Plasma temperature distribution & composition for low activity solar corona

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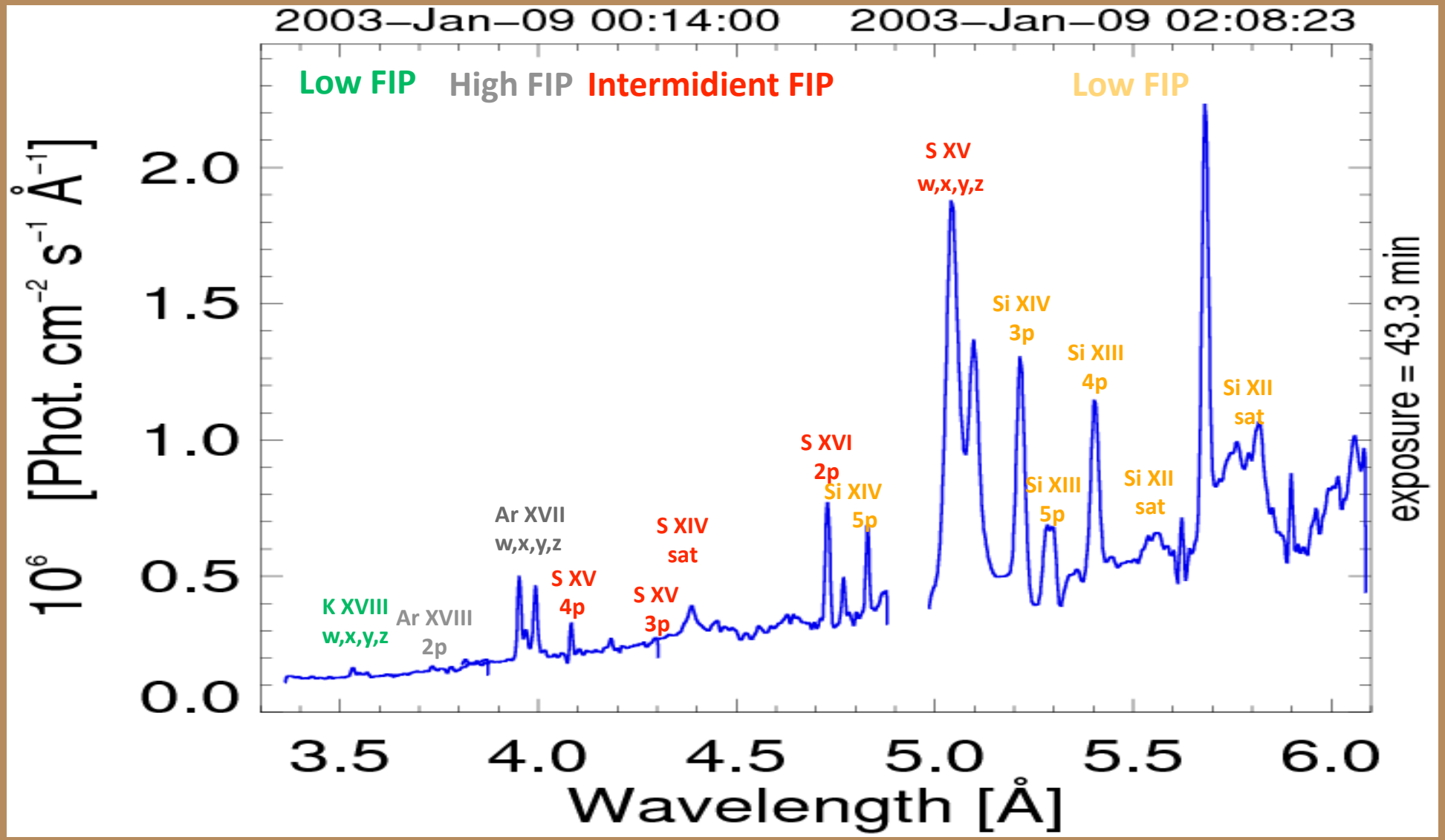
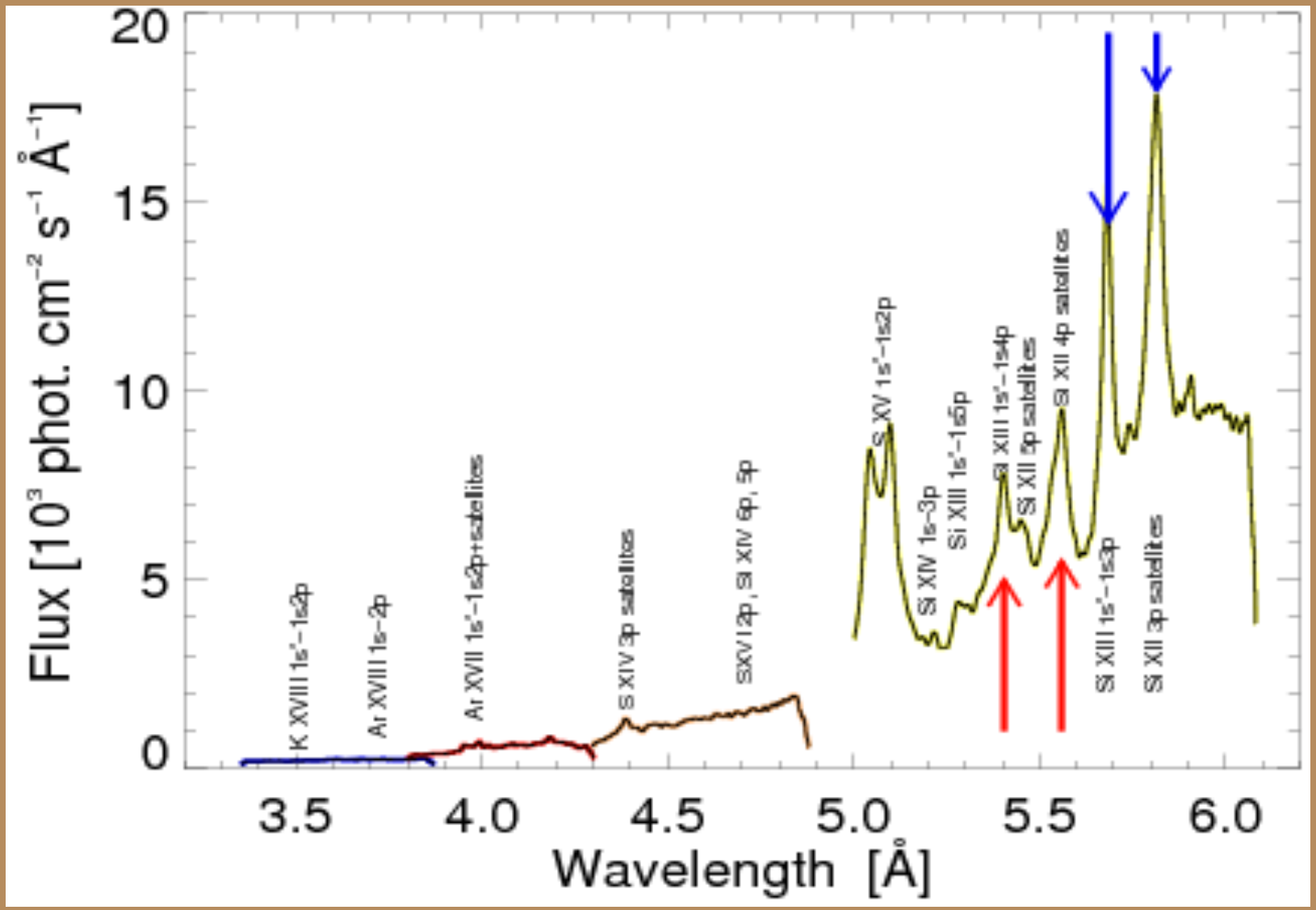
RESIK flare spectrum (9 Jan. 2003)



