Diagnostic potential of CII lines for NASA/ SMEX mission IRIS.

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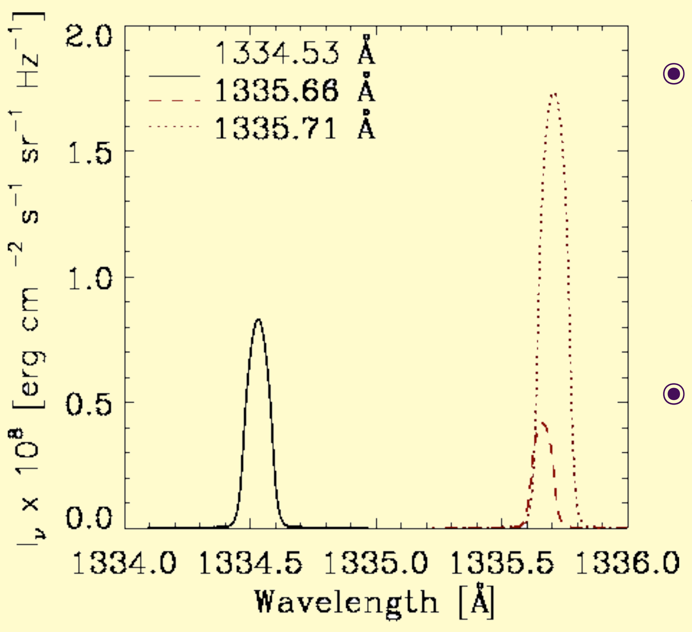
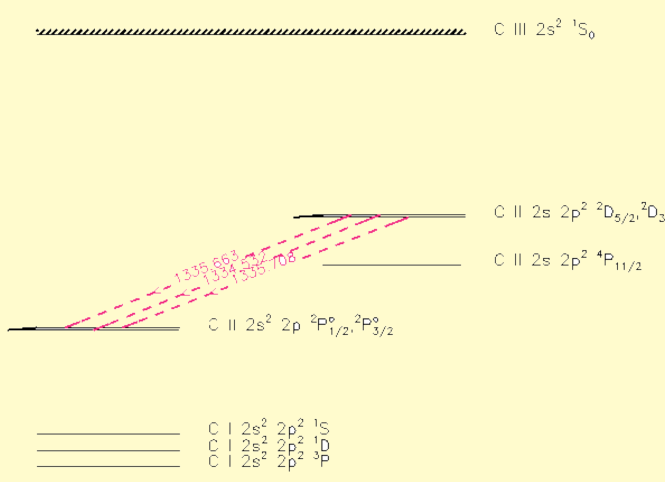
ABSTRACT

The lines from singly ionized carbon around 1335 Å are among the strongest lines in the far ultraviolet (FUV) region of the spectrum covered by the NASA/SMEX mission Interface Region Imaging Spectrograph (IRIS). The diagnostic potential of these lines is therefore of great interest. In the present piece of work, we investigate the formation of these lines and what one can learn about the solar atmosphere from IRIS observations of them. We do this with the help of 3D modeling.

ATOMIC MODEL



- The CII (2s2p² ²D – 2s²2p2P°) multiplet consists of three lines with wavelengths 1334.53Å, 1335.71Å and 1335.66 Å.
- 3 components but two are blended



