Resonant scattering in a microflare

Costis Gontikakis

Research Center for Astronomy
Academy of Athens

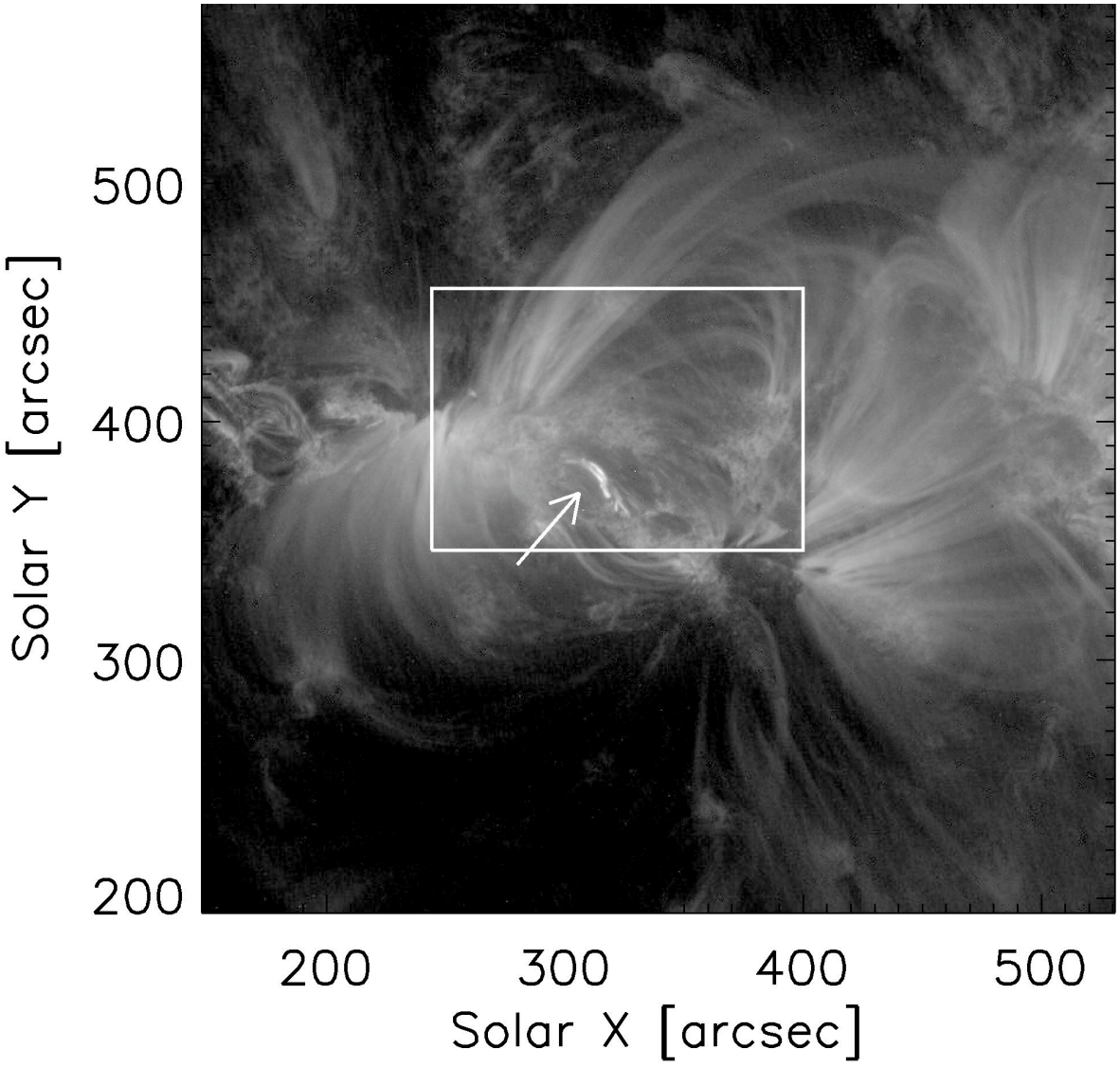
in collaboration with

Amy Winebarger

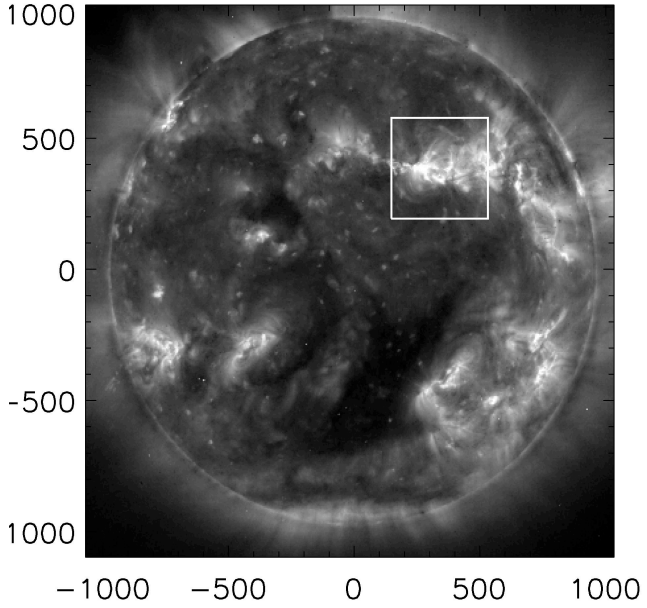
Alabama A&M University

14-09-2010

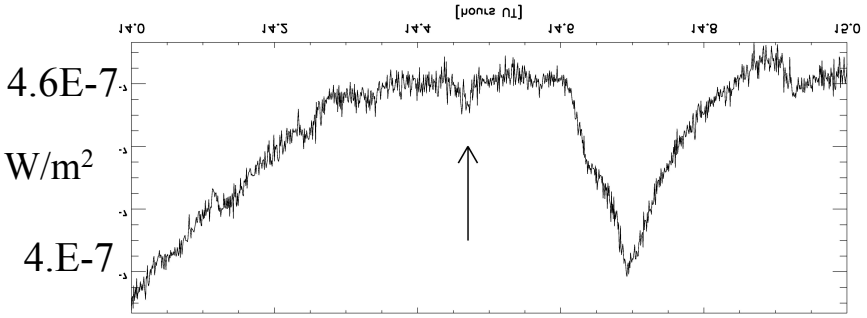
NOAA **1841** 15 May 1999 14:25 - 14: 29 UT



