Spectral inversion of simultaneous MSDP Hα and IRIS Mg II k & h lines in a quiescent prominence

S. Jejčič[1], P. Heinzel[2], B. Schmieder[3], S. Gunár[2], P. Mein[3], N. Mein[3], G. Ruan[4]

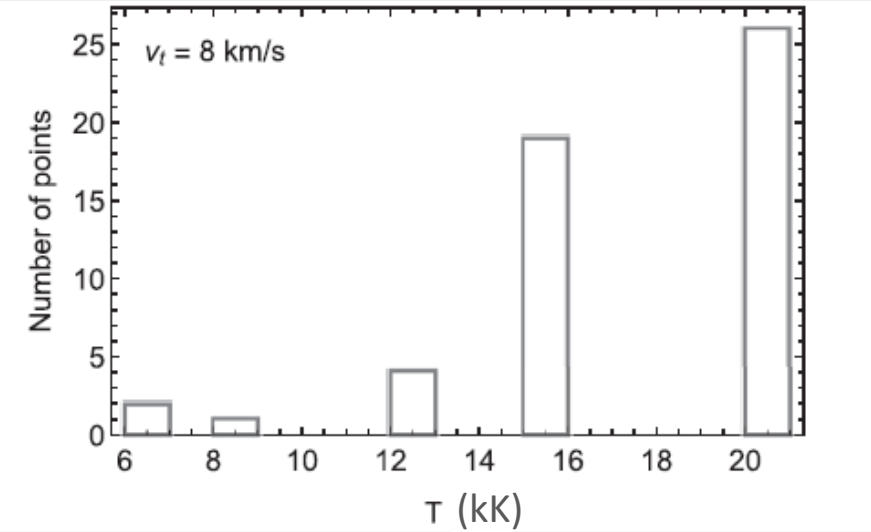
1 University of Ljubljana, Slovenia, sonja.jejcic@guest.arnes.si
2 Astronomical Institute, Ondřejov, Czech Republic
3 LESIA, Observatoire de Paris, Meudon, France
4 National Astronomical Observatories, Beijing, China

