EUV signatures of small scale heating in loops

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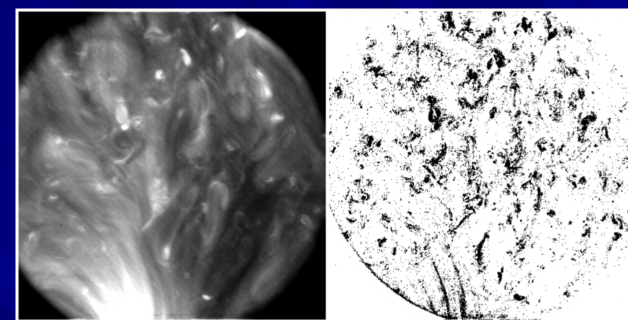
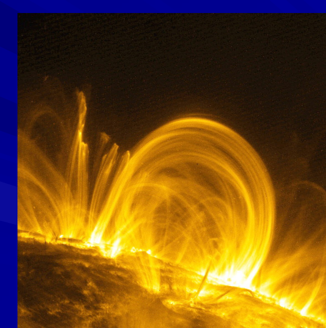
Nanoflares & Nanoflares

- ✓ Hard X-ray and EUV nanoflares
  - – Observed small scale brightenings

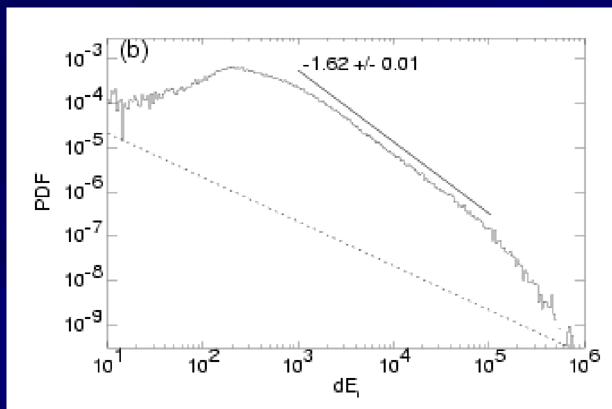


Parnell et al. 2000

- ✓ Nanoflares in loops
  - – Not resolved. The QS EUV brightenings may be due to a bunch of nanoflares
  - – Loop made of collection of strands: multi-thermal structure

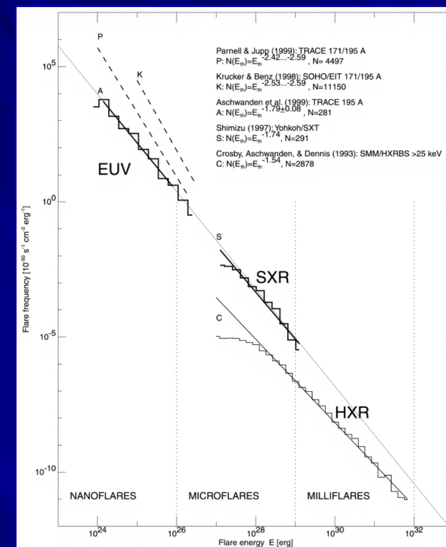


The frequency distribution of energy



Buchlin et al. 2003

Forward-modeling



Hypothesis : the frequency distribution of the energy derived from the observed (flare) emission is the same as the frequency distribution of heating events!

Plasma response

Small scale heating signature

The objective :

To verify if and under which conditions the statistical properties of the heating are preserved in the radiative (EUV) and thermal energies

