Rosseland Centre for Solar Physics

FORMATION OF THE O I & C I LINES IN A FLARE

ADITI BHATNAGAR, MATS CARLSSON
ROSSELAND CENTRE FOR SOLAR PHYSICS, UNIV OSLO
ESPM - 16

Introduction & Motivation

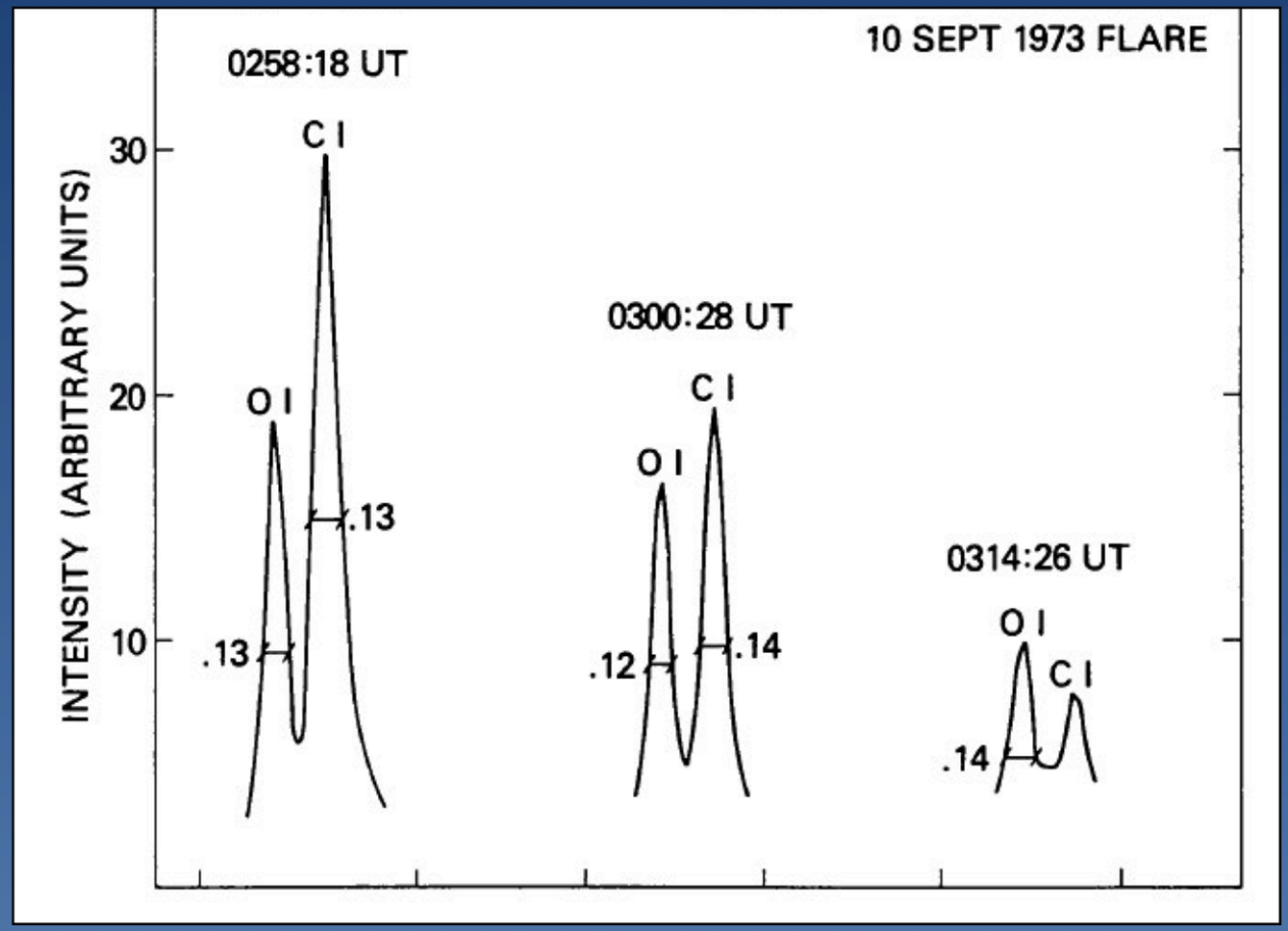
O I - 135.56 nm & C I - 135.58 nm

From Observations (Cheng et al 1980)