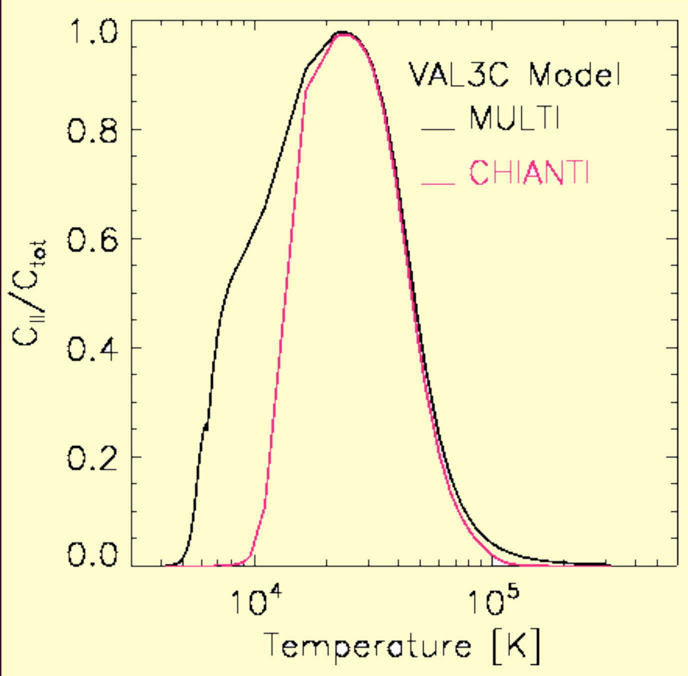
- A 22 level atomic model is simplified into a 9 level model.
- 9-level atom contains dominant rates and gives the same results as the 22-level atom

IONIZATION BALANCE

Dominant processes:

High temperature:
- Collisional ionization
- Dielectronic recombination

Low temperature:
- Photoionization from CI
- Radiative recombination

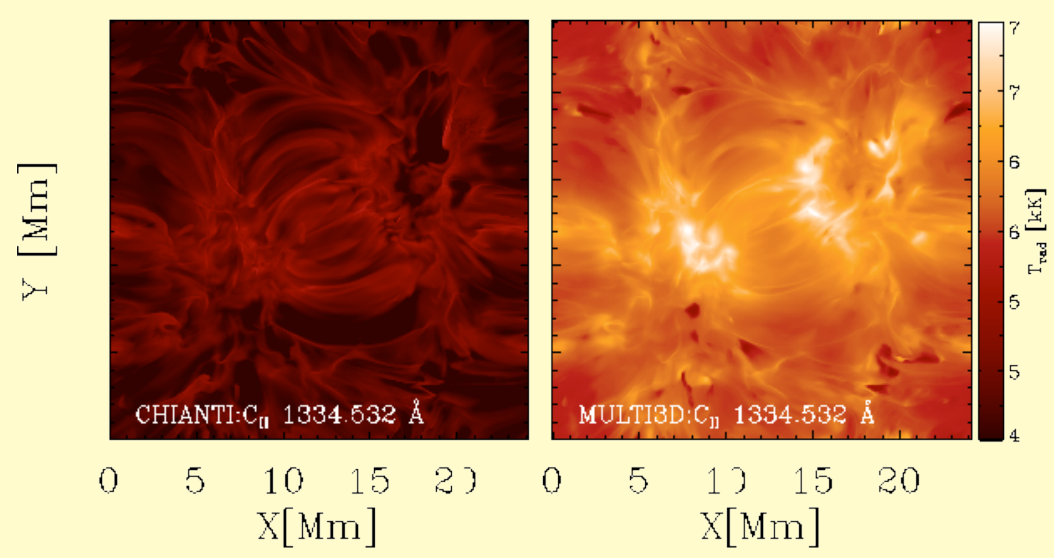


- CHIANTI does not include photoionization from CI and therefore gets too little CII at low temperatures and misplaces the formation to too high temperature.
- Average temperature of formation:

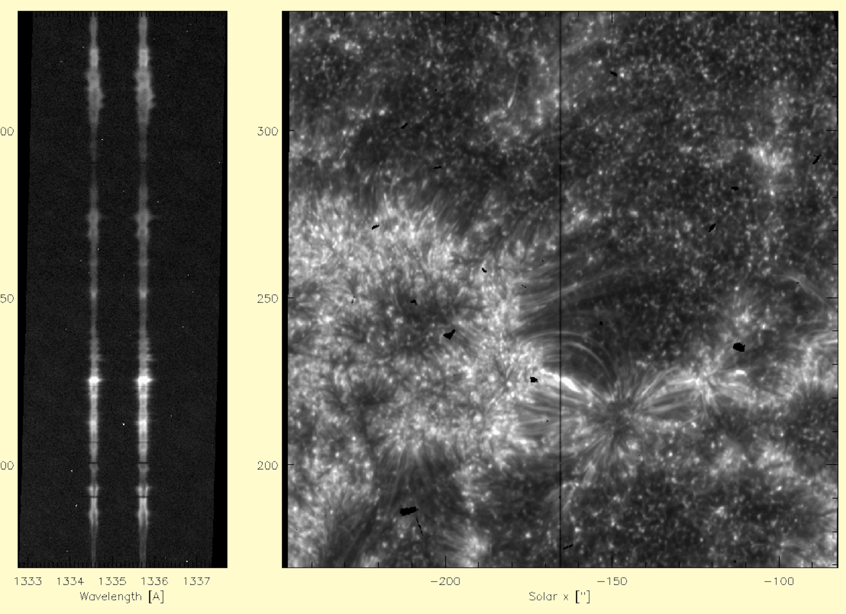
  CHIANTI: 44 kK
  our work: 15 kK

Resulting CHIANTI and Multi3D intensity:

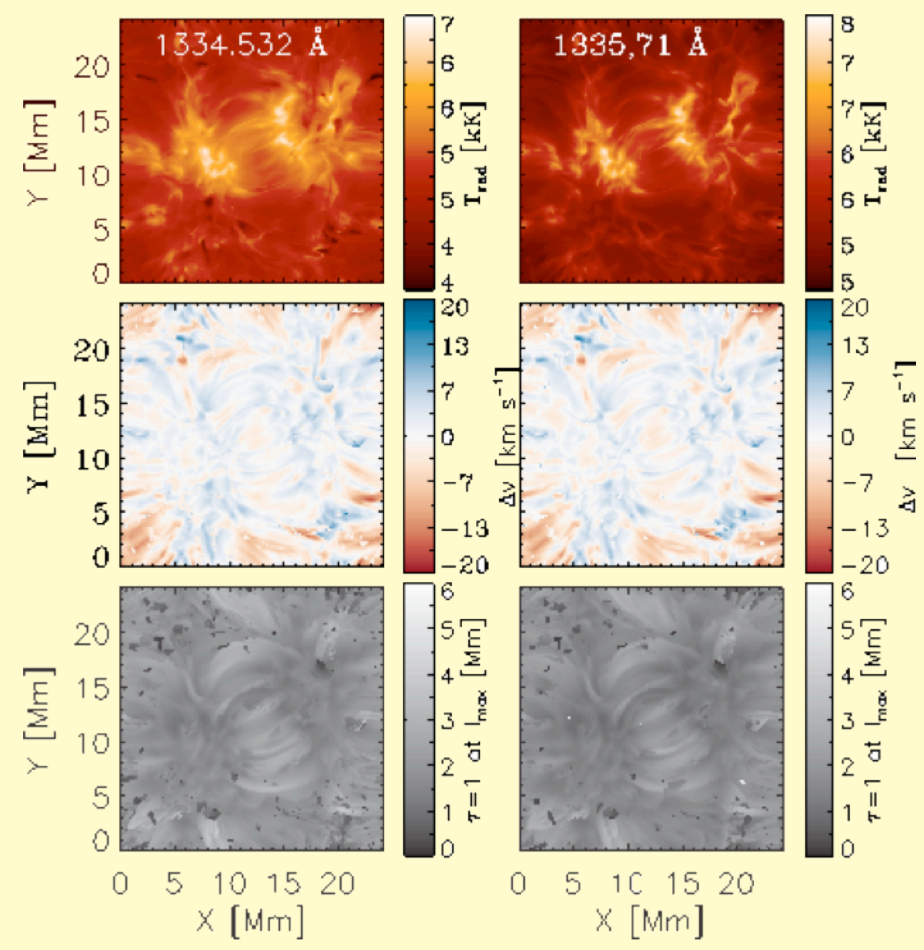
- The CHIANTI intensity is much lower due to lack of detailed photoionization from C I.