Average non-flare RESIK spectrum (312) intervals



Differential Emission Measure (DEM)

$$F_i = A_i \int_{T=0}^{\infty} f_i(T)\phi(T)\,\mathrm{d}T$$

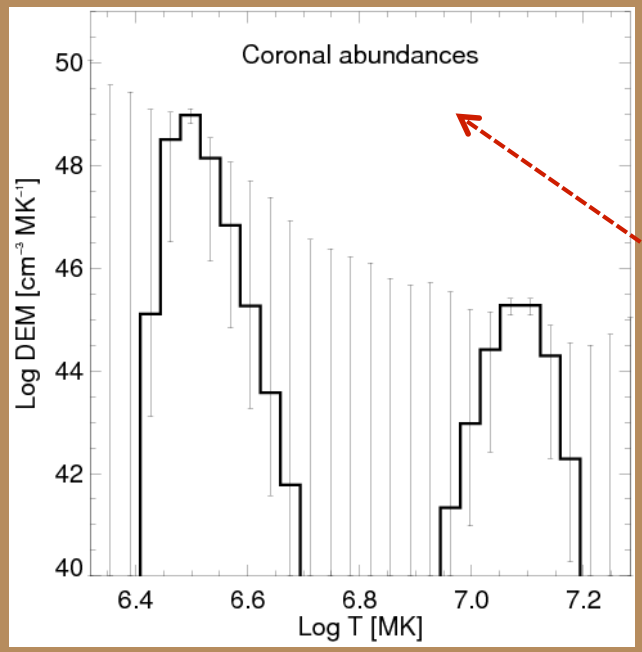
$\Phi(T) \equiv N_e^2 dV/dT \equiv DEM$ (always non-negative)

F_i → fluxes obtained from RESIK spectra in i=1, ….n passbands

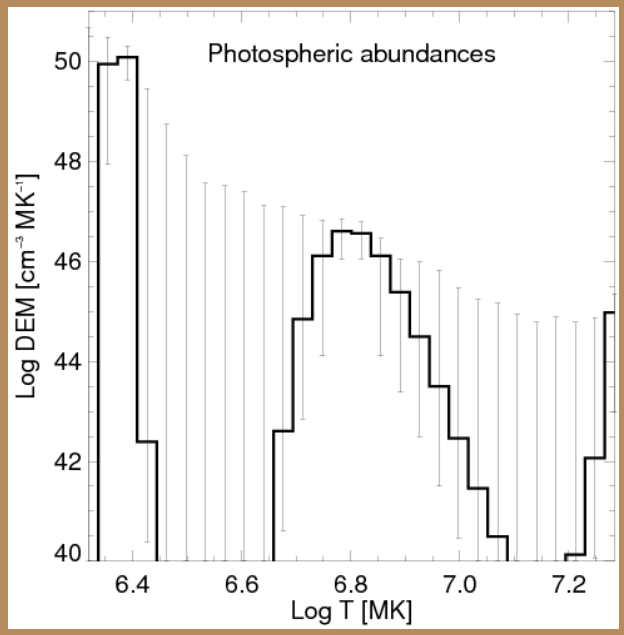
$f_i(T)$ → theoretical emission functions for each spectral band, calculated from CHIANTI 5.2