- O I/CI decreases during a flare
- Intensity of O I > Intensity of C I for Quiet Sun
- Intensity of O I ~ Intensity of C I for Active regions

From Simulations (Lin and Carlsson 2015, Lin et al 2017)-

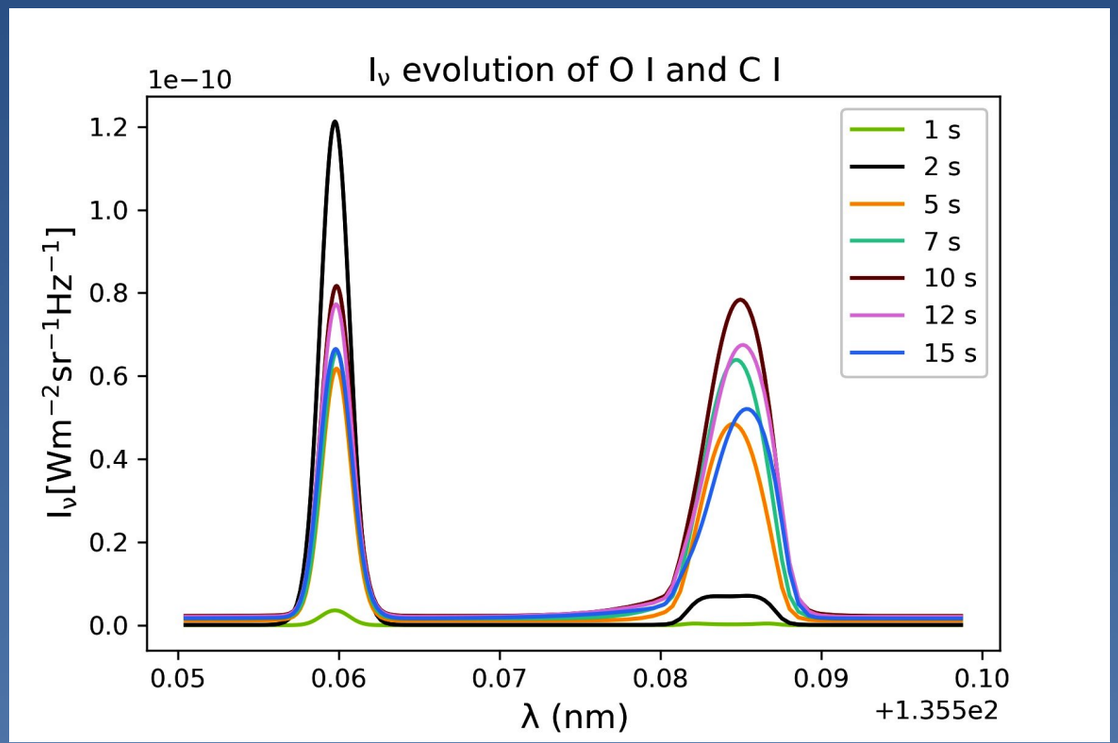
- $I_\nu \propto N_e^2$ (Oxygen)
- C I/O I line ratio $\propto 1/N_e$



Relative intensities of O I and C I lines during a flare

So what happens during a flare?

- 1D RADYN simulation of flare
- Temperature = 1 MK at z = 10 Mm
- Chromosphere similar to the VAL3C semi-empirical model.
- Duration of simulation = 50 secs
- Write RH atmosphere from RADYN output.