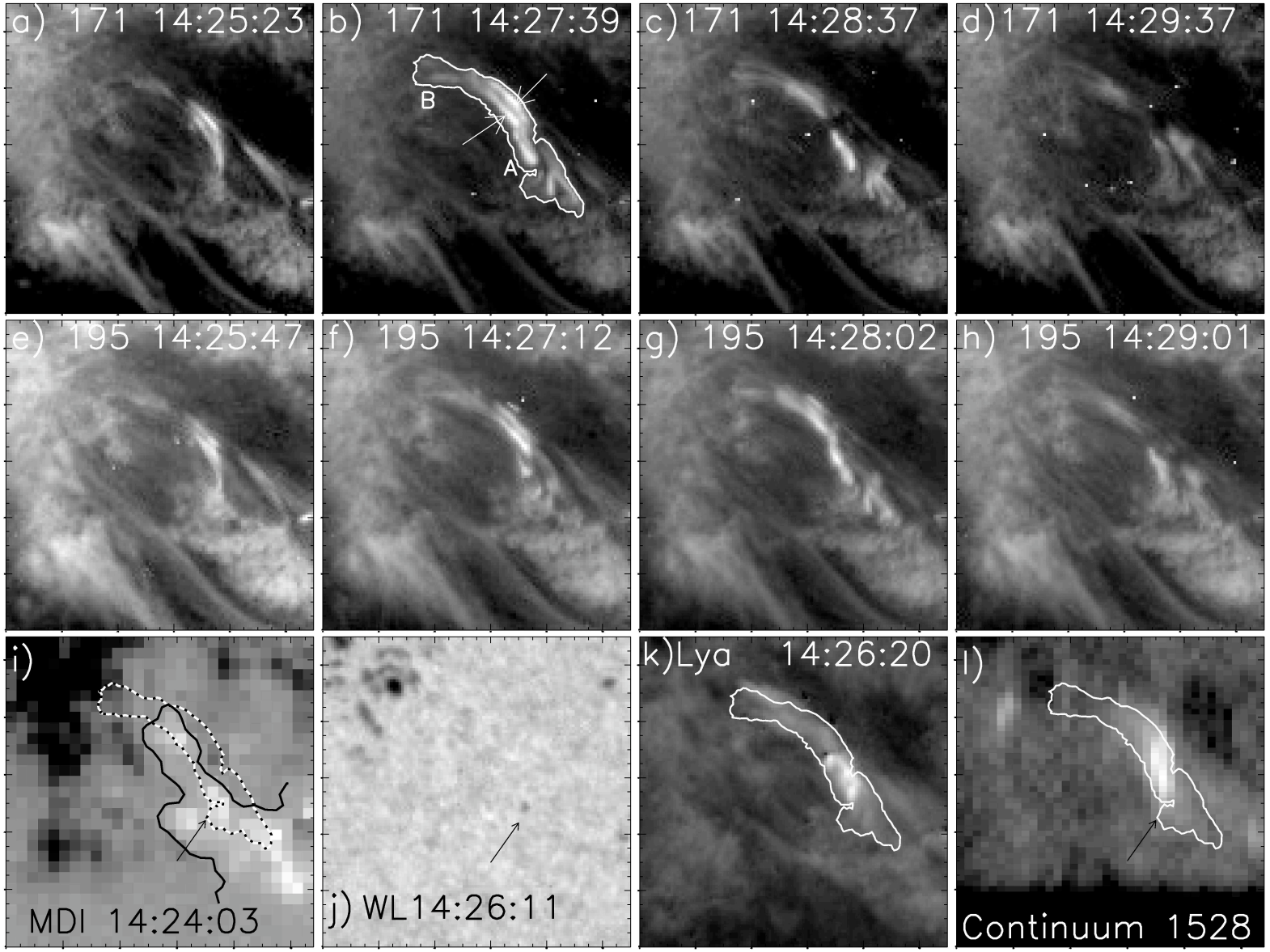
EIT 171



GOES A1 event



14:00 [hours] 14:35

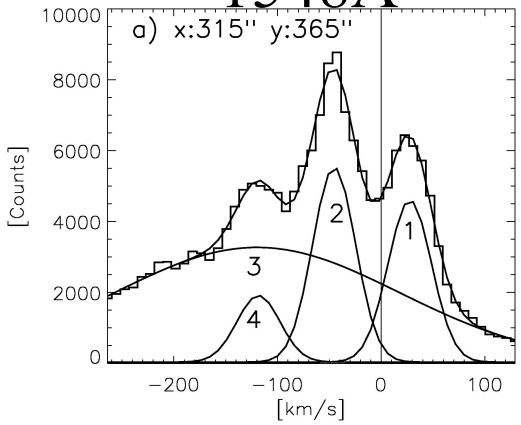