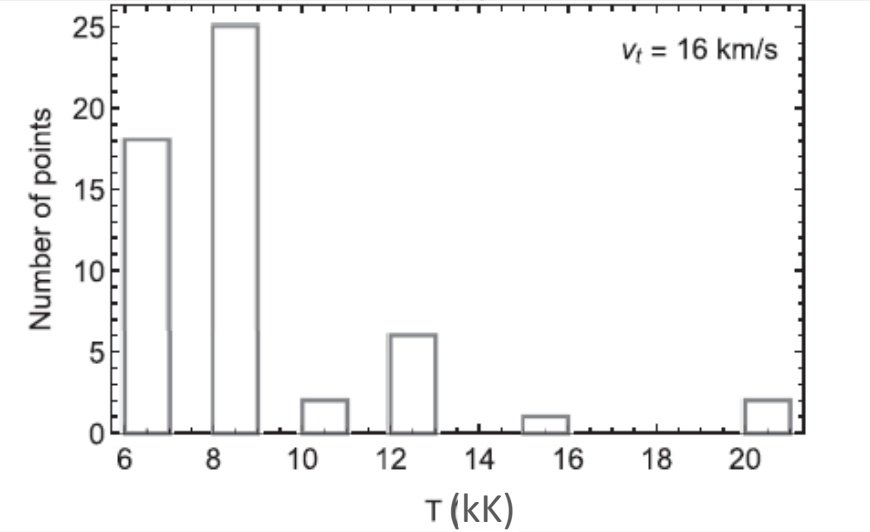
ESPM-16, 6 – 10. 9. 2021

Aim

Continuation of previous work by Ruan et al. 2019, ApJ 886, 134

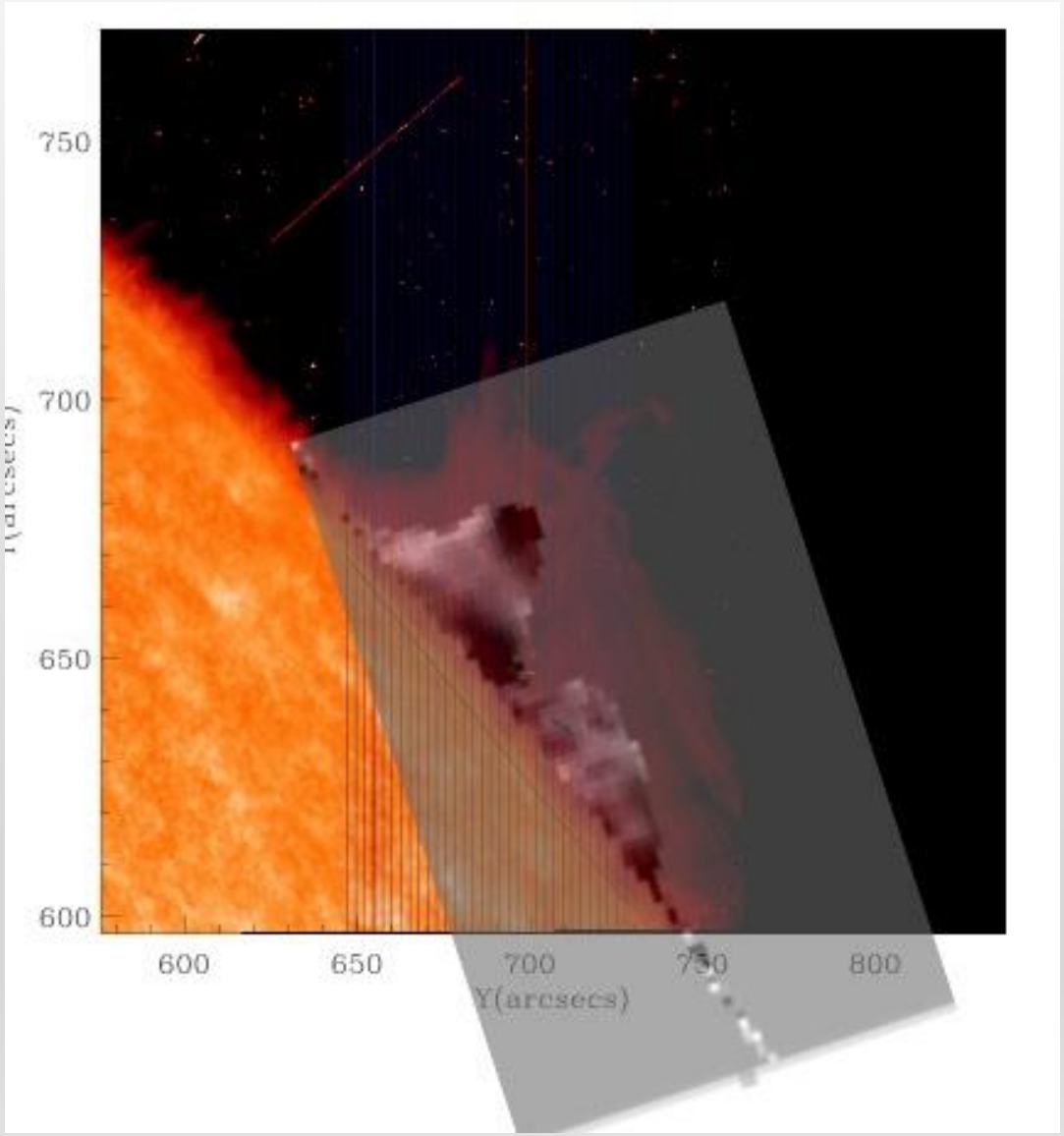
1.5 D inversion by Hα line gives 2 solutions:

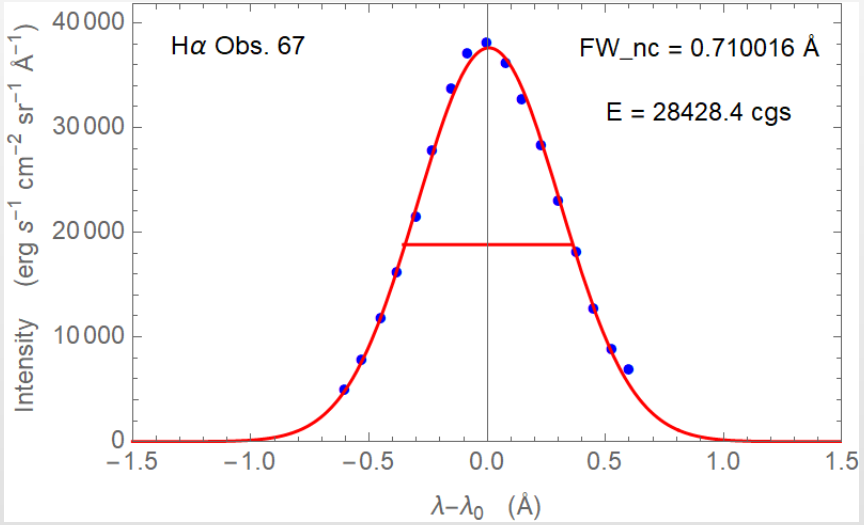




WHICH SOLUTION IS MORE REALISTIC?

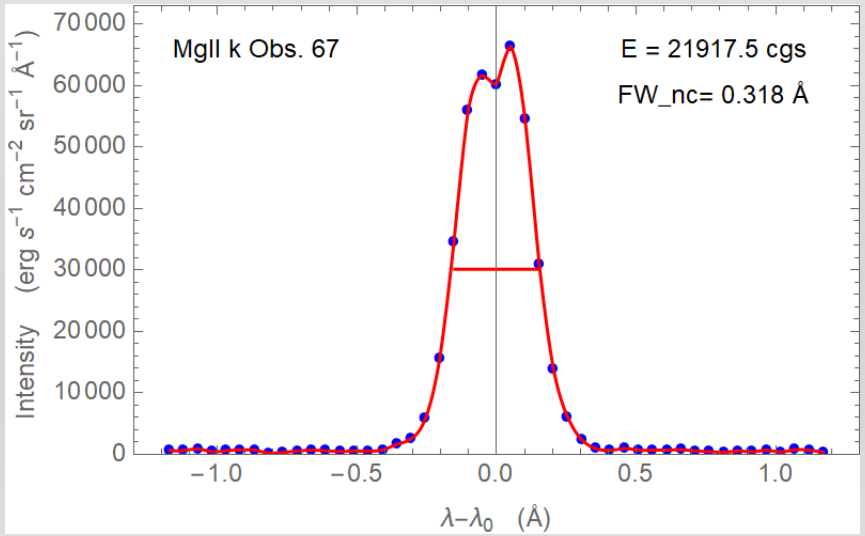
Quiescent Prominence, 30. 3. 2017





MSDP: Hα line

6562.8 Å



IRIS:

Mg II k & h line

2796.4 & 2803.5 Å

1D non-LTE MALI code

63000 isothermal-isobaric models (Heinzel et al. 2014, A&A 564, A132)