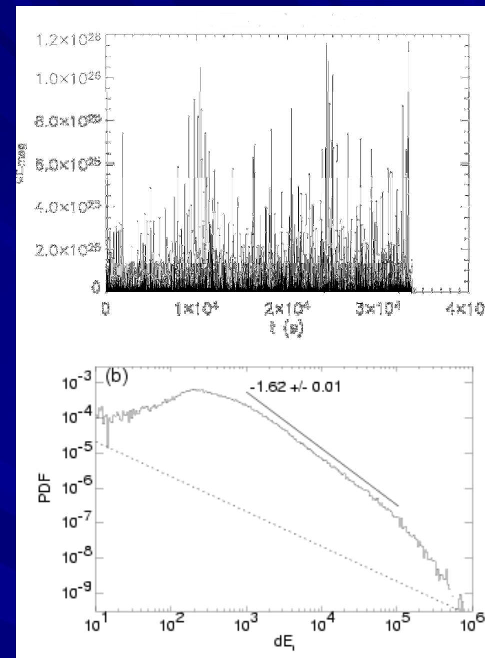
Application: multi-stranded coronal loop

The models

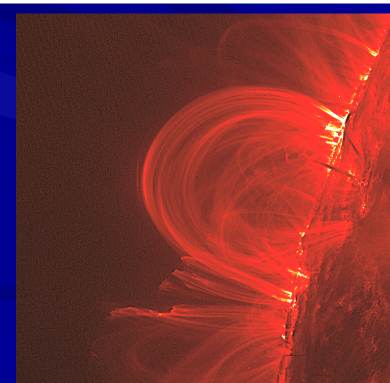
✓ Heating model: nanoflares are the result of energy dissipation originating from turbulent fluctuations in the photosphere (Einaudi et al. ’96, Buchlin et al, 2003). The number of events is distributed in energy as a power law of $\alpha = -1.6$.

✓ The cooling model (Cargill ‘94):

- ✓ Conduction phase, $\tau_R > \tau_C$: p = const; strand subject to subsonic plasma evaporation
- ✓ Radiative phase, $\tau_R < \tau_C$: $T_e \propto N_e^2$ (Serio et al. ’91, Jakimiec et al. ‘92)
  the strand is subject to draining (Antiochos ‘80)



Buchlin et al. 2003



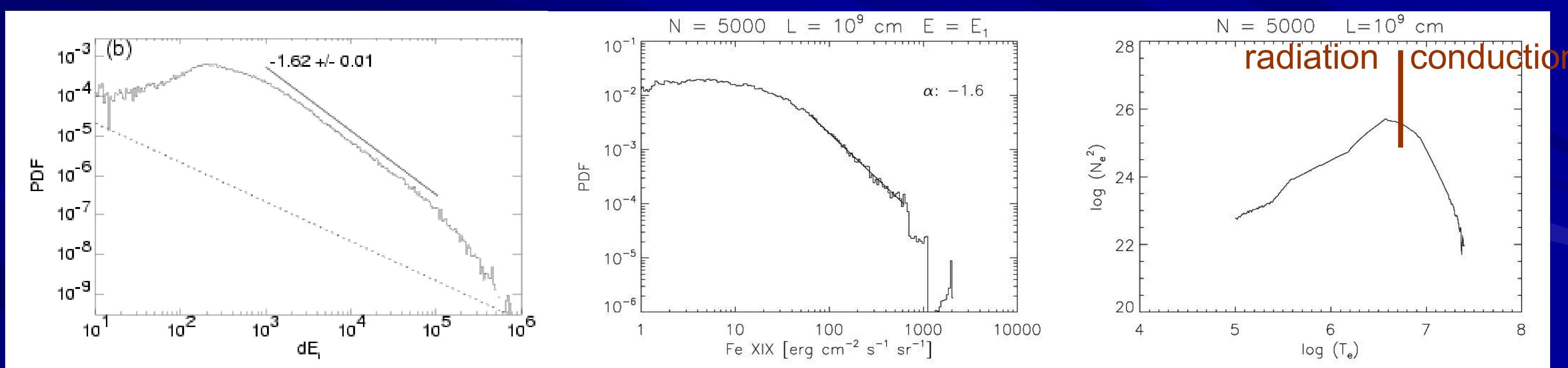
Results: the history of Ne and Te in each strand are used for the statistical analysis of the whole loop system

Results: (Parenti et al. 2006, ApJ, 651, 1219)

✓ Thermal energy: the statistical properties of the heating function can be better recovered if the loop filling factor is small and the dominant cooling process is thermal conduction.