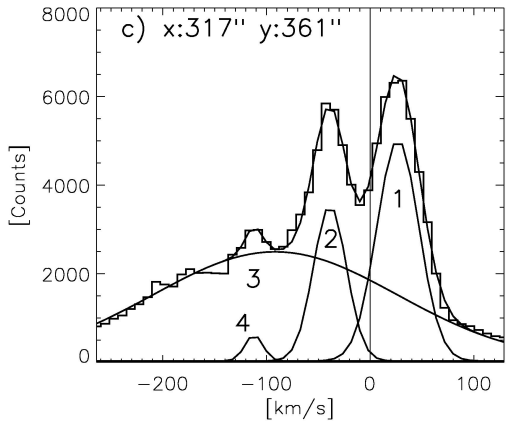
Fov 55” x 55”

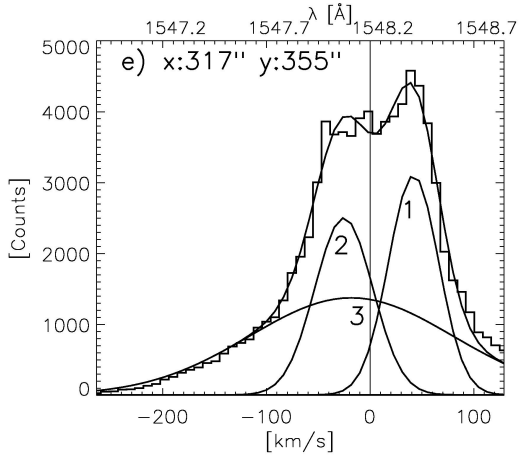
SUMER : Ne VIII 770A, **C IV 1548,1550A,**Si II 1535A