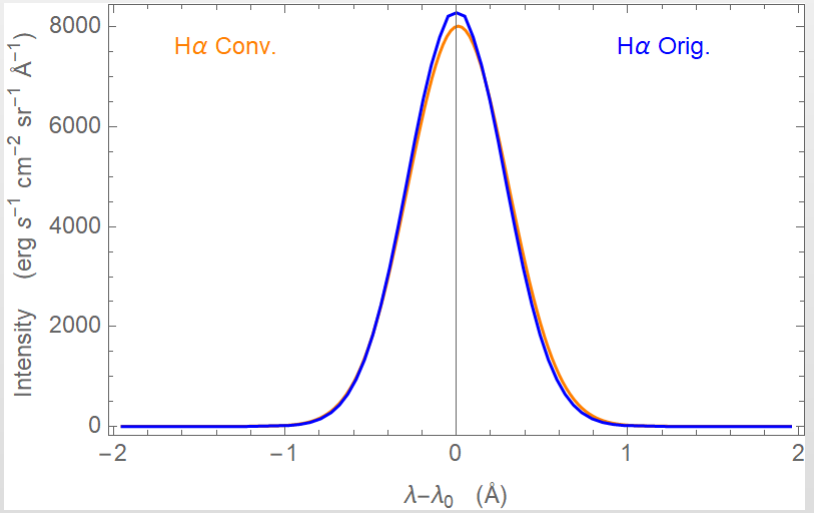
Input:
T: 4 - 21 kK
V_t: 4 - 22 km/s
p: 0.01 - 0.5 dyn/cm^2
D_{eff}: 200 - 5000 km
H= 13000 km

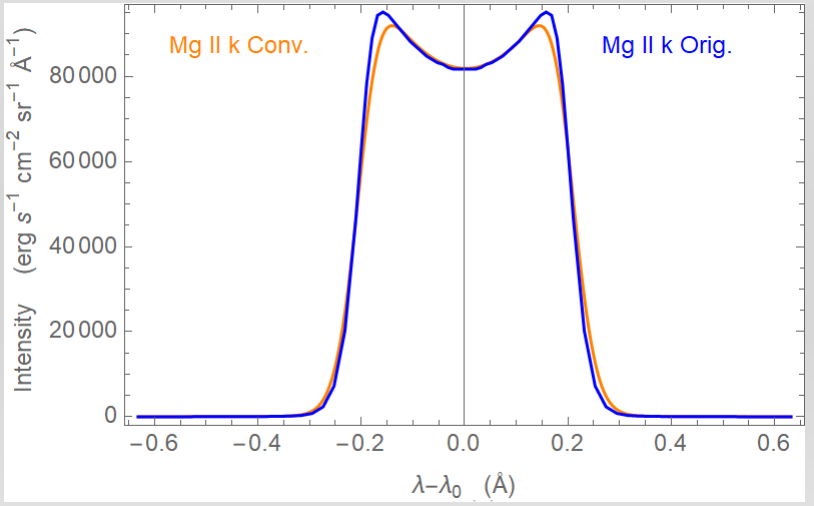
Instrumental Profile

0.18 Å Hα

0.052 Å MgII k&h

Output: profiles of all 3 lines
integrated intensities of all 3 lines
optical thicknesses of all 3 lines





1.5D inversion by Hα and Mg II h & k lines

5 parameter fit between observations and synthetic models:

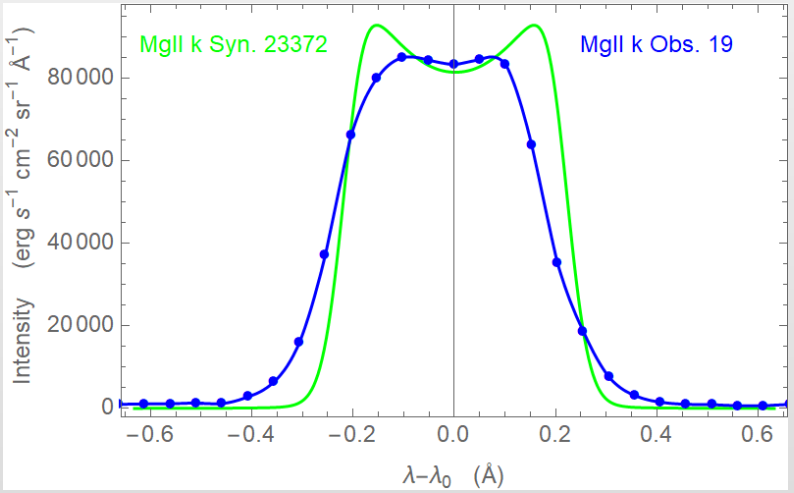
i= $E_{H\alpha}$, E_{Mgk}, $FWHM_{H\alpha}$, $FWHM_{Mgk}$, Ek/Eh

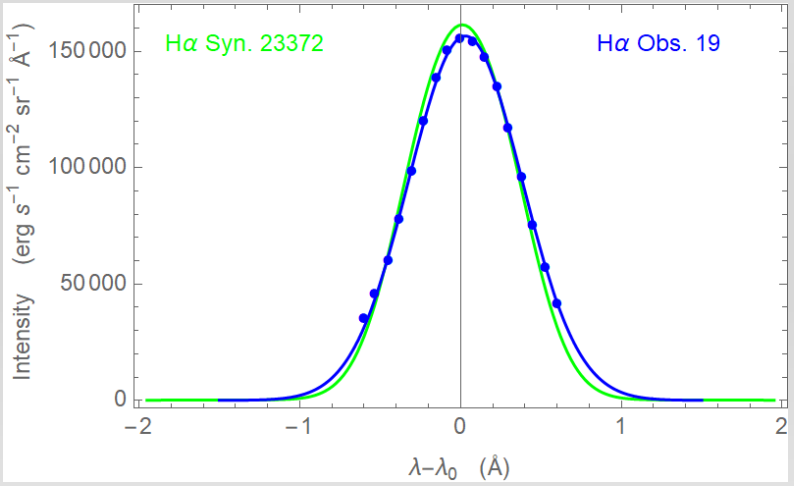
N=5

$$\chi 2 = \frac{1}{N}\sum_i \left(\frac{O_i - S_i}{\sigma_i\, O_i}\right)^2 = \min$$