CII OBSERVATIONS FROM IRIS



SIMULATION RESULTS



Diagnostic tools:
Line intensity and shift are the basic diagnostic tools that give atmospheric properties at the formation height.

CONTRIBUTION FUNCTION

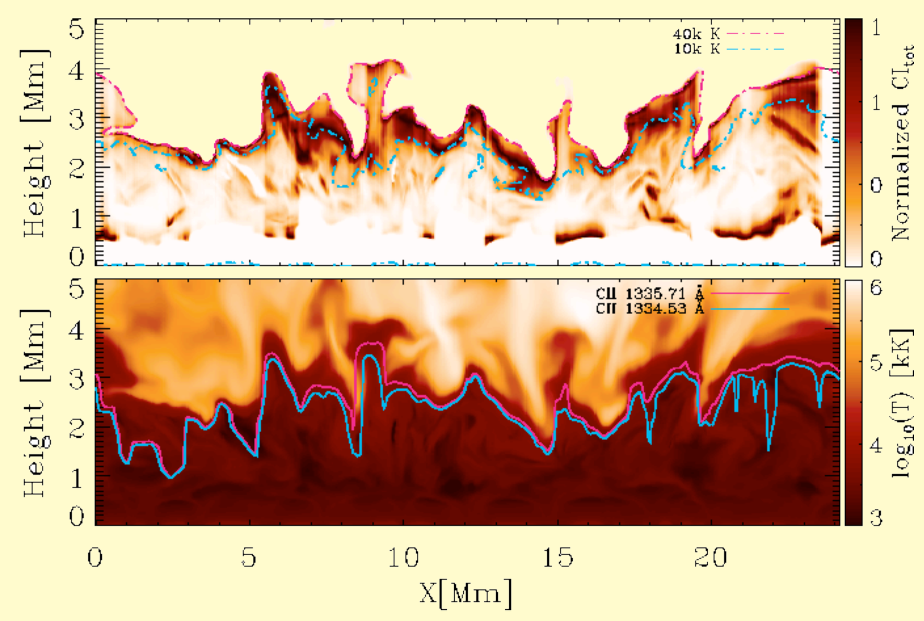
- Contribution to the intensity helps to map out the photons coming from different depths of the atmosphere.
- We have used frequency integrated contribution to the intensity.

