Can the DEM constrain the timescale of energy deposition in the corona?

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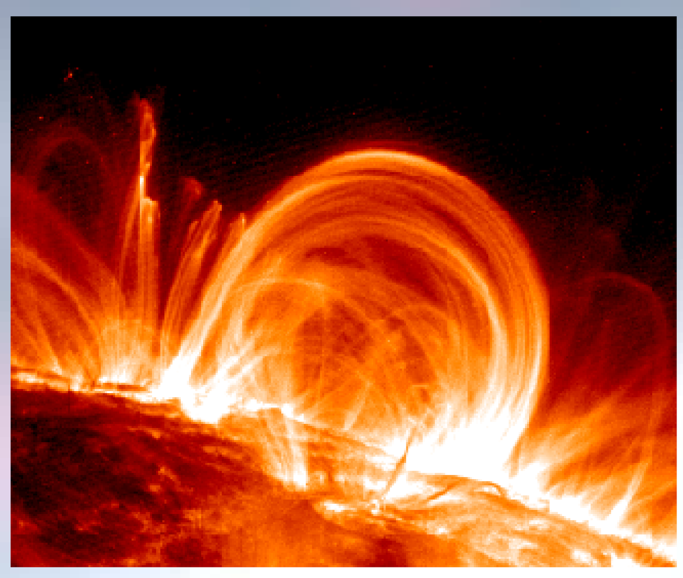
1 Abstract

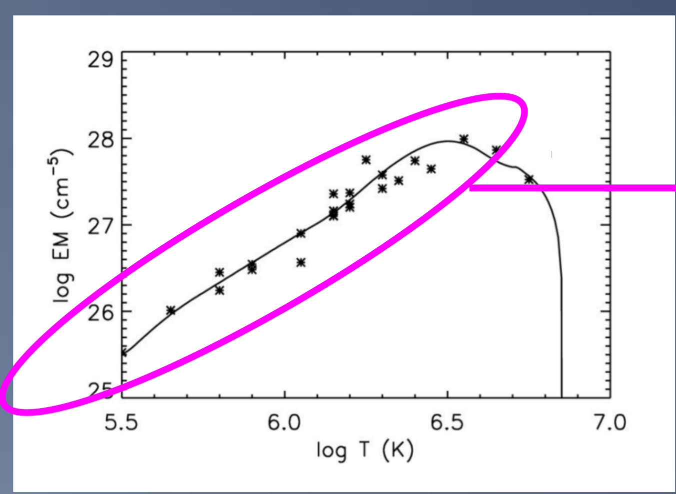
In this work, the ability of the Hinode/EIS instrument to detect radiative signatures of coronal heating is investigated. Recent observational studies of AR cores suggest that both the low and high frequency heating mechanisms are consistent with observations. The Differential Emission Measure (DEM) tool is one diagnostic that allows to make this distinction, important for identifying the physical mechanism(s) of the heating, through the amplitude of the DEM slope coolward of the coronal peak. It is therefore crucial to understand the uncertainties associated with these measurements. Using proper estimations of the uncertainties involved in the problem of DEM inversion, we derive confidence levels on the observed DEM slope. Results show that the uncertainty in the slope reconstruction strongly depends on the number of lines constraining the slope. Typical uncertainty is estimated to be about +/- 1.0, in the more favorable cases.

2 DEM diagnostic as a tool to measure the heating frequency



$$I_b = \frac{1}{4\pi}\int_0^{\infty} R_b(T_e)\xi(T_e)\mathrm{d}\,T_e$$

Active Region → DEM $\xi \propto T^{\alpha}$ (Warren et al. 2011, Winebarger et al. 2012, Schmelz 2012 ...)