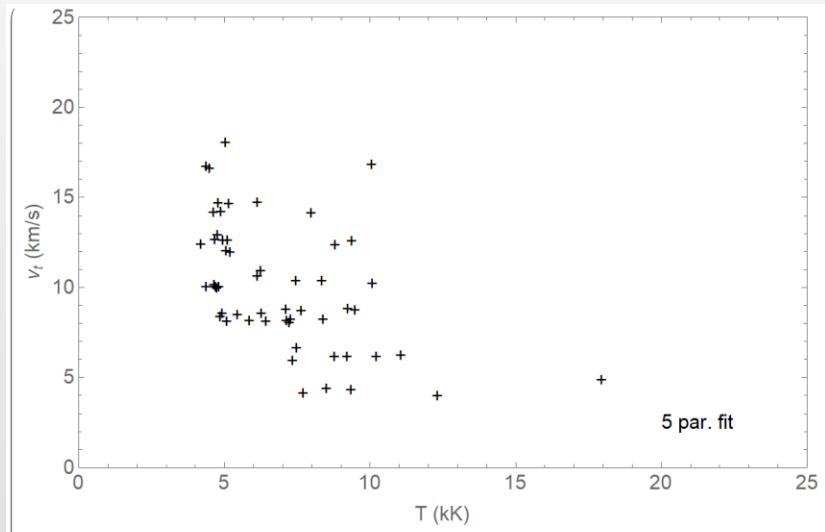
σ_i= 0.2 Mg II lines

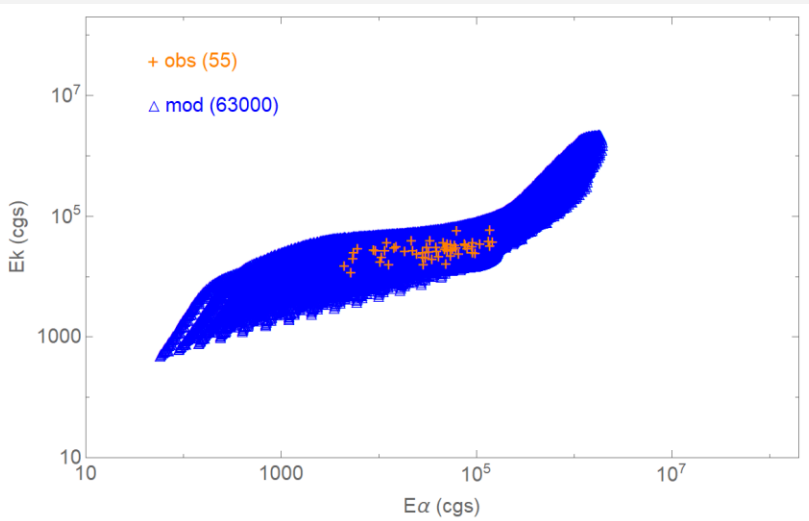
σ_i= 0.3 Hα line

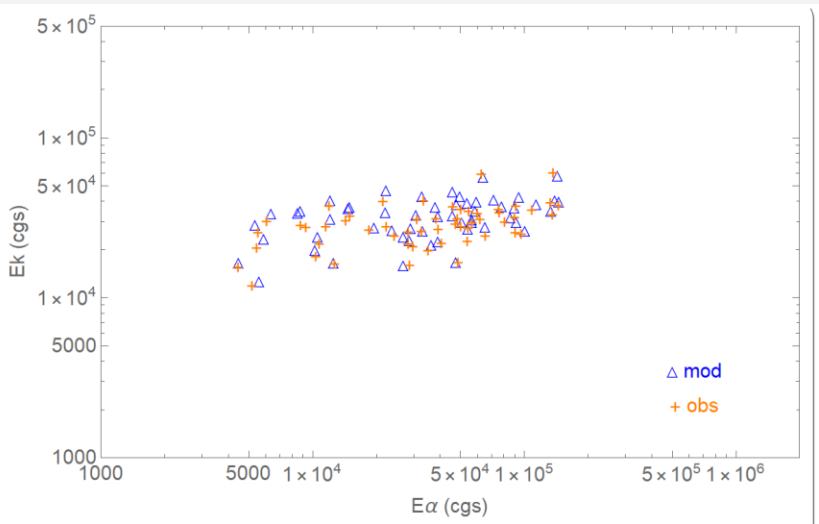


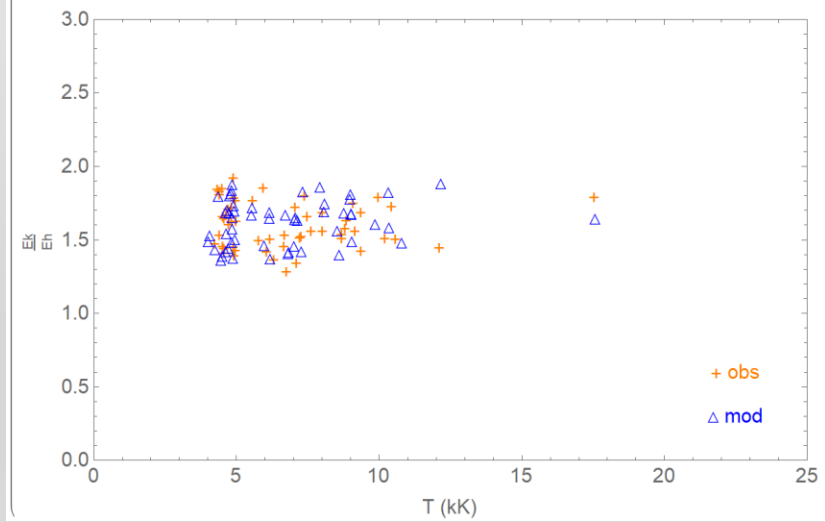