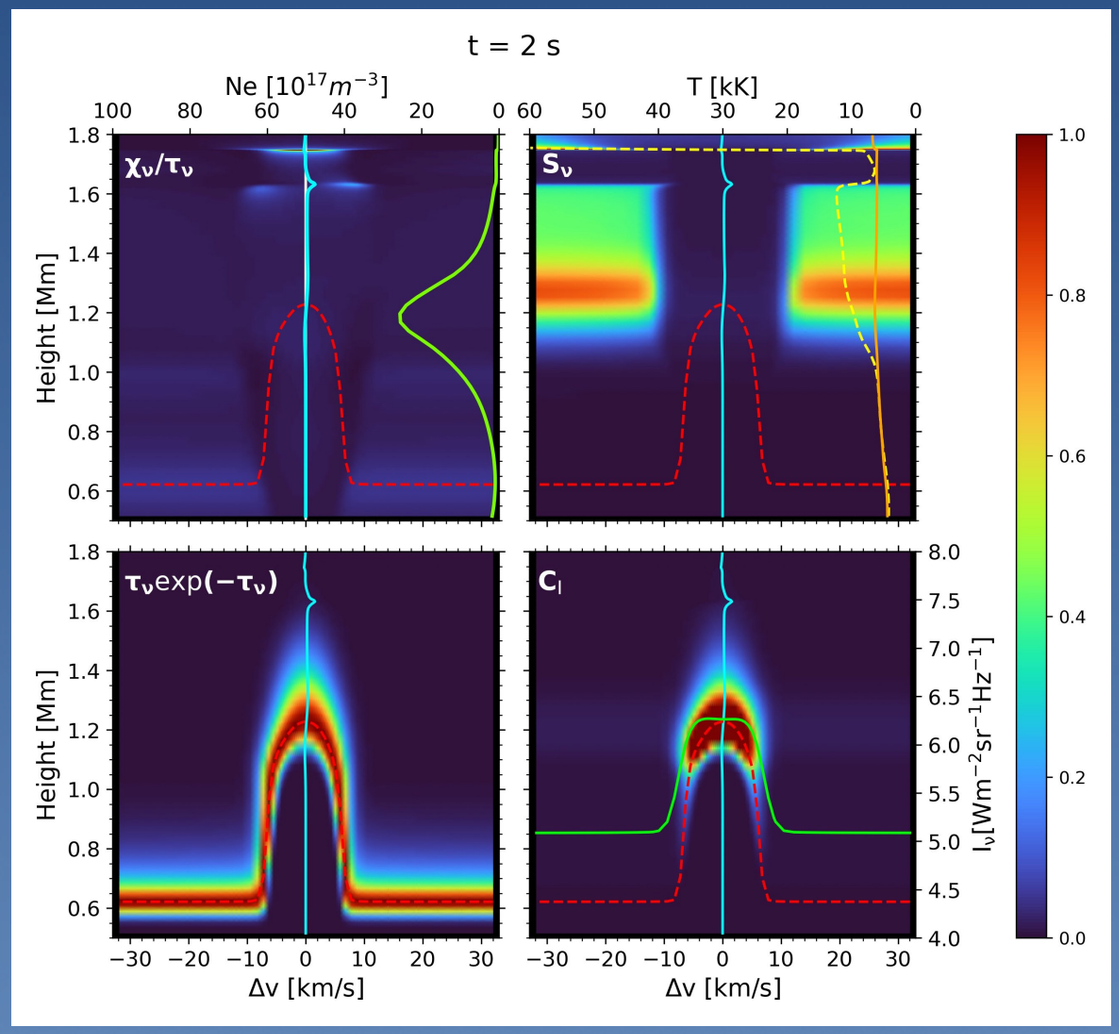


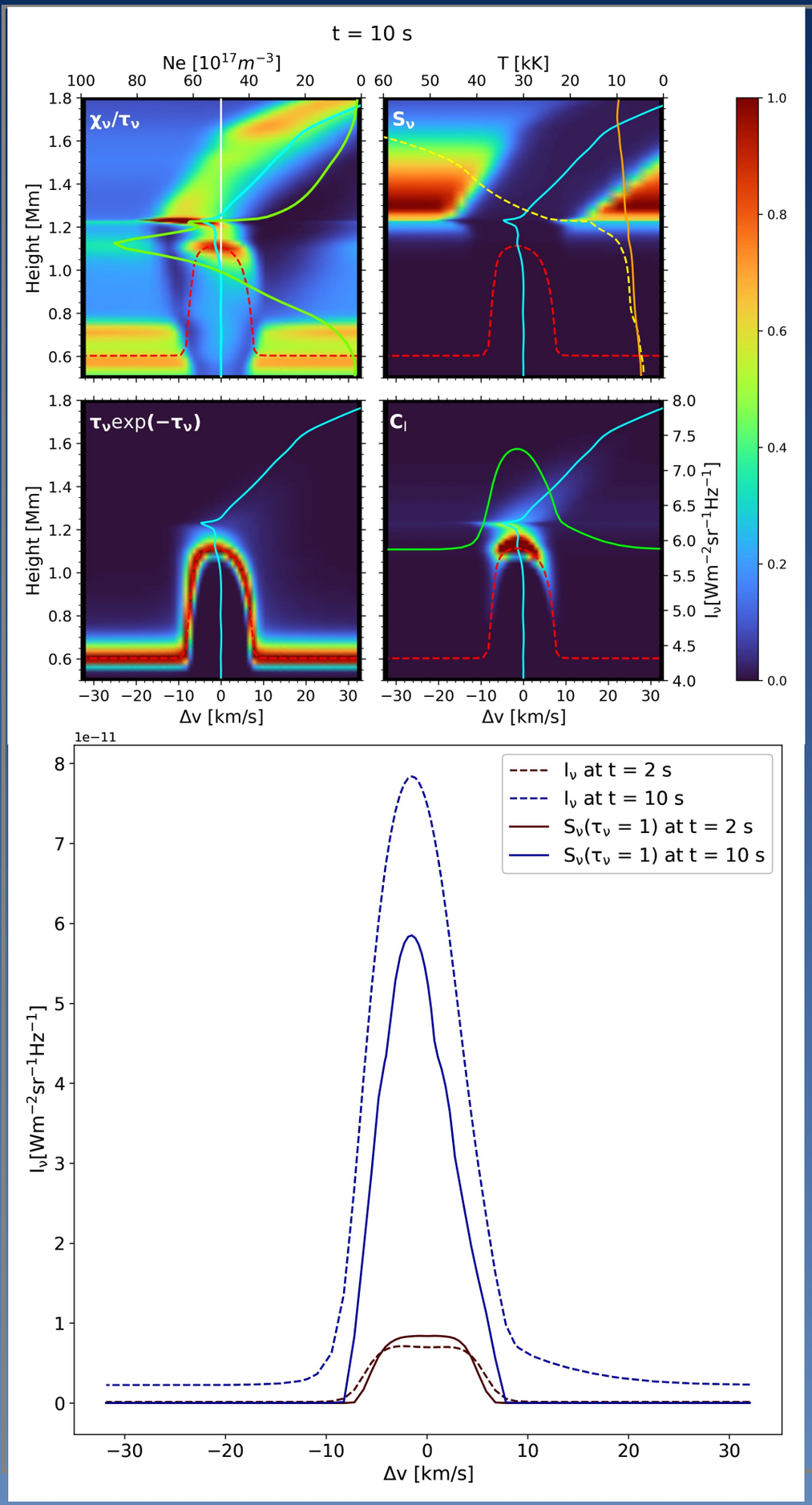
- O I peaks at 2 secs, C I peaks at 10 secs