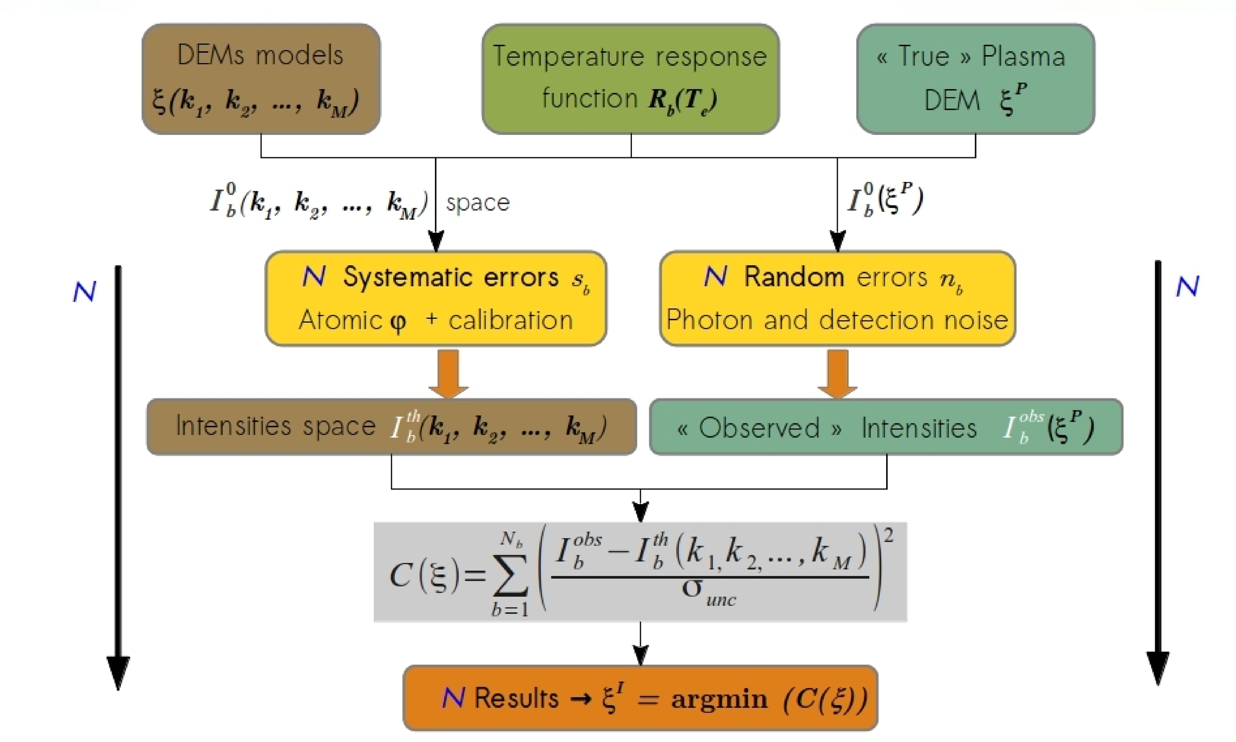
(Tripathi, Klimchuk & Mason, 2011)

- Slope determination :
  - → Indication of the cold/warm material ratio
  - → Timescale of the energy deposition in the solar corona

Uncertainties on the measured slope?

3 Measuring the robustness of the DEM inversion

Principle : Simulating the DEM inversion process



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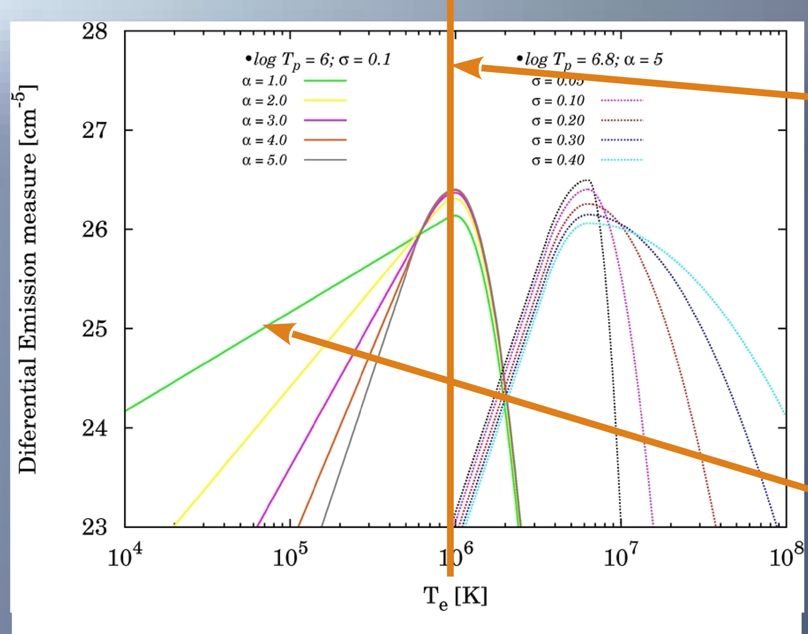