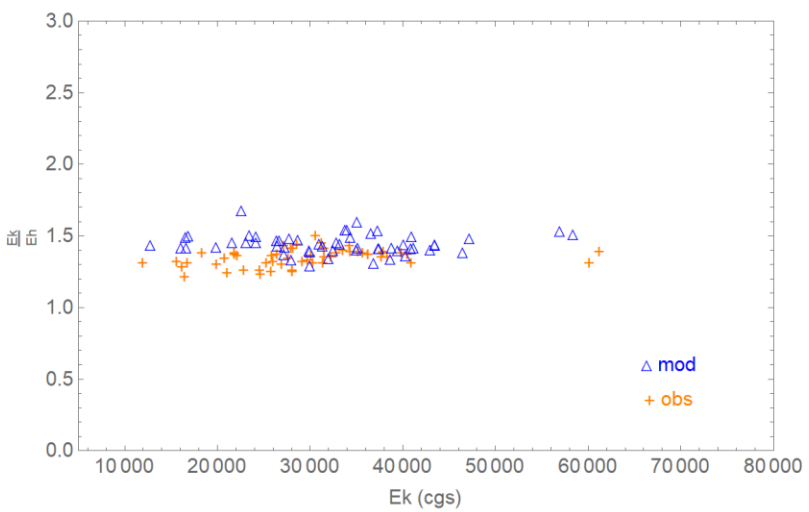
Results

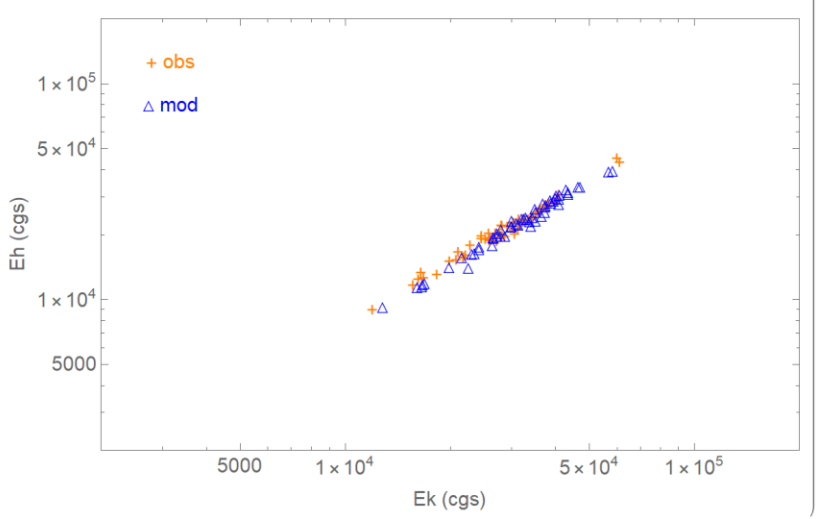

v_t (km/s)
T (kK)
5 par. fit


+ obs (55)
△ mod (63000)
Ek (cgs)
Eα (cgs)

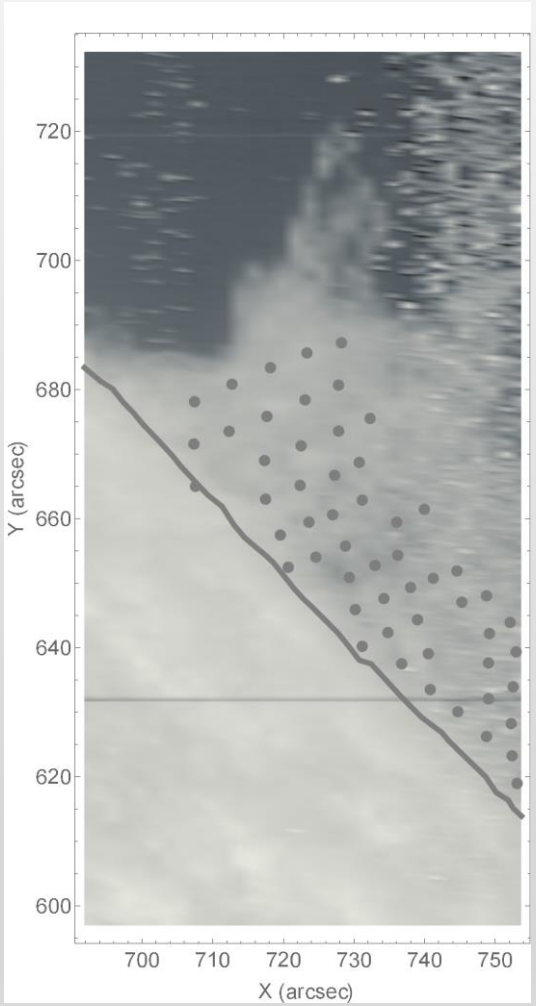

△ mod
+ obs
Ek (cgs)
Eα (cgs)