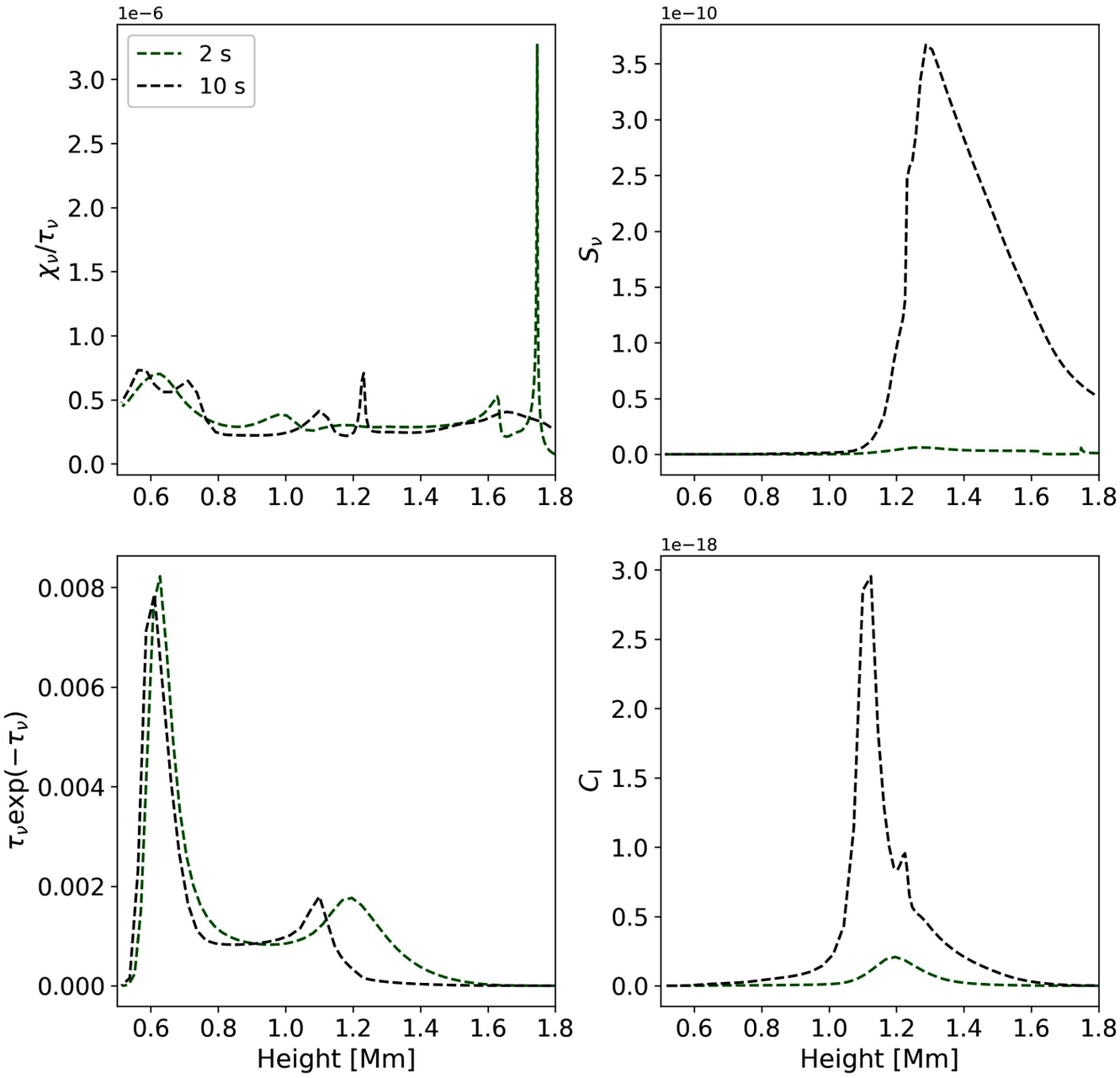
- Model atom O I - 16 levels
- Model atom C I - 26 levels

(As in the papers by Lin and Carlsson)

- Study the line formation using four panel diagrams (Carlsson & Stein 1997)
- $C_{I_\nu}(z) = S_\nu \tau_\nu e^{-\tau_\nu} \frac{\chi_\nu}{\tau_\nu}$