✓ Synthetic spectra in EUV : similar results but

- ✓ different behaviour of lines formed at different T
- ✓ best candidates are the lines which form at T > 3 MK



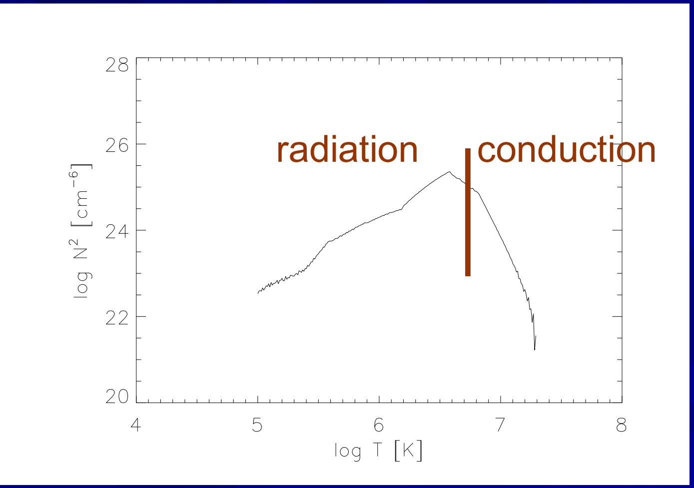
New results:

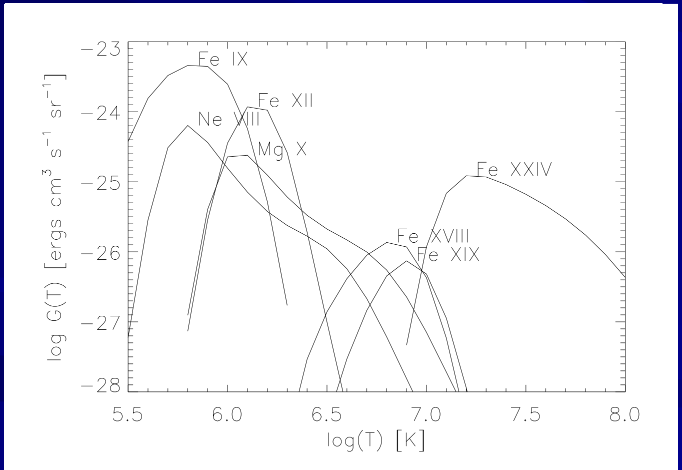
- ✓ Statistical distribution of EUV lines belonging to the Li isoelectronic sequence. Is there any difference with previous results?
- ✓ Comparison of PDF of EUV emissions from wide and narrow band instruments.

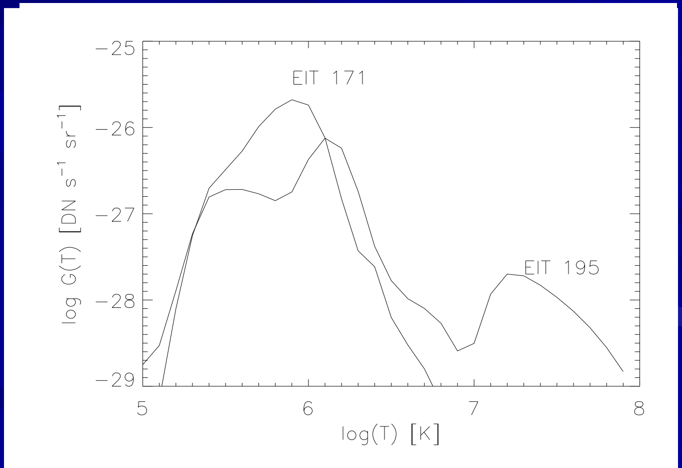
Parenti & Young 2008

Set up the simulation

- ✓ Multi-strand loop (2000)
- ✓ Nanoflare heating function with a power law distribution of index α = -1.7
- ✓ EIS, SUMER & EIT