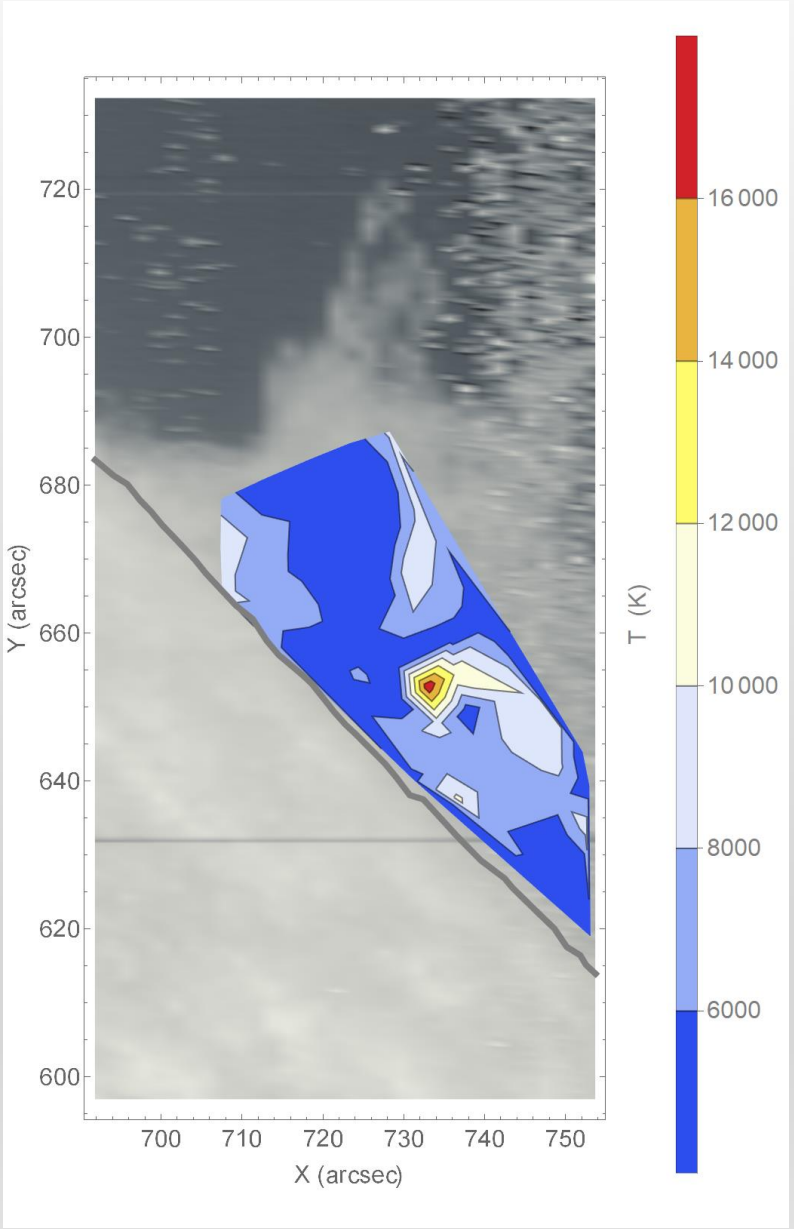

Ek/Eh
+ obs
△ mod
T (kK)

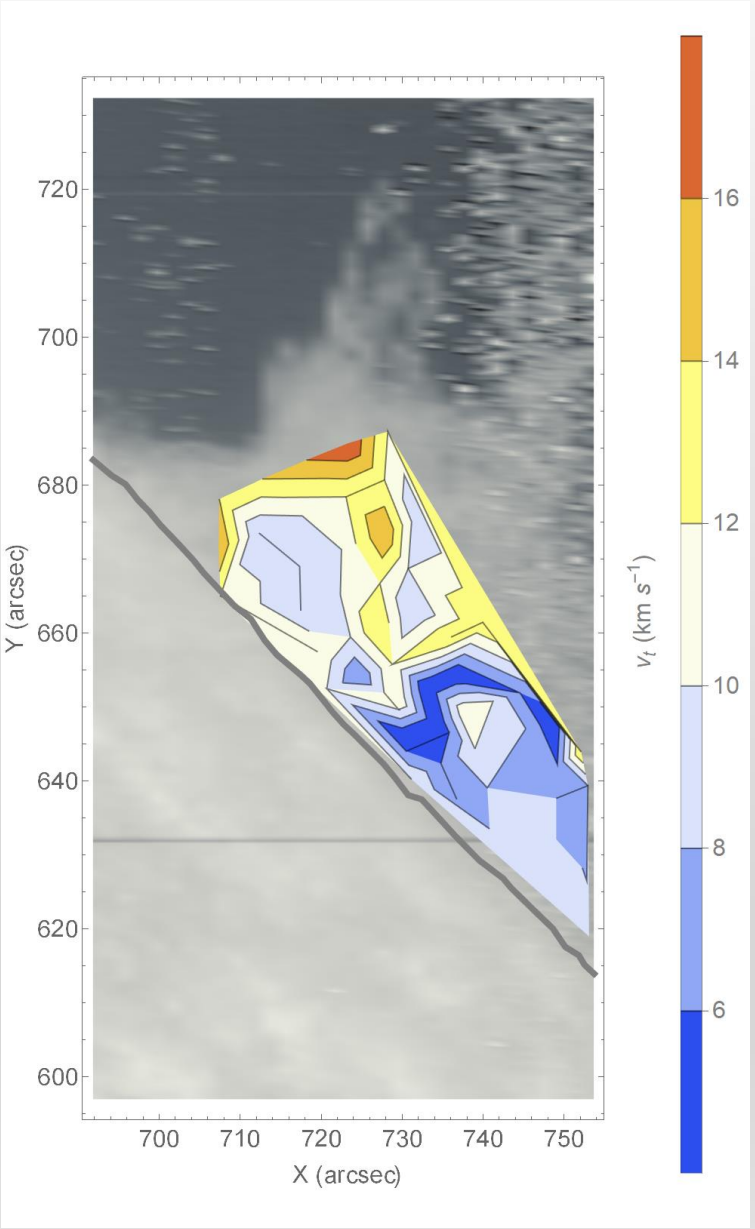

Ek/Eh
△ mod
+ obs
Ek (cgs)