Microflare C IV profiles

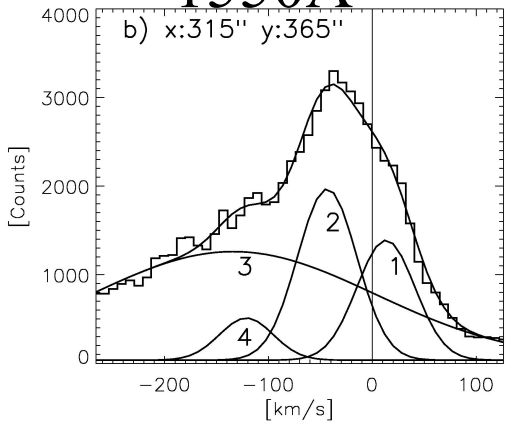
1548A

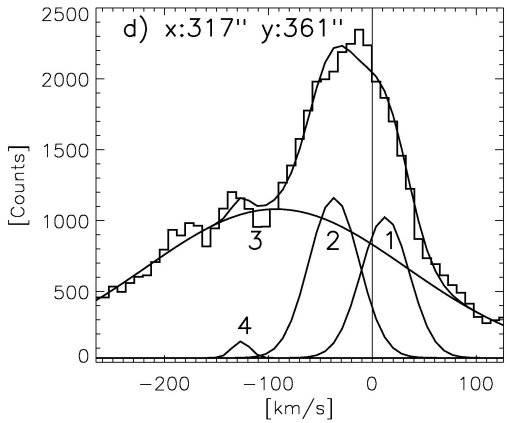


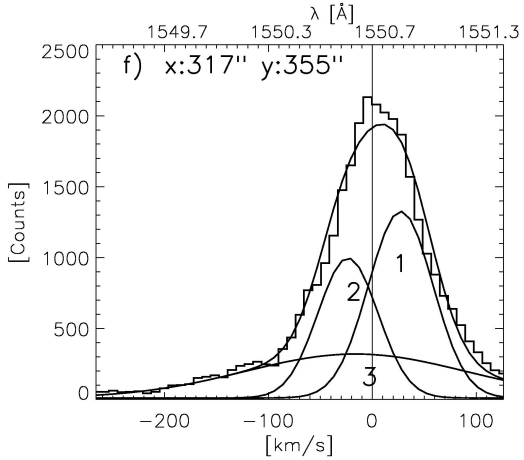




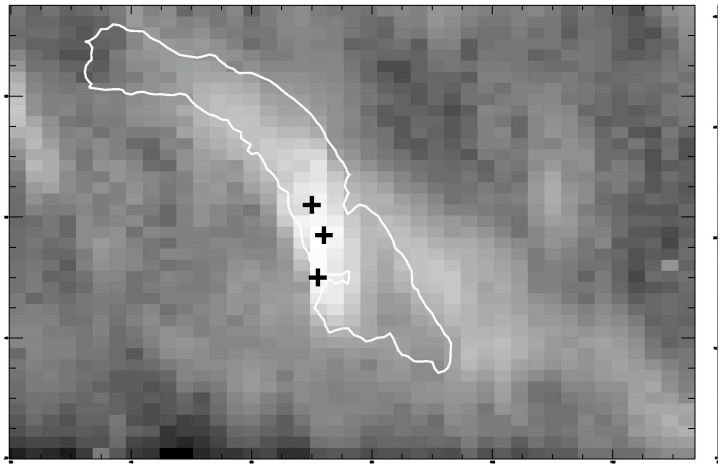
1550A

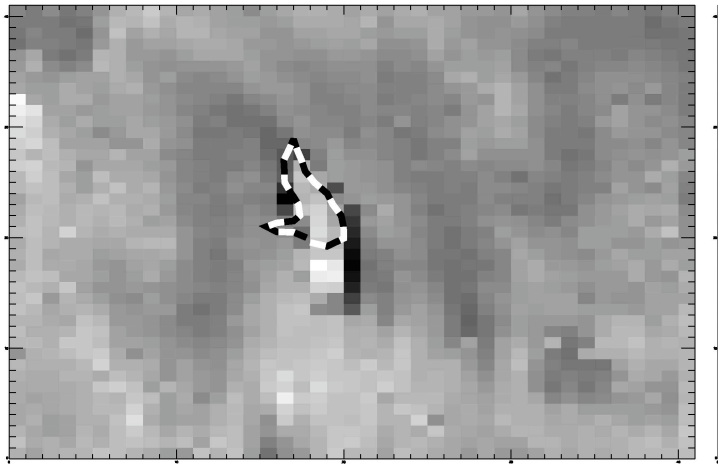






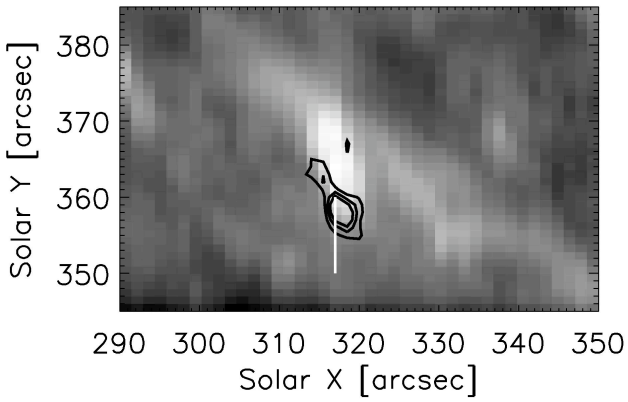
Intensity

