMUM: NEW RESULTS FROM ECLIPSE FLASH SPECTRA OF 2008- 2010

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Abstract. Flash spectra taken at high frame rate during the total solar eclipse of August 1st 2008 in Siberia and during the July 11th 2010 in French Polynesia are compared in the context of the quiet Sun near the minimum of activity. They both reveal the weak Paschen α 468.6 nm ionized helium line, seen as a helium shell in layers up to the 8 Mm heights. The preliminary evaluated effective height of the He I 4713 shell is 1.8 Mm and it is approximately 2.0 Mm for the He II 4686 emissions outside polar regions. These lines can be measured only in eclipse conditions, when the parasitic scattered light is negligible for very low solar fluxes corresponding to the coronal levels. Many faint lines are also seen in emission such as Ba +, Ti +, Fe +, but with a much lower radial extension. They were observed to be superposed to F-lines when defining the solar limb using the continuum background. A cartoon is proposed to describe the structuration of these low layers and to illustrate the contribution of the magnetic field. These observations are important new insights for understanding (i) the magnetic field inference in the very low layers of the solar transition region and (ii) the ionisation mechanisms producing the big jump of the temperature towards the corona, including the source of heating.

Keywords: ionized helium He II 4686, total solar eclipses, flash spectra, helium shells, solar transition region, intensity profiles, layers, faint emission lines

1 Observations and analysis of the helium shells

The faint emission lines and the helium lines were identified in the flash spectra at the last total eclipse of July 2010. (Mitchell 1935) (Bazin et al. 2009), (Hirayama & Irie 1984), (Zirin 1975), (Zirin 1975). The extension of the He I shell is evaluated to be 1.8 Mm and it is 2.0 Mm for the He II second helium shell. This result is almost in agreement of what was known for the helium He I shell D3 bright line (Avrett & Koutchmy 1989). But this difference of the extension is linked with the higher temperatures, and the ionisation potential of He II Pashen α is 54 eV, and 24 eV for the He I line (Athay 1965), (Koutchmy et al. 2009).

2 Cartoon of the TR of the layers above the limb.

We show the low layers of the transition region, and the field lines of the emerging magnetic field.

The red lines indicate the magnetic boundaries of the more dense plasma (Athay & Menzel 1956). Black lines are the magnetic lines of force. ff means the filling factor or heterogeneity factor, and β is the ratio of gas pressure to magnetic pressure. (Bazin et al. 2009).

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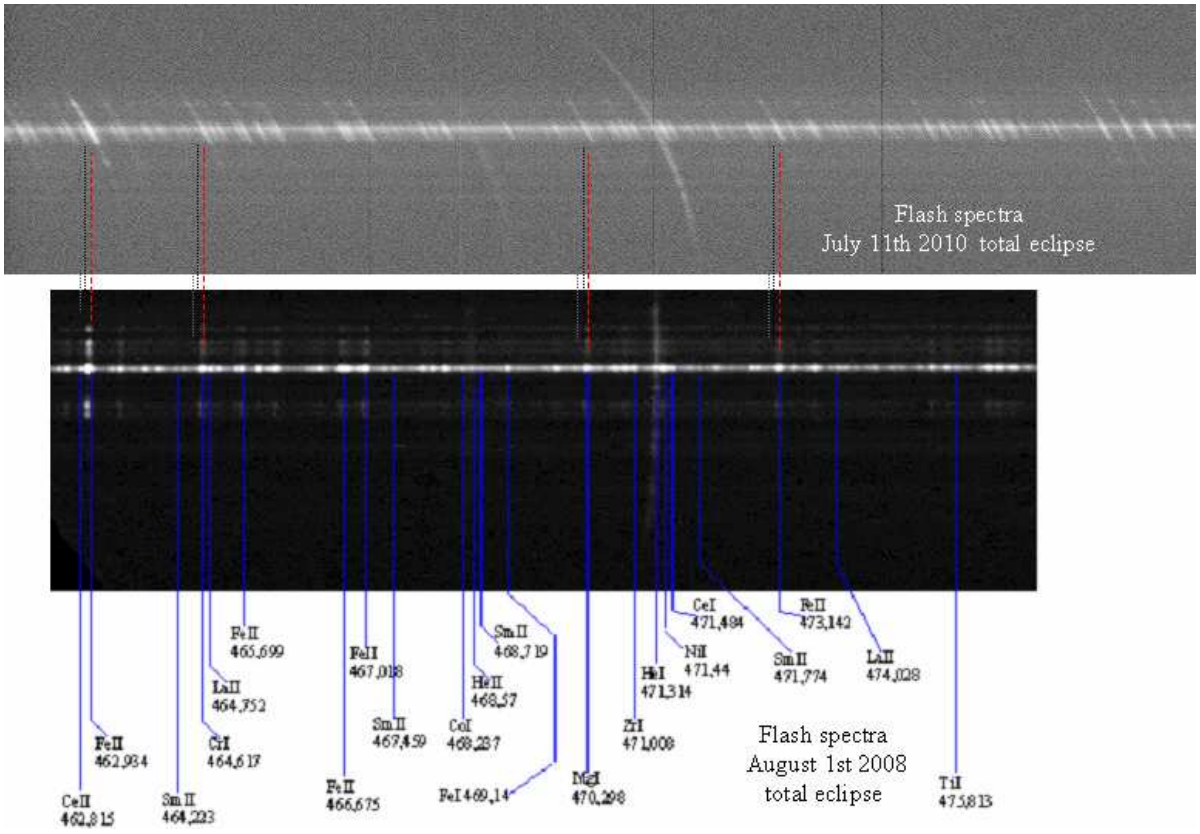