A_i → elemental abundance also taken as a variable parameter

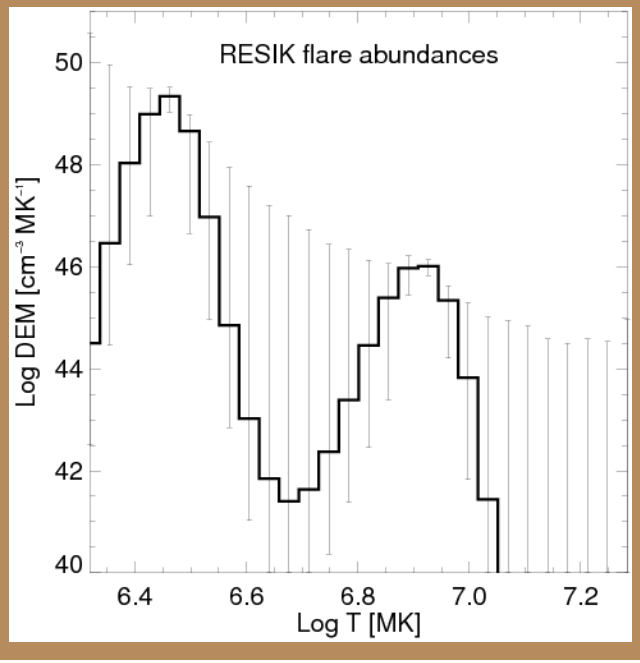
DEM: 312 spectra: 2-20 MK, changing abu., 15 bands

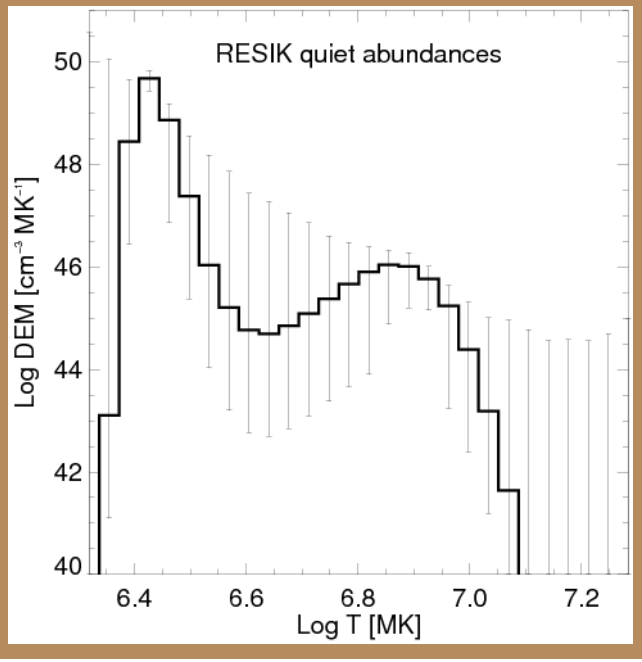


Initially, we thought that assuming coronal composition as characteristic for the coronal „quiet" emission is natural.