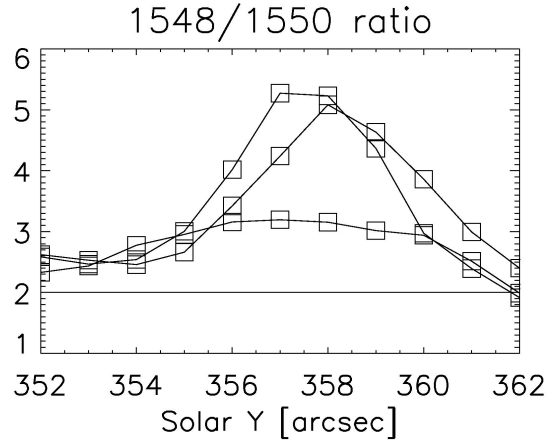


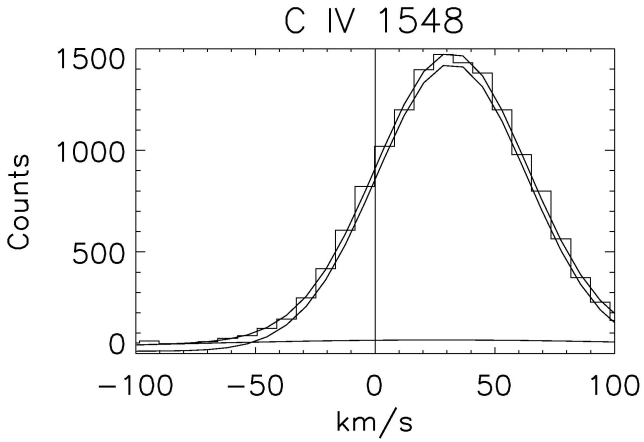


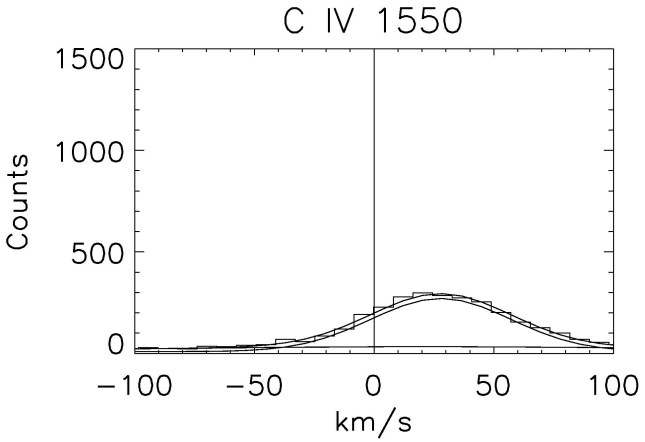
Dopplergram

I1548/I1550 for each gaussian in the range 1.2 to 5









The **scattering region** :
ratios 1548/1550 ~ 3 to 5
30 km/s redshifts
is above a **solar pore**