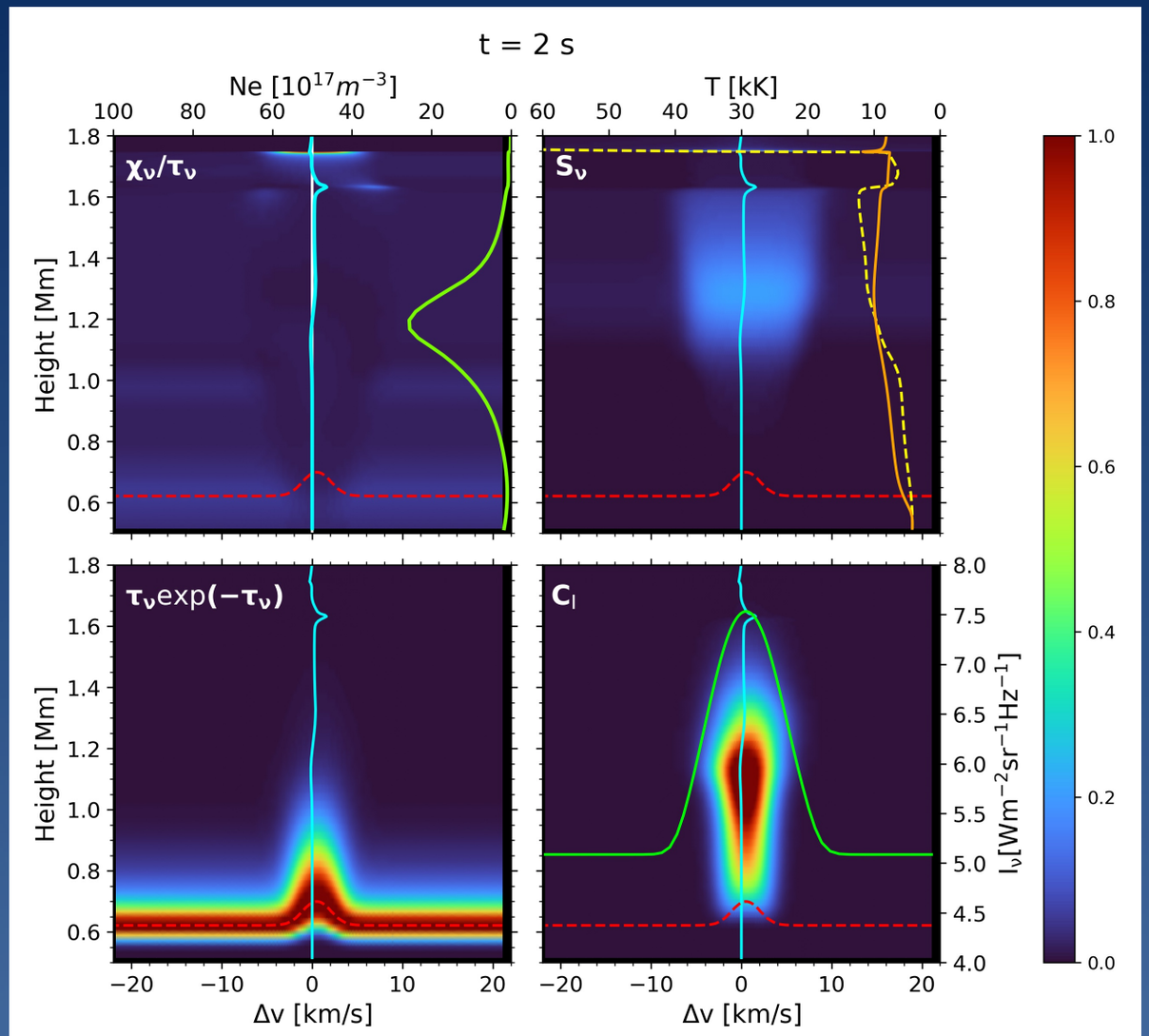






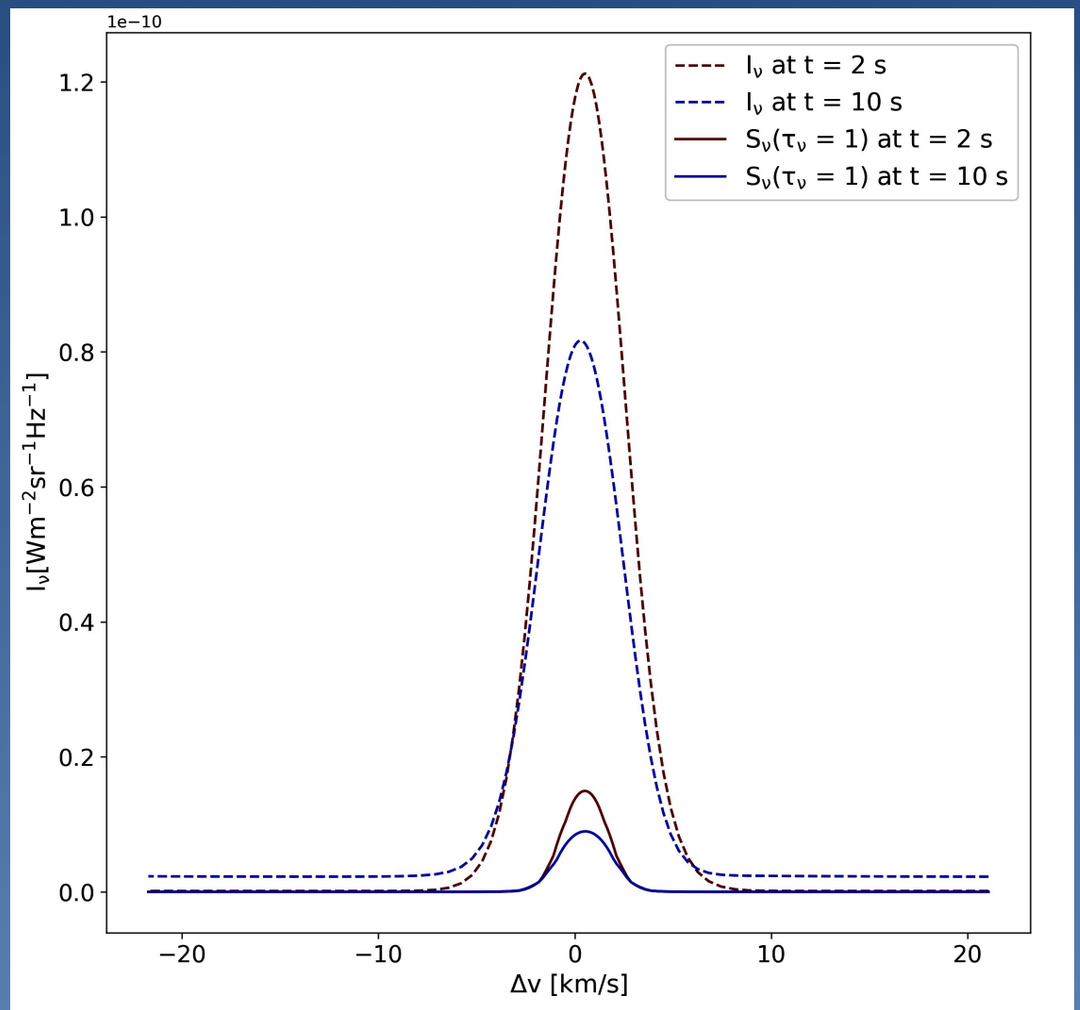
RESULTS (C I 135.58 nm)

- Optically thick
- The height of line formation is defined by $\tau_\nu e^{-\tau_\nu}$, S_ν is the major factor in increasing $C_{I_\nu}(z)$



RESULTS (O I 135.58 nm)

- $\tau_\nu = 1$ peaks at z = 0.7 Mm, but $C_{I_\nu}(z)$ peaks at 1.2 Mm, for t = 2 secs