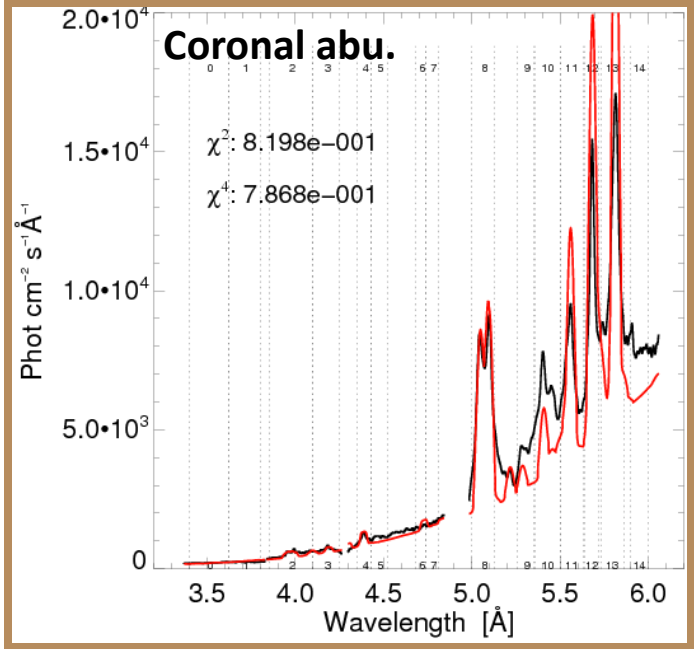


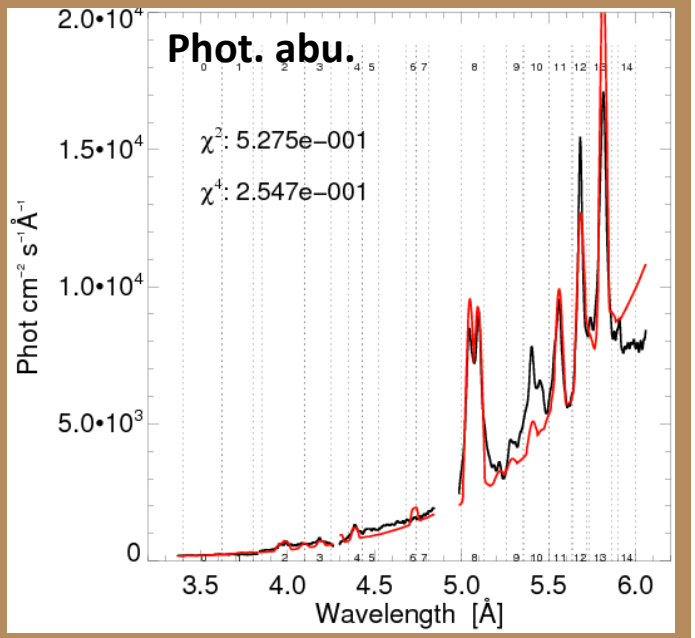
We checked however that the results of DEM is VERY sensitive to the assumed abundance pattern. Therefore, we decided to use the other sets of composition in the calculations of DEM and optimize abundance in order to get the best spectral fit.





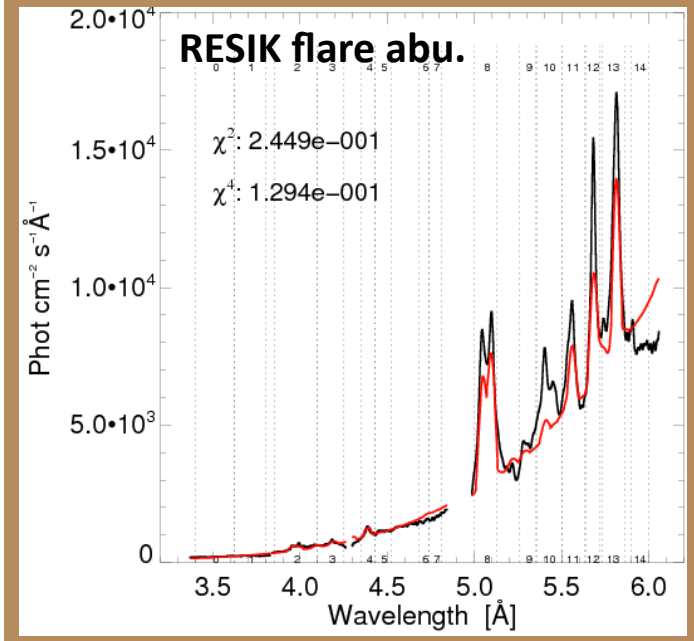
312 spectra: changing abu., 15 bands, 2-20 MK