$$C_{I_{tot}} = \int_0^\infty C_{I_{line}} - C_{I_{cont}} d\nu$$

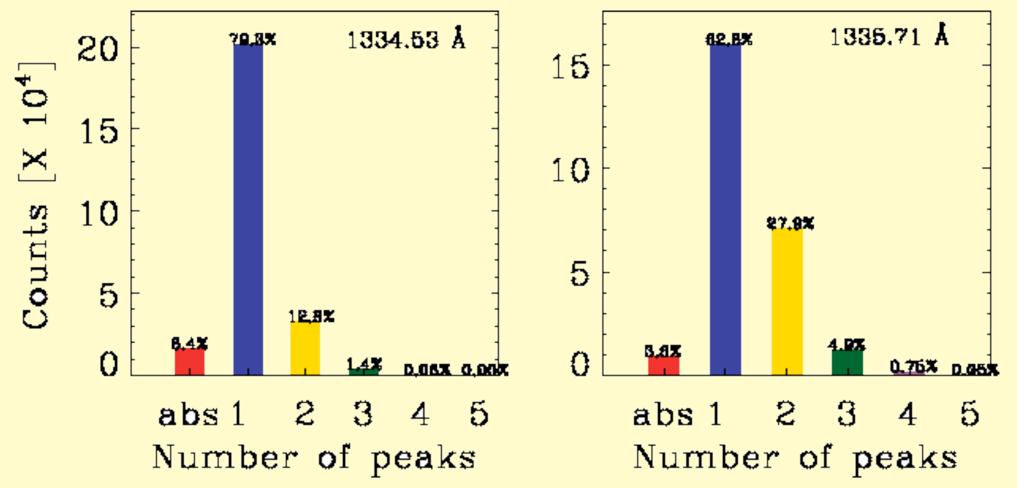
Where,

$C_I = S_\nu e^{\tau_\nu} \chi_\nu$ comes from $I_\nu = \int_0^\infty S_\nu e^{\tau_\nu} \chi_\nu dz$

Contribution to the total intensity and formation height.



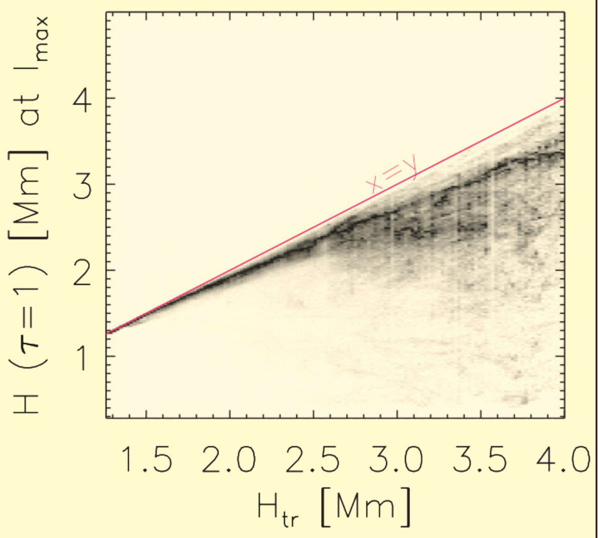
DIAGNOSTIC POTENTIAL

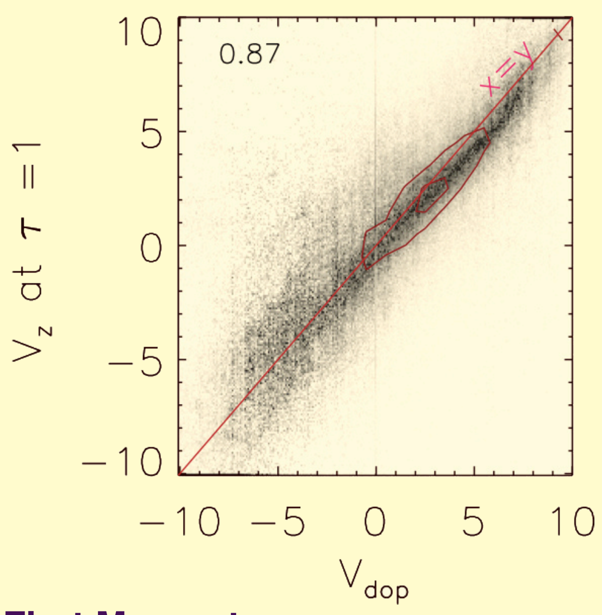


Multiple peaks:
Depending upon the atmosphere, a different number of peaks can form.

Formation Height:

- The joint probability distribution function (JPDF) formation height at maximum intensity tends to be below the transition region height in the atmosphere.
- CII lines form just below the transition region when the transition region is at low heights, also in the mid-chromosphere otherwise.