$$I_{13} = h\nu_{13}(n_i\, n_e C_{13}(T) \,+\, n_i B_{13}\bar{J}_{13})\frac{L}{4\,\pi}$$

$$I_{12} = h\nu_{12}(n_i\, n_e C_{12}(T) \,+\, n_i B_{12}\bar{J}_{12})\frac{L}{4\,\pi}$$

$r = I_{13}/I_{12}$ lines ratio.

$$n_e(T) = \frac{B_{13}\bar{J}_{13} - r B_{12}\bar{J}_{12}}{r\, C_{12}(T) - C_{13}(T)}$$

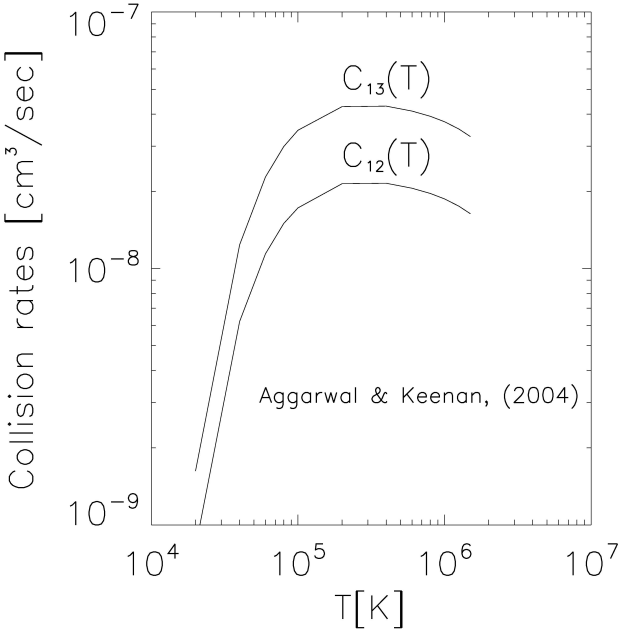
Exciting radiation fields (Rutten 2003)

$$\bar{J}_{13} = \frac{\lambda_{13}}{\nu_{13}}\frac{\Omega}{4\pi}\int I_{13}(\lambda)\phi_\lambda d\lambda$$

$$\bar{J}_{12} = \frac{\lambda_{12}}{\nu_{12}}\frac{\Omega}{4\pi}\int I_{12}(\lambda)\phi_\lambda d\lambda$$