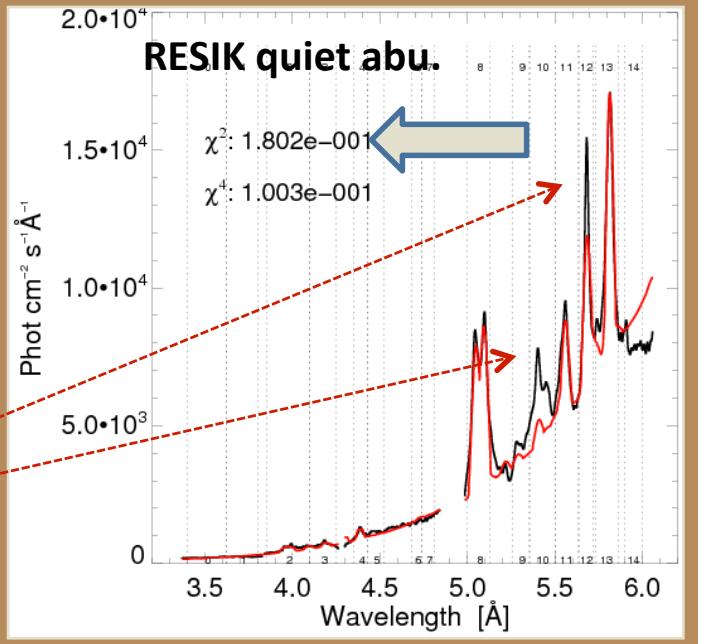




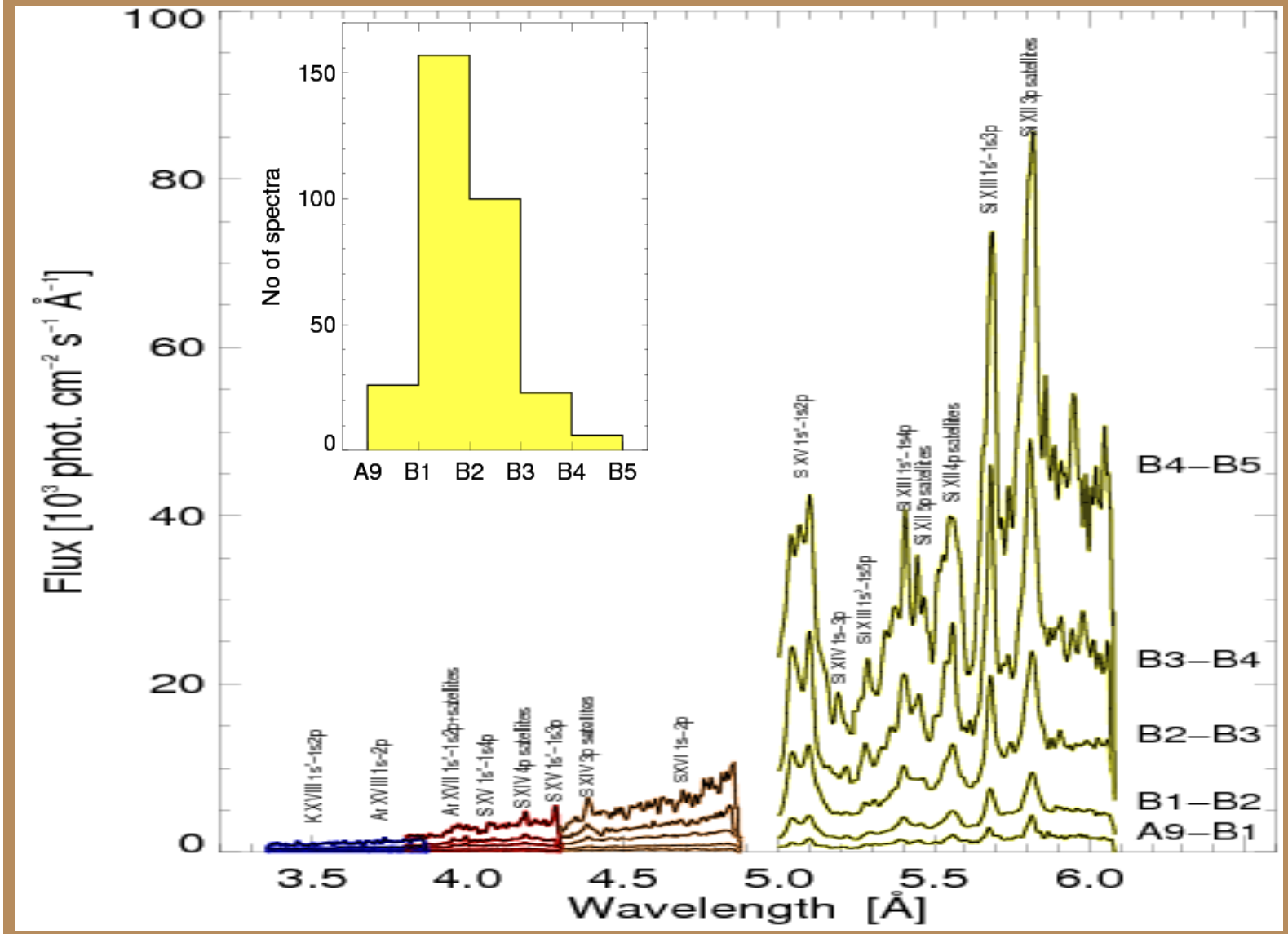
The results of optimum spectral fits between observed (RESIK) and synthetic (CHIANTI 5.2) spectra. It is seen that by adjusting the abundances, it is possible to reproduce the observations relatively well.

We note that intensities of dielectronic satellites and continuum are reproduced well, but the resonance transitions of the type 1s-np (n>2) are observed stronger than in theory.