Fig. 1. Flash spectrum at the 2008 and 2010 total eclipses.

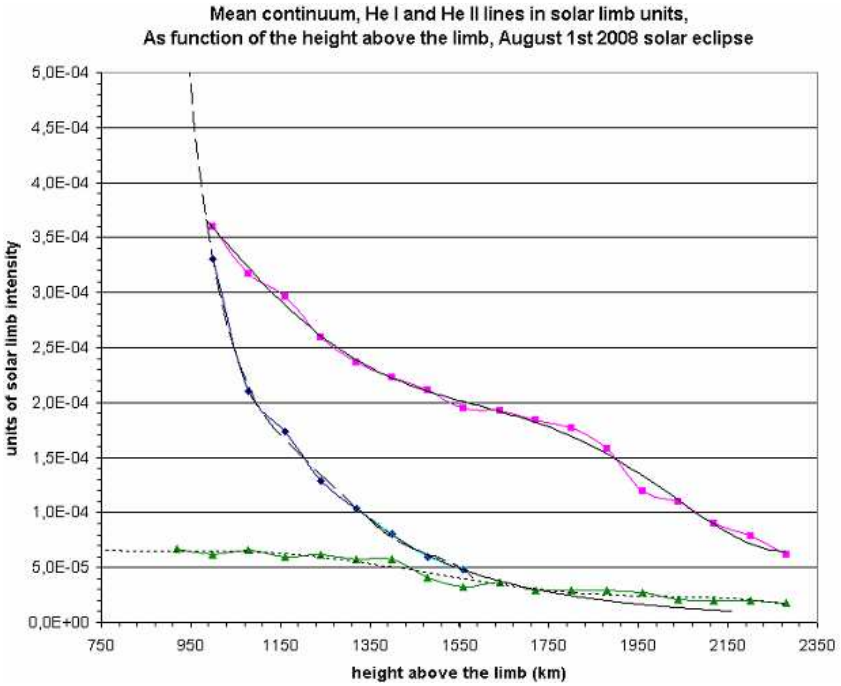

Fig. 2. Intensity profiles of the helium lines and continuum at the August 1st 2008 total eclipse

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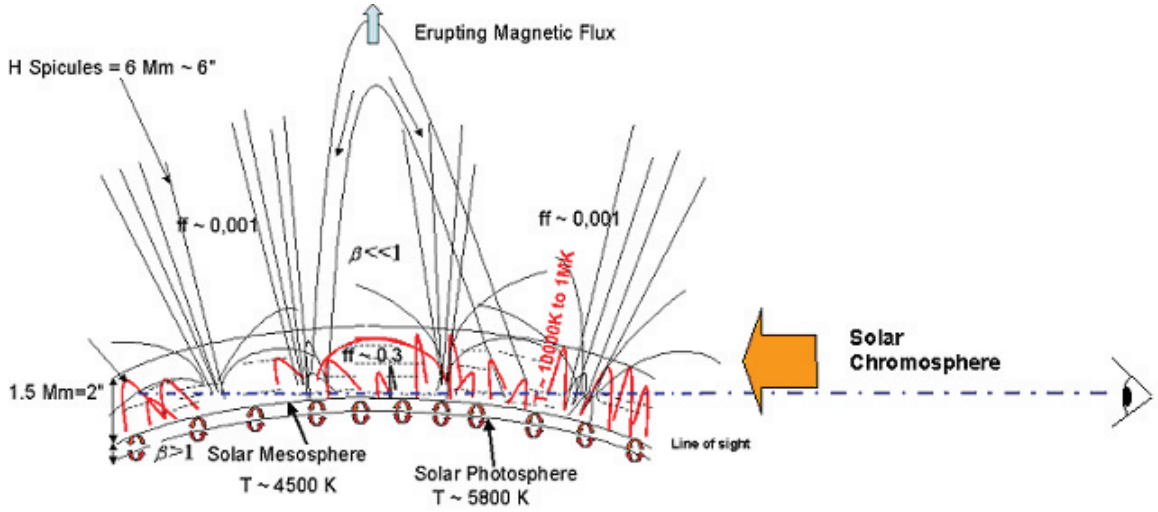

Fig. 3. Cartoon to show the low layers of the transition region (TR) including the emergence of flux tubes.

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