+ obs
△ mod
Eh (cgs)
Ek (cgs)

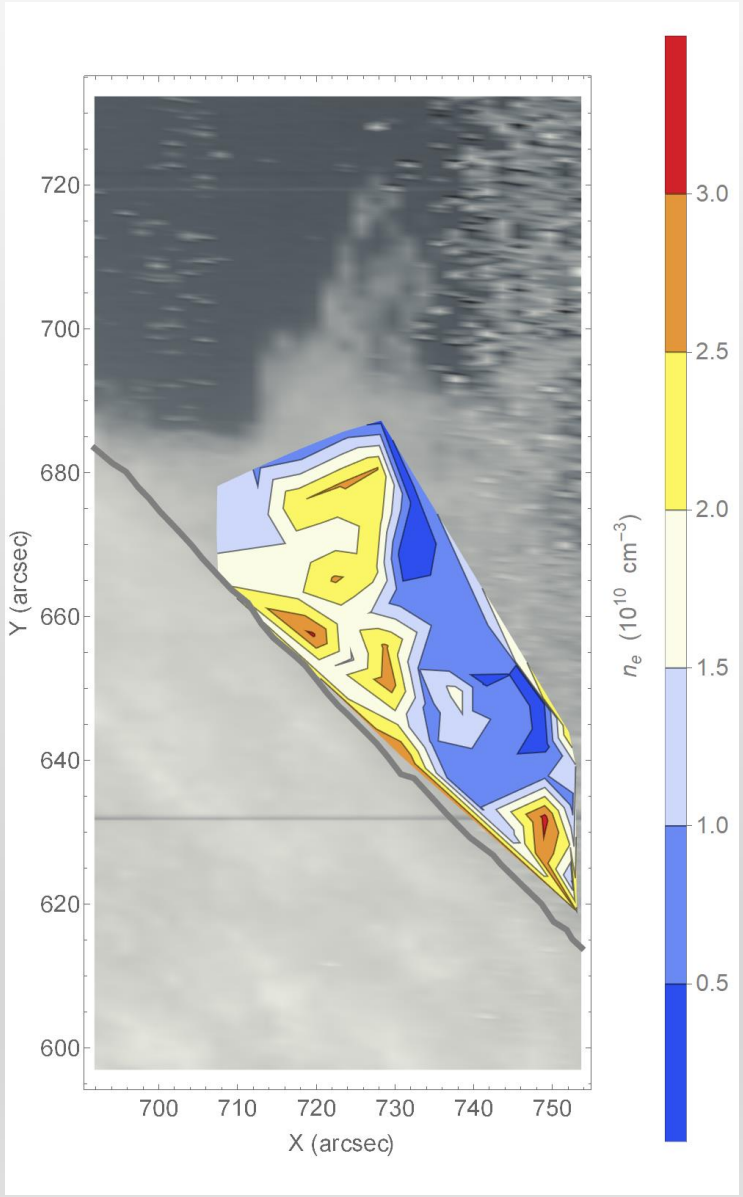
Results

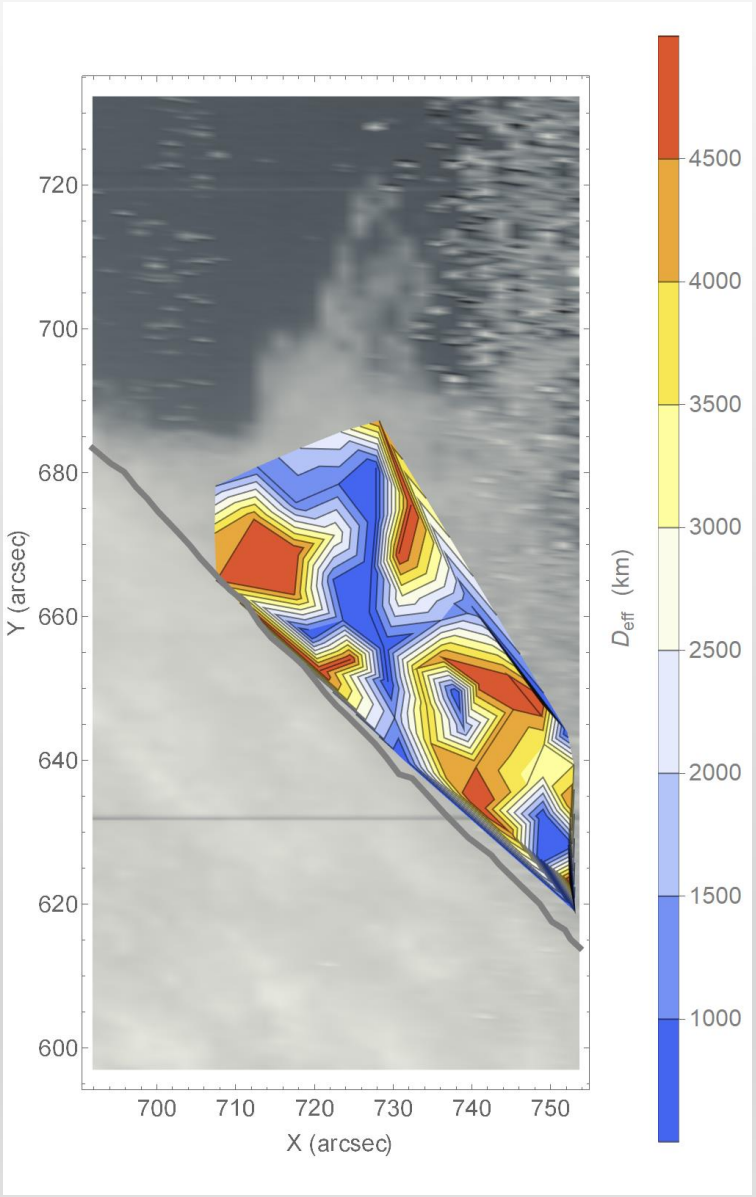

720
700
680
660
640
620
600
Y (arcsec)
700 710 720 730 740 750
X (arcsec)

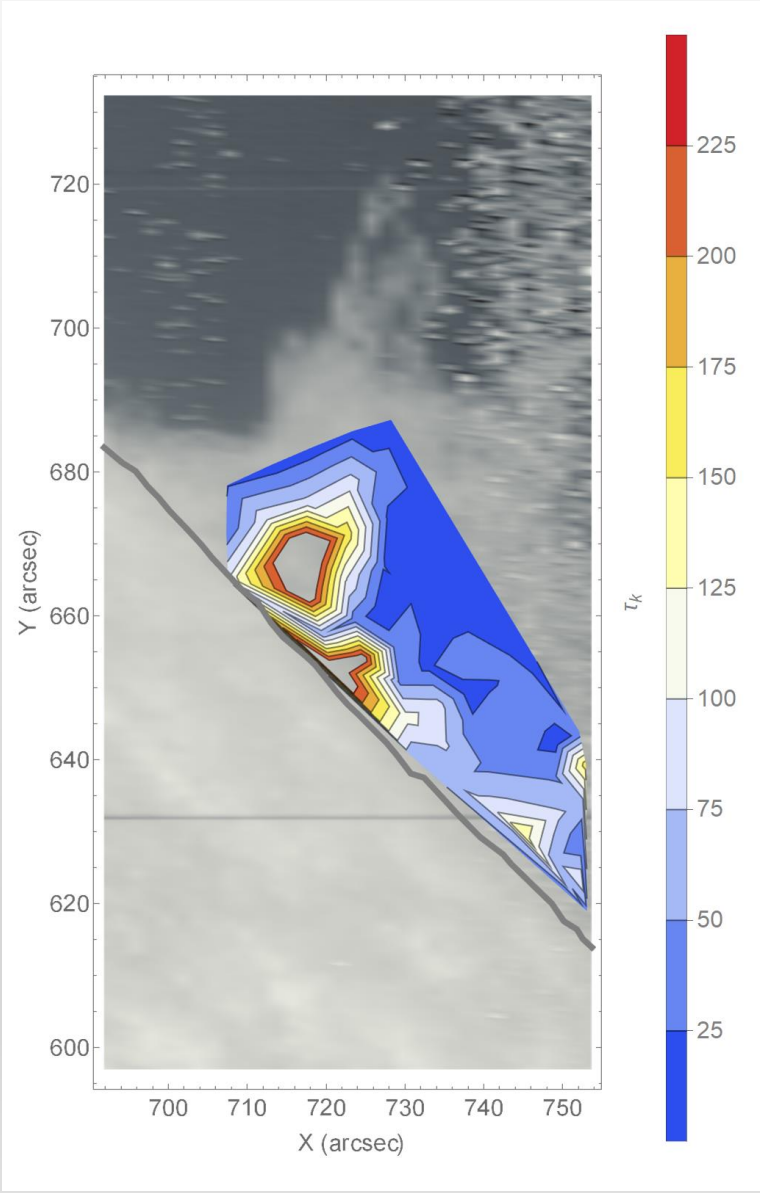

720
700
680
660
640
620
600
Y (arcsec)
700 710 720 730 740 750
X (arcsec)
16 000
14 000
12 000
10 000
8000
6000
T (K)


720
700
680
660
640
620
600
Y (arcsec)
700 710 720 730 740 750
X (arcsec)
16
14
12
10
8
6
v_t (km s^{-1})

Results


Y (arcsec)
720
700
680
660
640
620
600
700 710 720 730 740 750
X (arcsec)
n_e (10^{10} cm^{-3})
3.0
2.5
2.0
1.5
1.0
0.5


Y (arcsec)
720
700
680
660
640
620
600
700 710 720 730 740 750
X (arcsec)
D_{eff} (km)
4500
4000
3500
3000
2500
2000
1500
1000


Y (arcsec)
720
700
680
660
640
620
600
700 710 720 730 740 750
X (arcsec)
τ_k
225
200
175
150
125
100
75
50
25

Conclusions

- Improved 1.5D spectral inversion by simultaneously observed MSDP Hα and IRIS MgII k&h lines.
- Strong non-thermal motions are interpreted as a mixture of microturbulence and the line-of-sight dynamics of prominence fine-structure threads.
- Detailed multithread modeling with the 2D non-LTE code and stochastic distributions of the threads (position, dynamics) needs to be performed in the future.