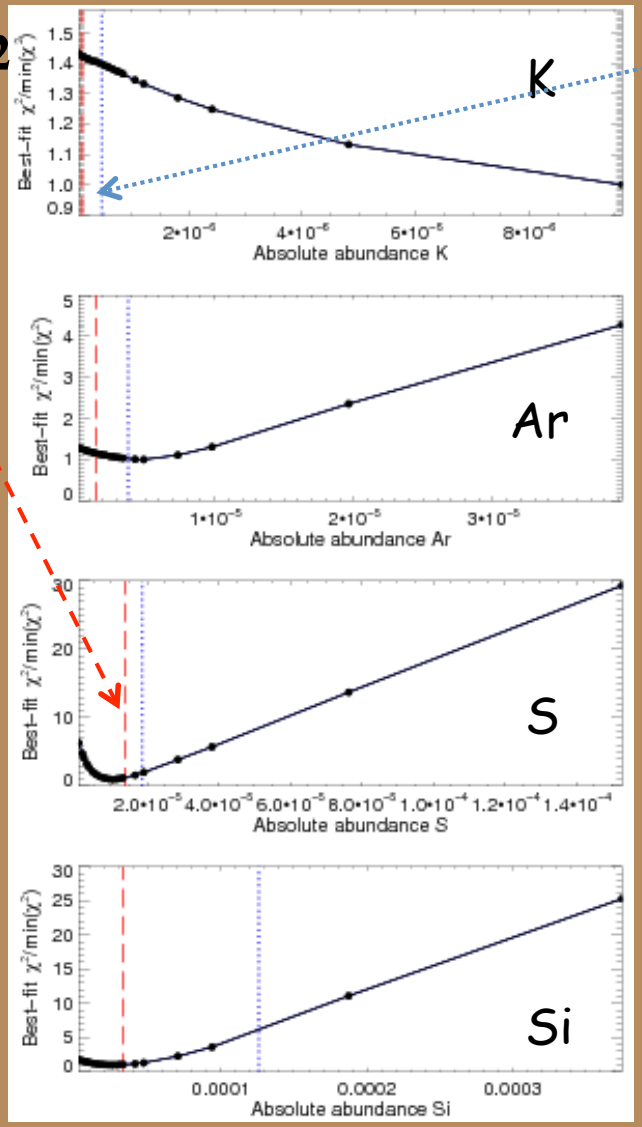


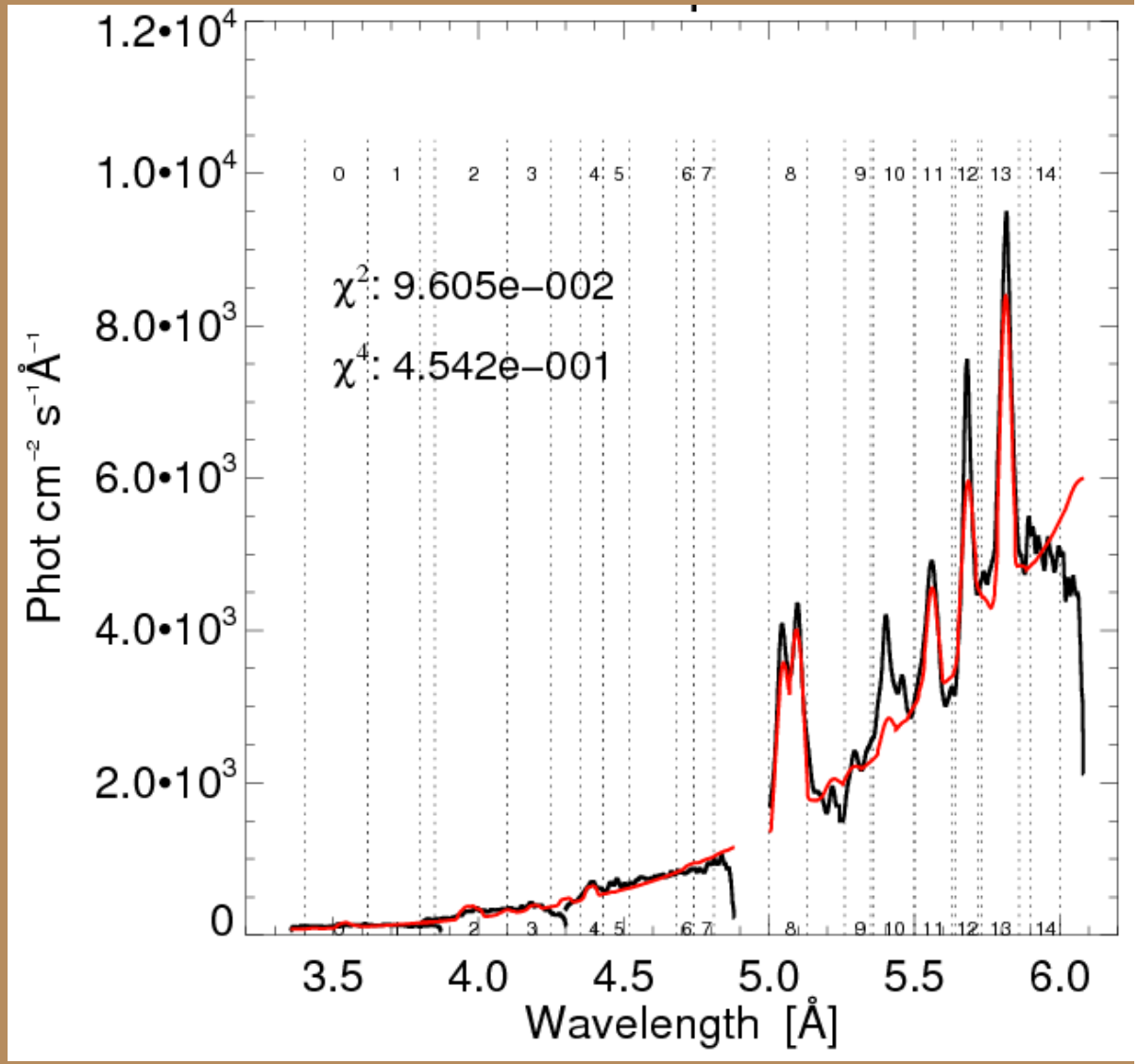
312 quiet intervals: division for 5 classes



We developed fitting algorithm, which allows to optimize χ^2 characteristic of the fit between the input and calculated fluxes in **15 spectral** bands.

It is seen that χ^2 values have minima for particular values of abundances, close, but different from coronal or photospheric





The optimization resulted in determining the abundance patterns → chracteristic of particular class of activity

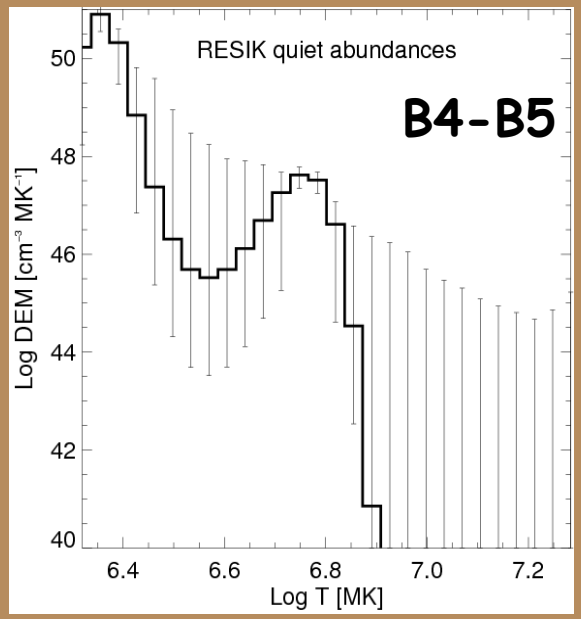
Abundances [10^{-6}]