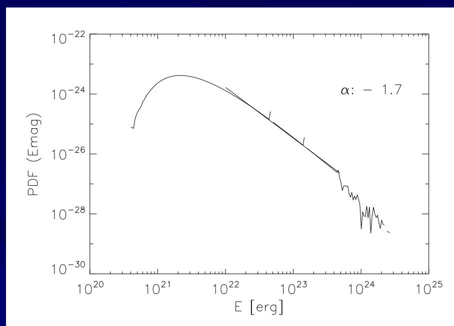




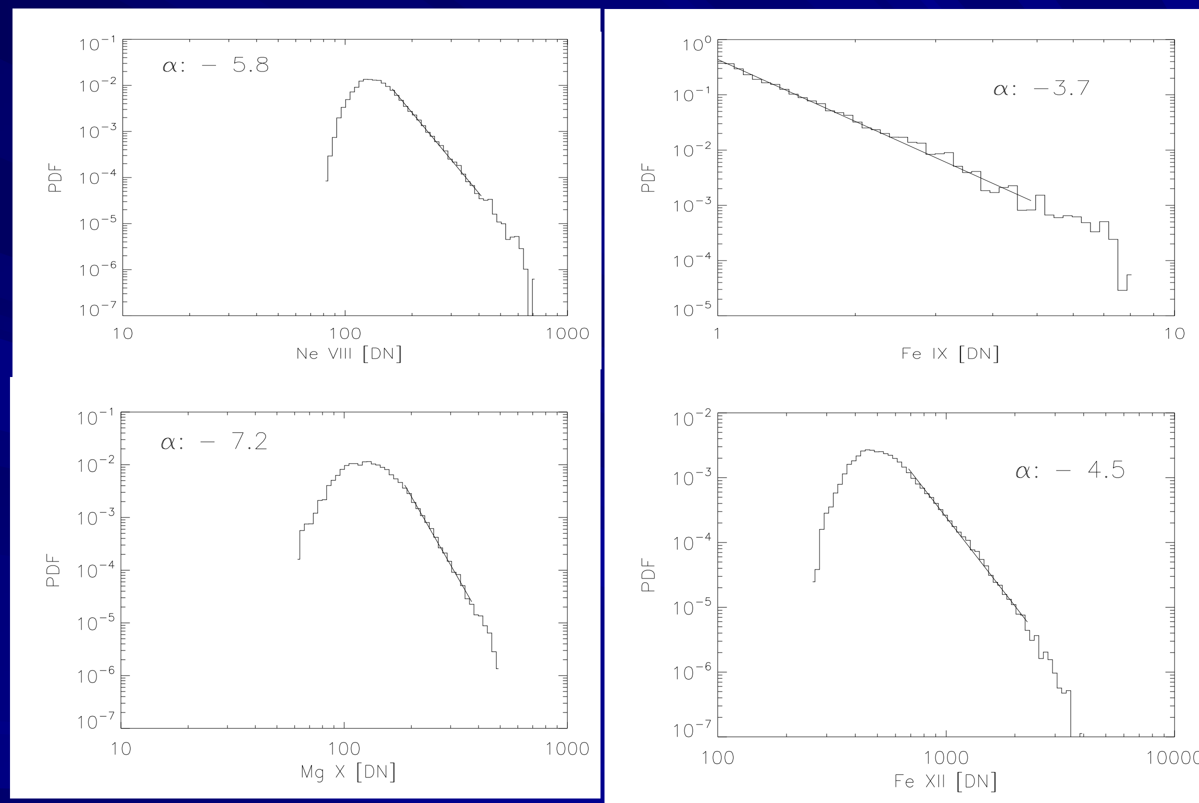
Parenti & Young 2008

Narrow band instruments

Input: heating energy



Li-like



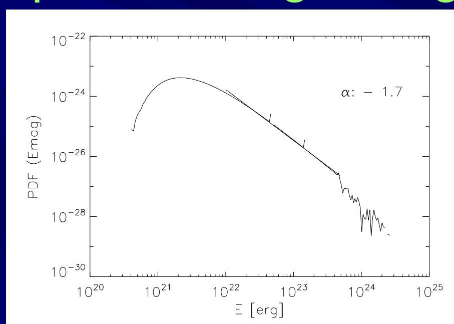
logT = 5.8

logT = 6.1

Parenti & Young 2008

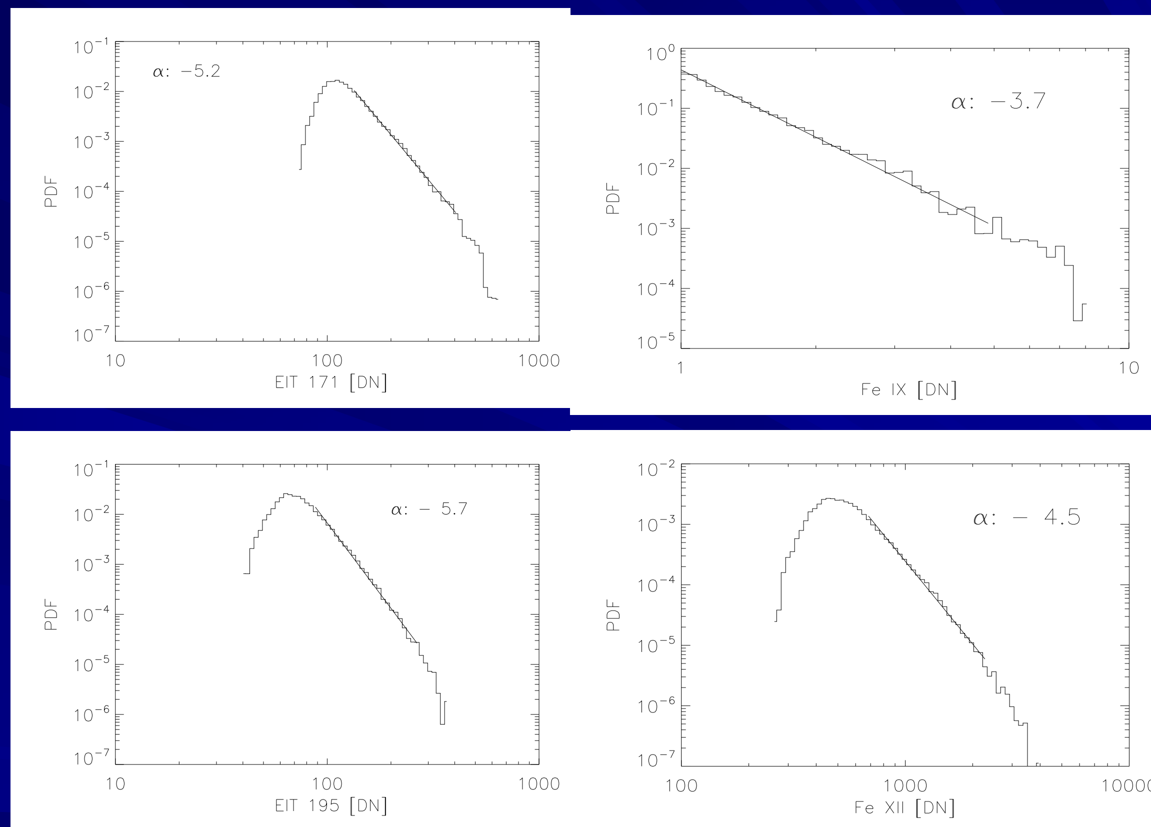
Wide-narrow band instruments

Input: heating energy