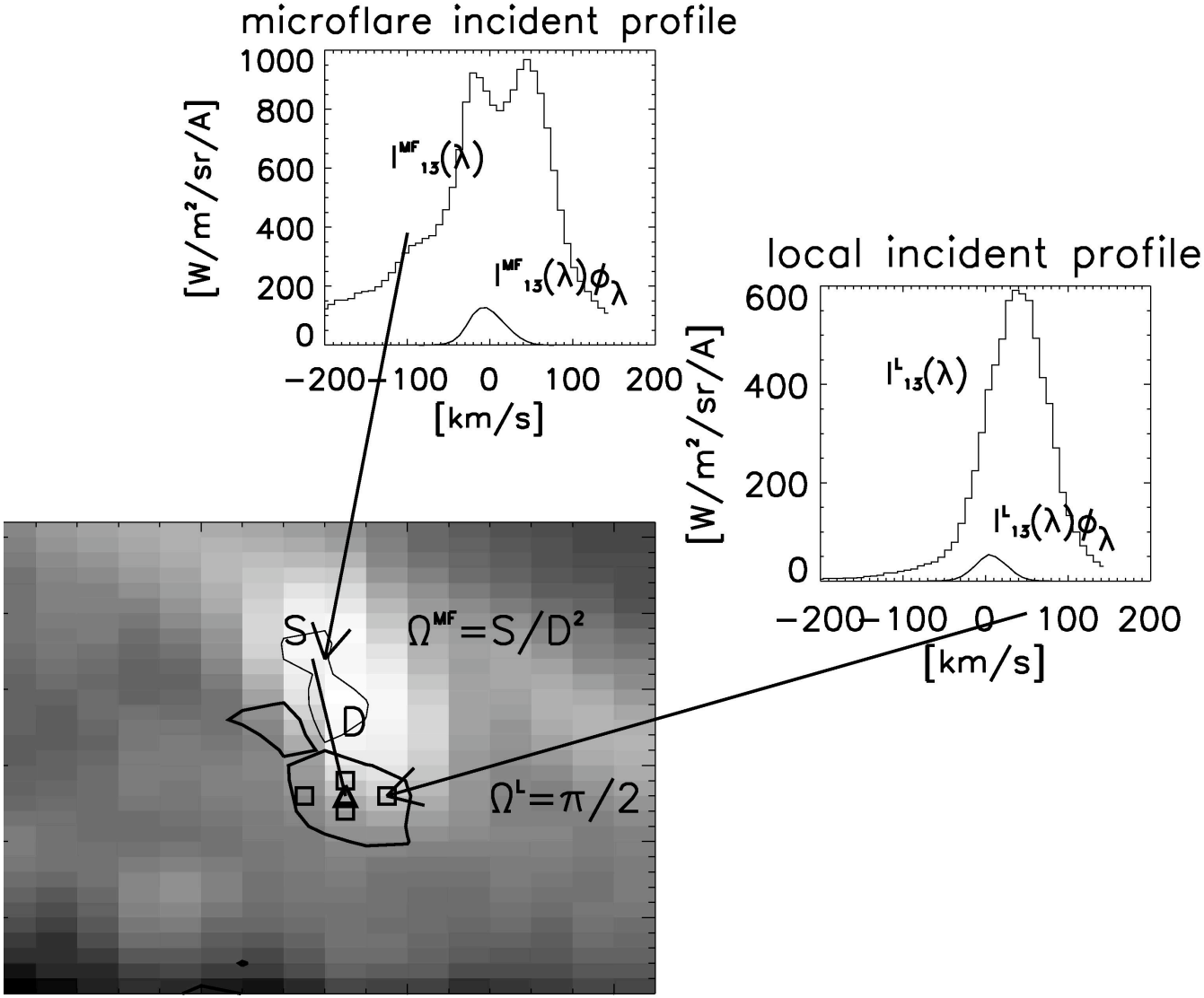
Ω : solid angle, ϕ_λ : C IV absorption profile.

Electron collision excitation rates



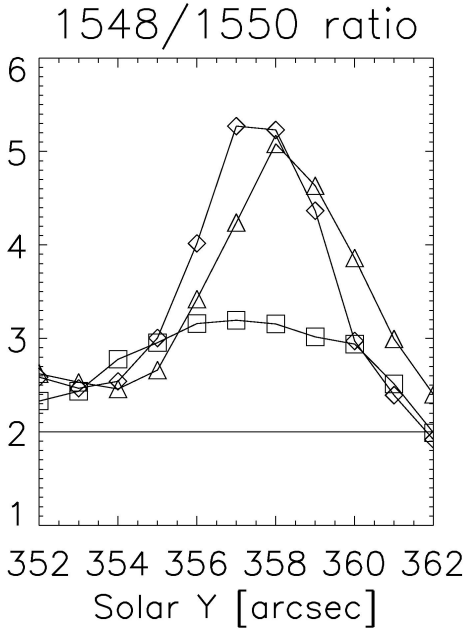
Solar Wind
Kohl & Withbroe (1982)

Noci Kohl & Withbroe (1987)
Patsourakos & Vial (2000)



$$\bar{J}_{13} = \frac{\lambda_{13}}{\nu_{13}} \left[\frac{\Omega^{MF}}{4\pi} \int I_{13}^{MF}(\lambda)\phi_\lambda d\lambda + \sum_{i=1}^{n=4} \frac{\Omega_i^L}{4\pi} \int I_{i\,13}^{L}(\lambda)\phi_\lambda d\lambda \right]$$

$$I_{13} = h\nu_{13}(n_i\, n_e C_{13} + n_i B_{13}\bar{J}_{13})\frac{L}{4\,\pi}$$