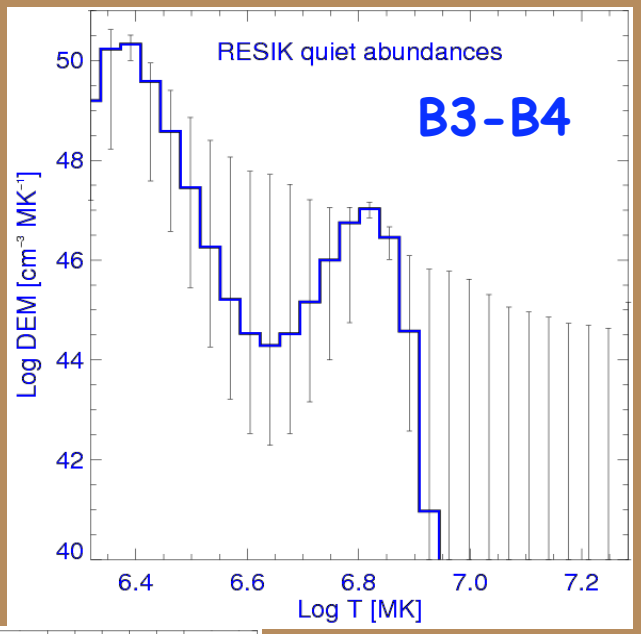
Above coronal — Below phot.

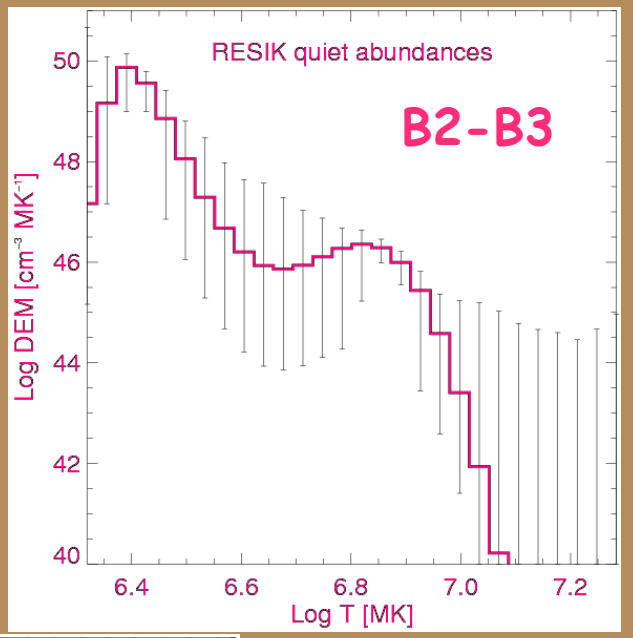
KLASA	Ar [15.76 eV]	S [10.36 eV]	Si [8.15 eV]
B4 - B5	4.27	17.8	27.7
B3 - B4	4.45	17.6	25.4
B2 - B3	4.35	14.3	26.5
B1 - B2	4.59	10.6	25.5
A9 - B1	4.65	5.62	27.4
Photospheric	1.51	14.45	32.4
Coronal	3.8	18.62	125.9
Flare-RESIK	2.6	8.9	33.7