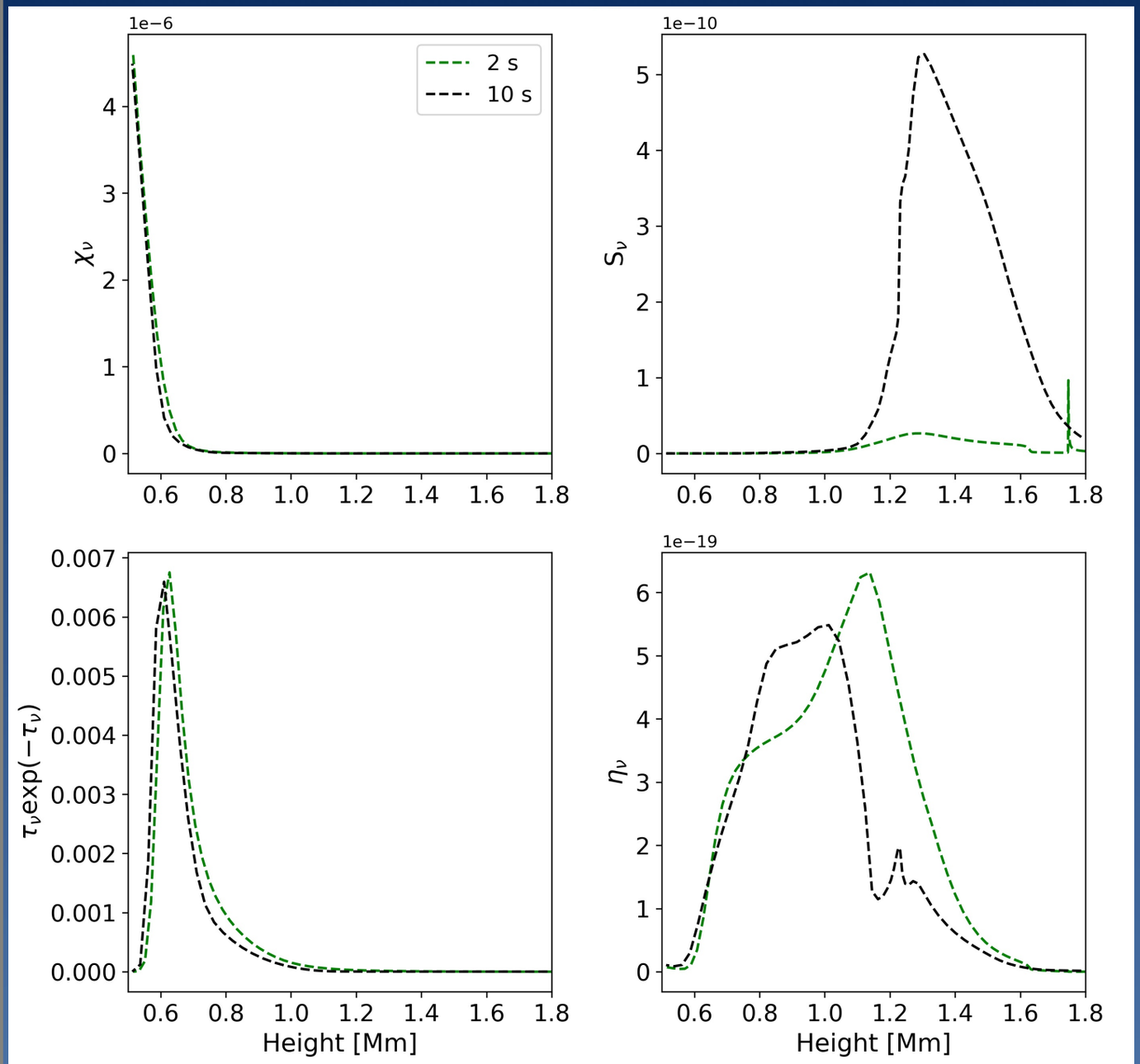


RESULTS (O I 135.58 nm)

- Optically thin
- Redefine the Contribution function
- $\eta_\nu = \chi_\nu \times S_\nu$

Conclusions

- C I 135.58 nm line is Optically thick during a 1D simulation of flare
- Source function is the major factor in increasing the Contribution function for the optically thick case.
- O I 135.56 nm line is Optically thin during a flare, same as in the Quiet Sun simulations
- Hence, we redefine the Contribution function as emissivity
- Also, C I line core forms at a higher height than O I during both peaks
- Electron density dependency?



RESULTS (O I 135.58 nm)

- $\tau_\nu e^{-\tau_\nu}$ peaks at z = 0.6 Mm, doesn't affect O I line formation!
- Line core forms at height 1.15 Mm for t = 2 secs