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edited by  Hardi Peter
Kiepenheuer-Institut für Sonnenphysik
Freiburg, Germany
peter@kis.uni-freiburg.de
We report here on observations of a solar prominence obtained on 26 April 2007 using the Extreme Ultraviolet Imaging Spectrometer (EIS) on Hinode. Selected profiles for lines with formation temperatures between log(T)=4.7 and log(T)=6.3 are given and are used to explain the existence of dark features in the raster images. We estimate the contribution of the He II 256.32 Å line in the raster image at 256 Å in the prominence region. We compare the observed prominence profiles with theoretical profiles from non-LTE radiative transfer models and deduce the contribution of resonant scattering in the He II 256 Å emission.
Solar Prominence Diagnostic with Hinode/EIS

With a touch of non-LTE radiative transfer calculations

Nicolas Labrosse
University of Glasgow

Brigitte Schmieder
Observatoire de Paris Meudon

Petr Heinzel, Stanislav Gunar
Ondrejov Observatory, Astr. Inst. of Academy of Science

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Prominence observed on 25 and 26 April 2007

JOP 178: http://gaia.bagn.obs-mip.fr/jop178/
– EIS:
  ● Rasters with 1” and 2” slits
  ● Line profiles in [167-211] and [246-291] Å
– SOT Hα

– Dark prominence structure seen in TRACE and EIS 195 Å images
  ● due to absorption in HI, HeI and HeII resonance continua
  ● and to coronal emissivity blocking due to prominence cavity
– XRT void due to X-ray emissivity blocking
– Determination of column densities and ionization degree of H
• Movie / stills
The blend at 256 Å

A typical raster with EIS at 256 Å
Contributions from [Young et al. 2007]

- He II 256.32 Å (log T ~ 4.7)
- Si X 256.37 Å (log T ~ 6.1)
- Fe XII 256.41 Å (log T ~ 6.1)
- Fe XIII 256.42 Å (log T ~ 6.2)

The coronal lines dominate above the limb (not in prominence)

Procedure to obtain the 'real' He II emission at 256.32 Å

- Use Si X 261.04 Å (unblended)
  - has fixed ratio with Si X 256.37 Å
- Remove Si X 256.37 Å
- Fit resulting signal with 1 or 2 gaussians to remove Fe XII/Fe XIII
The blend at 256 Å
Line profiles at 256 Å in bright prominence

Si X 261.04
Si X 256.37
Fe XII/Fe XIII 256.4

EIS spectrum with line blends

He II 256.32 contributes for ~ 25% of the total emission!
Calculation of He II line at 256.32 Å

• 1D plane-parallel vertical slab

Free parameters
- Gas pressure
- Temperature
- Column mass
- Height above the limb
- Radial velocity

Equations to solve
- Pressure equilibrium, ionisation and statistical equilibria (SE), radiative transfer (RT) for H (20 levels)
- SE, RT for other elements: He I (29 levels) + He II (4 levels)

\[
\begin{align*}
p(m) &= 4p_c \frac{m}{M} \left(1 - \frac{m}{M}\right) + p_0 \\
T(m) &= T_{cen} + (T_{tr} - T_{cen}) \left[1 - 4 \frac{m}{M} \left(1 - \frac{m}{M}\right)\right]
\end{align*}
\]

(Anzer & Heinzel 1999)
Prominence plasma parameters

Obtained by comparison between grid of computed profiles and observed profiles

Model results

- Column mass: $9 \times 10^{-4}$ g cm$^{-2}$
- Mean H density: $8.4 \times 10^{10}$ cm$^{-3}$
  
  (He abundance=0.10)

- Area of bright part: $5 \times 10^{18}$ cm$^2$
- Mass: $5 \times 10^{15}$ g
Results (2)

Hydrogen ionisation

\[ \frac{n_p}{n_H} \]
- Surface: 1
- Centre: 0.94

Temperature
- Surface: $10^5$ K
- Centre: $10^4$ K

Helium ionisation

\[ \frac{n_{(He II)}}{n_{(He)}} \]
- Surface: 0.20
- Centre: $3.3 \times 10^{-5}$
- Max = 0.99

\[ \frac{n_{(He III)}}{n_{(He)}} \]
- Surface: 0.8
- Centre: 0
EIS provides a new view on prominences
Enables us to probe different regions of prominences
Emission at 256 Å can be understood in this prominence as

- ~25% He II 256
- The rest coming from coronal lines (emission from the corona in front of the prominence)

The He II line is formed by

- Scattering of the incident radiation (50%-70%)
- Collisional excitation

Non-LTE computations are necessary to interpret this part of the spectrum