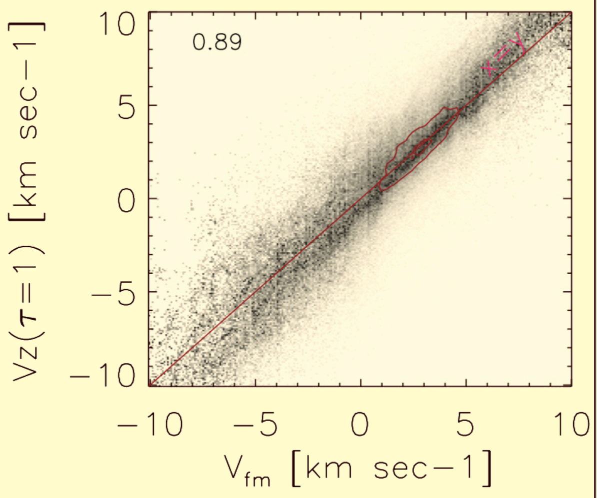


Doppler shift:
The Doppler shift of the line center corresponds very well with the vertical velocity at the formation height.

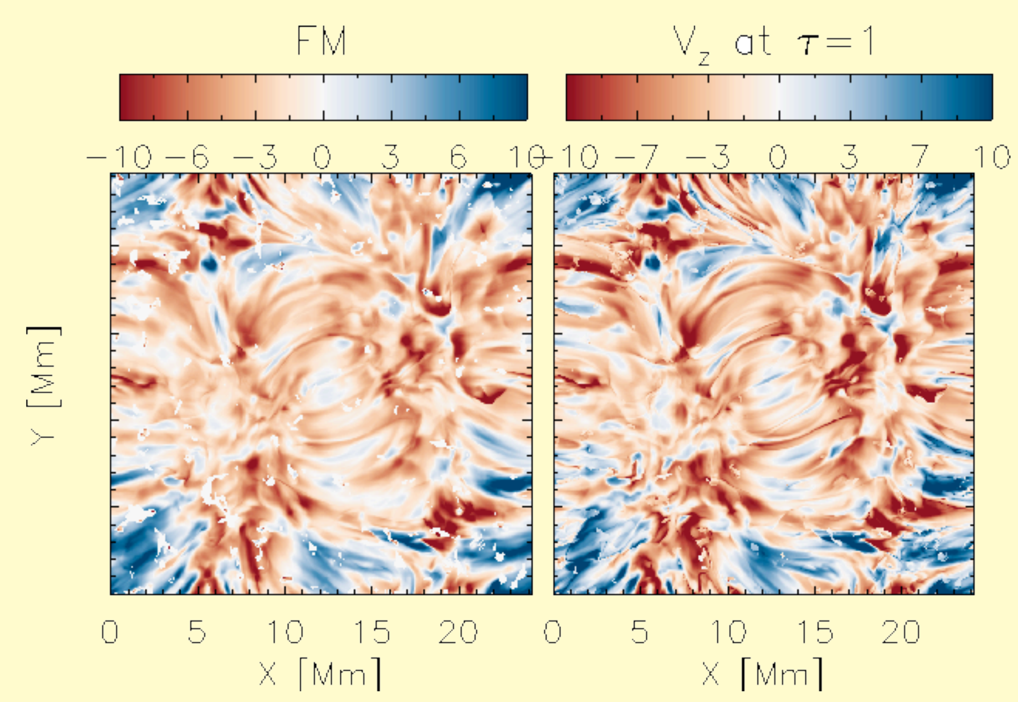
(Pearson correlation coefficient given in the upper left corner)

First Moment:

- The first moment of the intensity is a good measure of the velocity. It is less affected by noise than the Doppler shift at line-center and is well defined also for multiple peaked profiles. It is, however, sensitive to a larger part of the atmosphere center. (has a broader response function) and has the peak of its response function lower down than the Doppler shift of the line



- The image below shows how closely the first moment is correlated with the vertical velocity at the formation height.



RESULTS

- The C II lines cannot be described with the coronal approximation - photoionization from C I needs to be taken into account.
- The average temperature of formation is 15 kK, the average height of formation in mid-upper chromosphere
- The C II lines are good velocity diagnostic.

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