I13 comparable to observed 1548 intensity for :

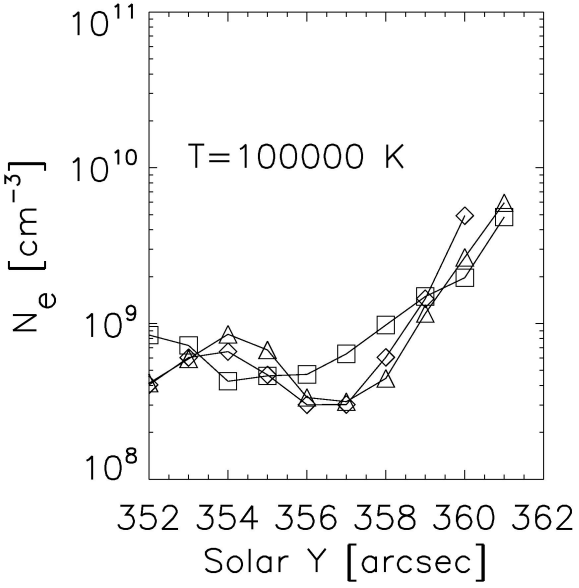
n_e~1.E9- 1.E10 cm-3

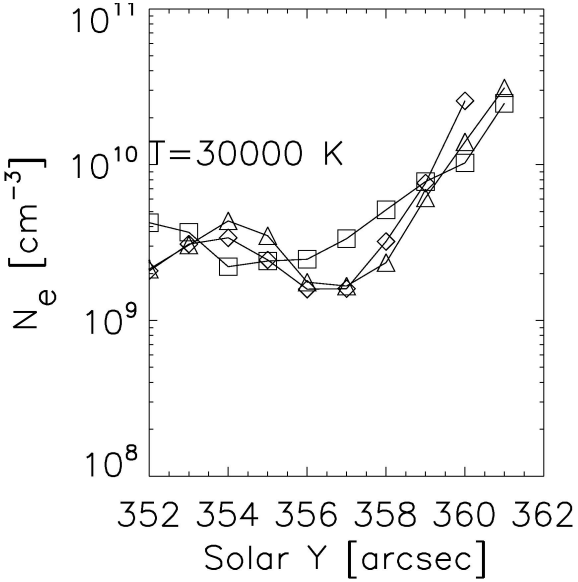
T: 30000 K - 40000K

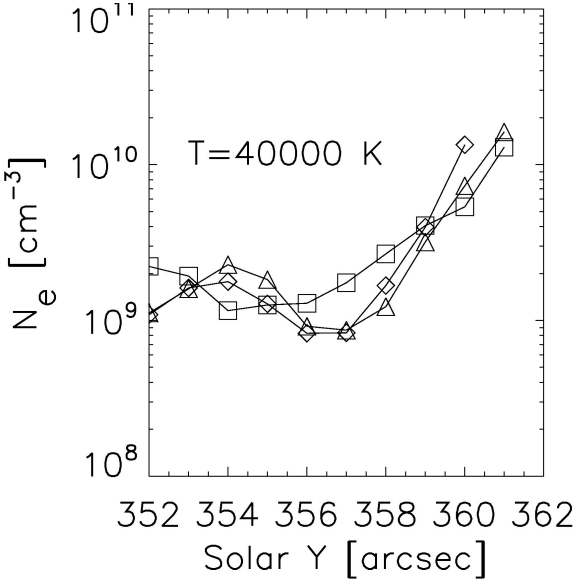
ni ~ ni(100000K) out of ionization equil.

L~ 10 Mm

Low densities in sunspots (Tian et al 2009)







Conclusions

1) Different 1550 and 1548 spectral profiles
due to **resonant scattering and opticall thickness**

2)**Resonant scattering** above the solar pore
due to low electron density ~3.E9 (1/cm^3)
and low temperature (~30000 K to 40000 K).

3) Resonant scattering detected in other parts of NOAA1841
using 1548/1550 >2

Thanks to J.-C. Vial, A. Gabriel, M. Georgoulis, S. Patsourakos
for userful suggestions

Thanks to Helen Mason for all these inspiring papers !