EIT

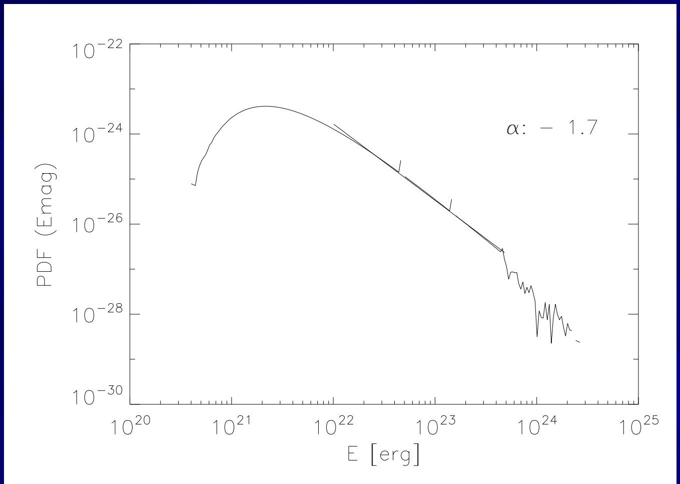
SUMER & EIS

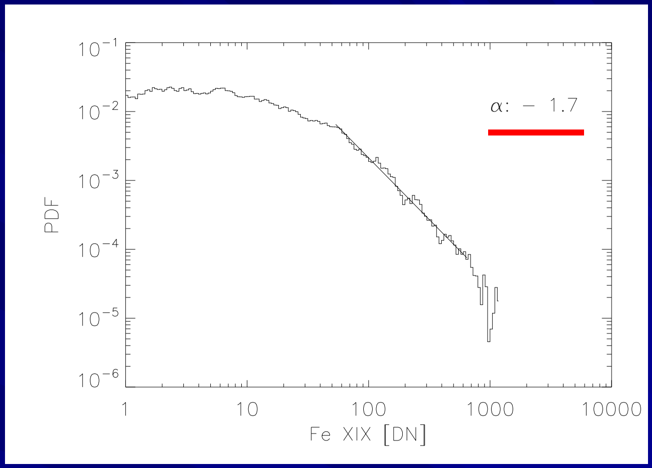


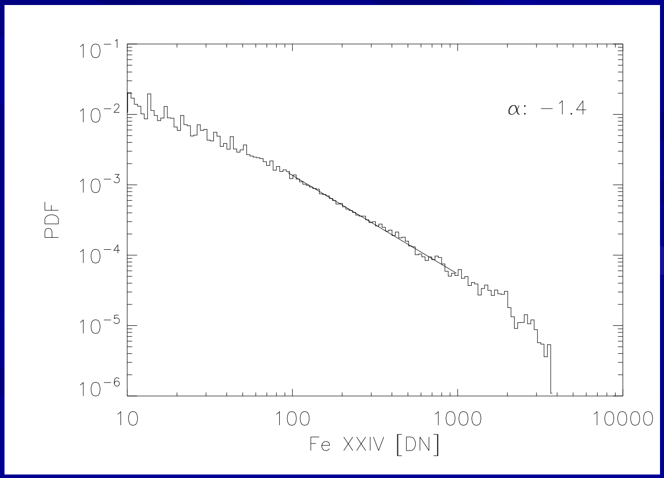
Parenti & Young 2008

The hot lines

Input: heating energy







Conclusion

- ✓ The shape of the PDF of EUV lines depends on the iso-electronic sequence of the ion.
  - ✓ Li-like lines do not look suitable for this diagnostic
- ✓ Wide-band instruments affect the PDF shape of the EUV lines
- ✓ Confirmed that the high T lines better preserve the properties of the heating function (also Li-like)
- ✓ Work useful for SDO, Solar Orbiter data. The high T channels may bring insight on the coronal heating statistical properties.