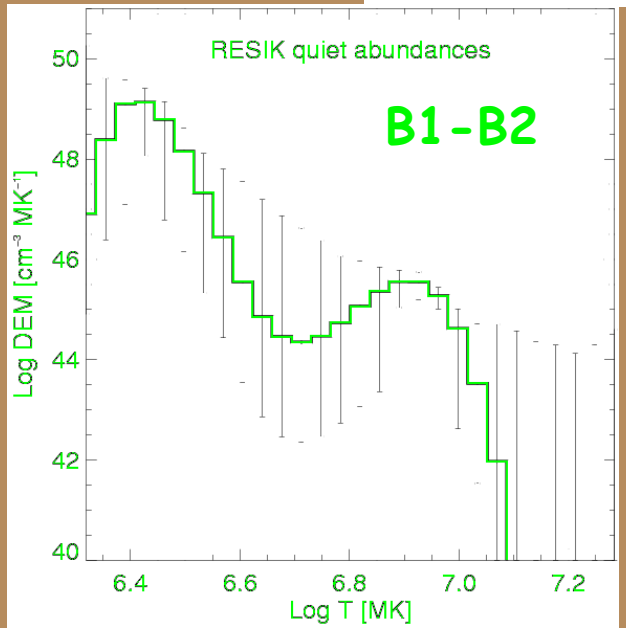
Systematically changing

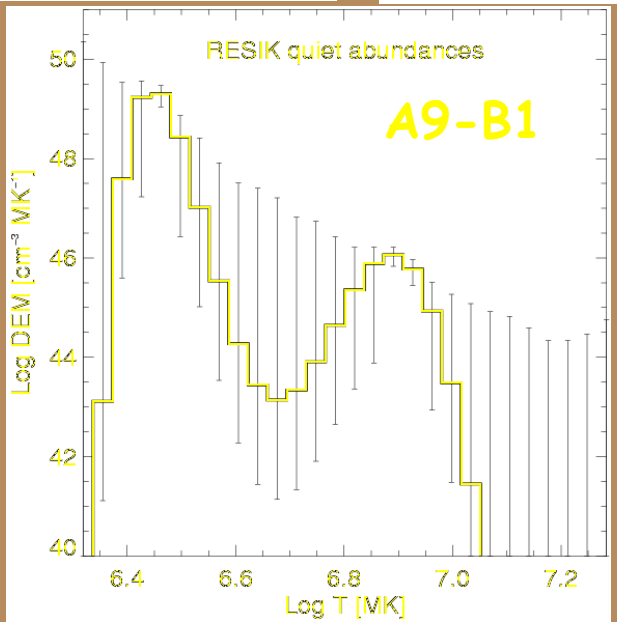
DEM for different activity levels



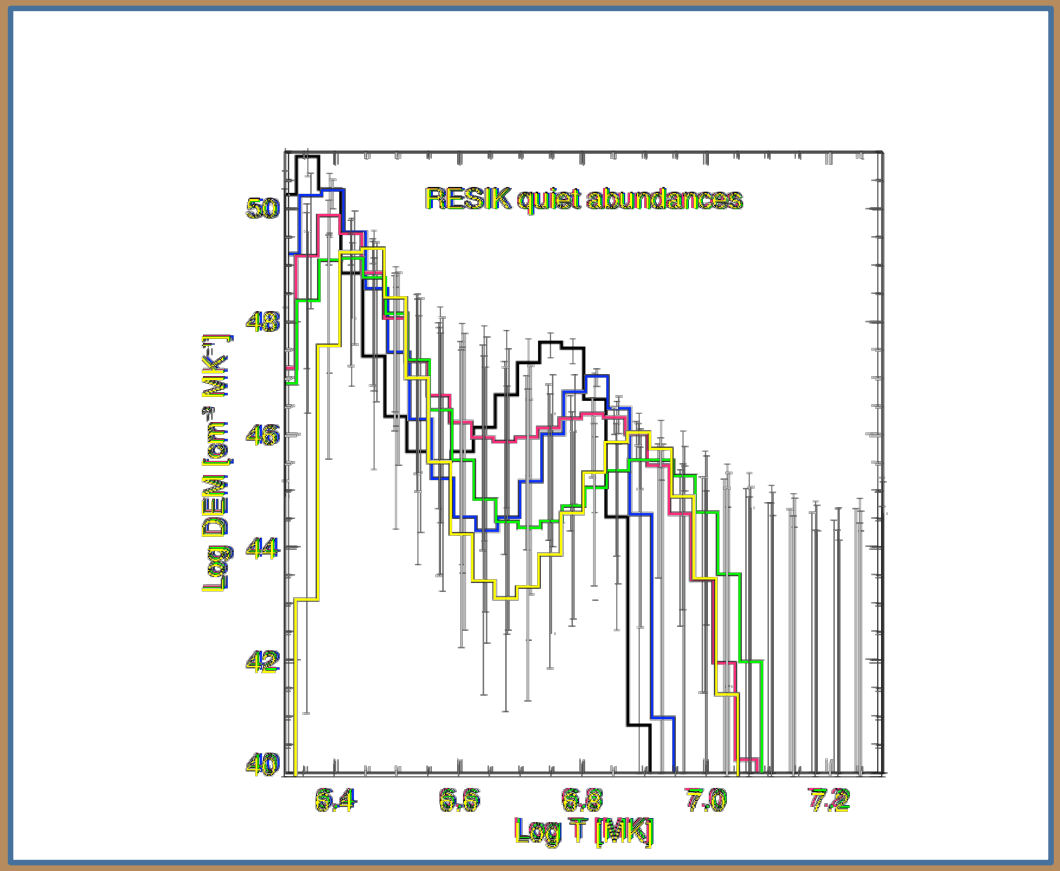








Two plasma components are always present



The low temperature component (2.2-2.8 MK) represents possibly a classical corona, the higher T component (5.6-8 MK) is due to active region (6 MK) and the energy release region (10 MK) components. Note that with decrease of the activity level, the temperaure of the hotter component rises, being always within the tail „envelope".

Thermodynamic plasma characterisctics as derived from DEM for a cooler and hotter components

EMl/EMh	Class	Tl [MK]	EMl [10^{48}]	THMl [10^{15}]	Th [MK]	EMh [10^{46}]	THMh [10^{14}]	THMl/THMh
1190	B4-B5	2.3	222.0	14.1	6.1	18.6	11.1	12.7
	B3-B4	2.4	86.3	9.25	6.5	10.3	8.72	
	B2-B3	2.5	27.7	5.54	6.9	4.15	5.85	
	B1-B2	2.6	7.89	3.08	8.0	0.89	3.15	
750	A9-B1	2.9	1.74	1.58	9.1	0.23	1.82	8.7

It is seen that the emission measure, EM, of the hotter component is ~ **0.001** of the cooler one, while the characteristic of total energy content (thermodynamic measure THM) of the hotter component is only ~ **0.1** of the cooler one.

We are in a process of trying to understand this derived behaviour.

Concluding remarks

- It is necessary to allow for the changing elements abundances in the process of DEM calculations → the better agreement of the observed and synthetic spectra can be achieved.
- Independent on the level of solar activity the DEM distributions for non-flaring conditions are always two-component.
- What does the two-component DEM distributions mean ? Is this related with the existence of two different scales (short and long loops) ? Do the favoured scales exist on the Sun and the distribution of scales is discontinuous (similarly to the granular and supergranulation pattern observed over the solar disk).
- The obtained changes of absolute abundance for **S** with the level of solar activity need further analysis and explanation.