

Diagnostics of the off-limb corona using EUV and forbidden lines

Jaroslav Dudík



with

Giulio Del Zanna, Helen E. Mason Vanessa Polito, Paola Testa Elena Dzifčáková, Juraj Lörinčík and Jan Rybák

University of Cambridge, UK DAMTP. Palo Alto, USA LMSAL, ASU CAS, Ondřejov, CZ Tatranská Lomnica, SK AI SAV,

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EUV and Forbidden Lines



Coronal Fe ions produce many emission lines across the solar spectrum:

Allowed lines

mostly in EUV (observed by *Hinode/EIS*)

Forbidden lines

are located at larger wavelengths (UV, IR)

Fe XII 1349 Å: IRIS

Fe XIII 10747 & 10797 Å observed by *COMP*

 Requires coordinated observing campaigns: IHOPs 246 and 316

> <u>Dudík et al. (2014)</u> <u>AA 570 A124</u>

<u>Fe XIII</u>: *Hinode***/EIS and** *COMP*



Fe XIII electron densities: EIS and COMP



 Electron densities measured to be the same by both instruments, once photoexcitation and background subtraction are accounted for

<u>Fe XII</u>: *Hinode***/EIS and** *IRIS*



- Off-limb observations of AR and QS taken on 2013-10-22
- IHOP 246, both *Hinode*/EIS and *IRIS*
- Fe XII produces several lines in EUV: 192.39, 193.51, 195.19 Å are strong and part of the same multiplet
- Their intensity ratios should be constant, but are not: Fe XII 192/195 Å



-1060-1040-1020-1000-980 -960 -940 X ((arcsecs))

<u>Fe XII</u>: *Hinode***/EIS and** *IRIS*



Fe XII: *Hinode*/EIS and *IRIS*



log Ne [cm-3]

- EIS allows measurements of both electron densitites and temperatures
- In AR, the observed Fe XII 192 / 1349 Å ratio is not consistent with T and N_e:
- Predicted about 30
- Observed about 20





Fe XII: Hinode/EIS and IRIS

 In AR, the observed ratio is not consistent

- Can be explained if there are high-energy power-law tails
- We use the κ -distributions (where $\kappa \rightarrow \infty$ Maxwellian)

We measure к = 2–3



Fe XII 192/1349 Å

-150

-200

-250

Y ((arcsecs))

40

35

30

25

20

15

10

XII 1349.400Å $\log(n_e/cm^{-3}) =$ 9.1 Maxwellian 10 = Φ ĿĒ 92.438Å) Box AR 394Å σ_{phot} 192. σ_{20} 10 σ_{30} +368Å (192. $\overline{\times}$ С Ц

0.10

Del Zanna, Polito, Dudík et al. (2021), in prep

0.01

/ Fe XIII (202.044Å + 202.065Å)

Fe XII (192.368Å + 192.394Å + 192.438Å) /

1.00

10.00

Summary

- Forbidden lines present interesting diagnostics opportunities
- Ratio of the <u>Fe XIII IR lines</u> is density-sensitive We validated these measurements using EIS: <u>Electron densities are the same once photoexcitation</u> and background subtraction are taken into account
- <u>Fe XII 1349 Å</u> observable by *IRIS* has interesting diagnostics capabilities:
 - in Maxwellian conditions (QS), its ratio with respect to EUV lines is temperature-sensitive
 - but also depends on non-Maxwellian electrons
- Active regions are likely non-Maxwellian
 Fe XII offers strong sensitivity to *k* that is not available from EUV lines alone