Parametric model of AR DEM

=

$$P(\alpha^I|\alpha^P)$$

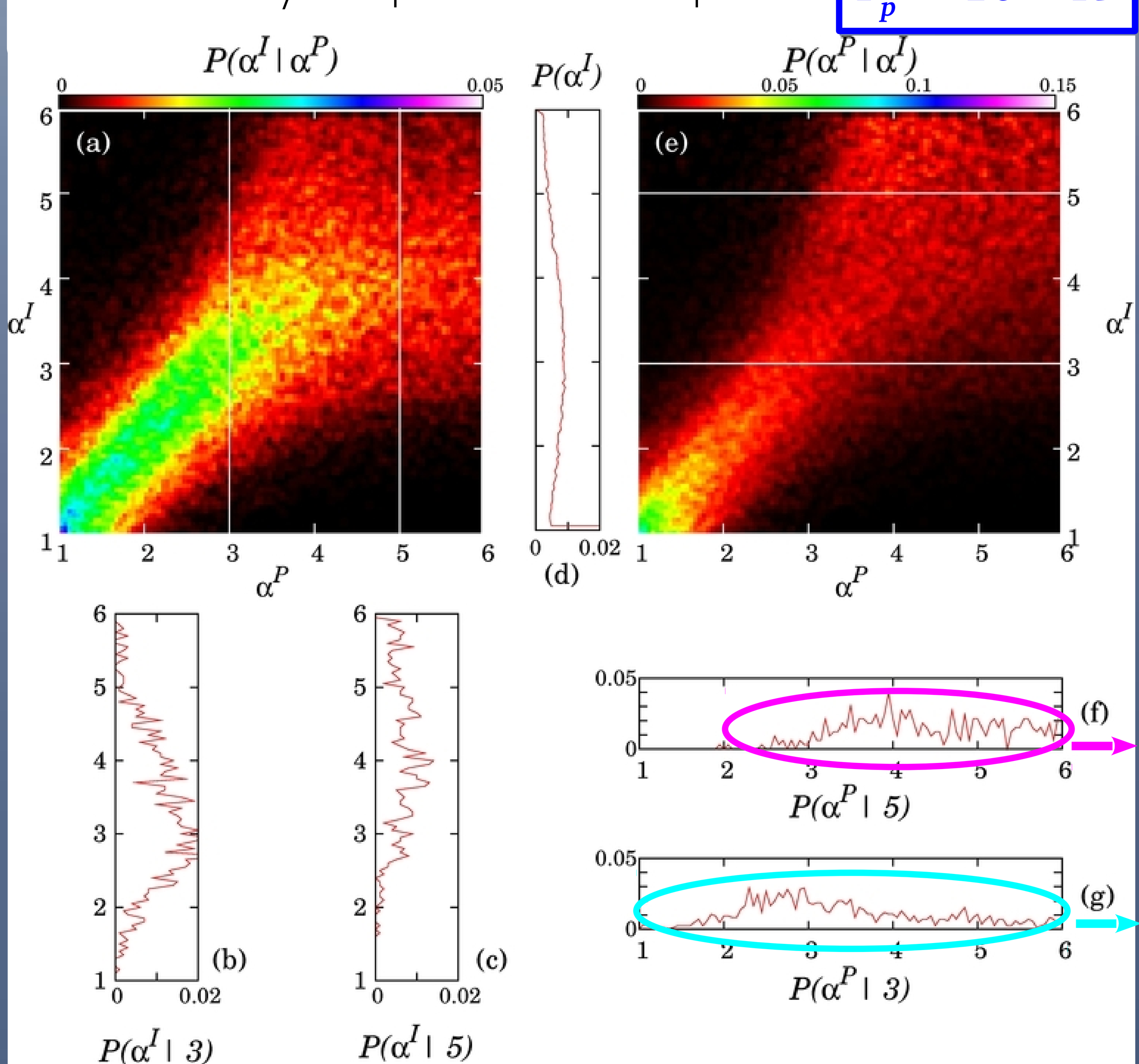
+ Bayes' theorem

$$P(\alpha^P|\alpha^I)$$

Probability of all solutions consistent with the data and the uncertainties

4 Results

Probability maps of the slope $T_p = 10^{6.8}$ K



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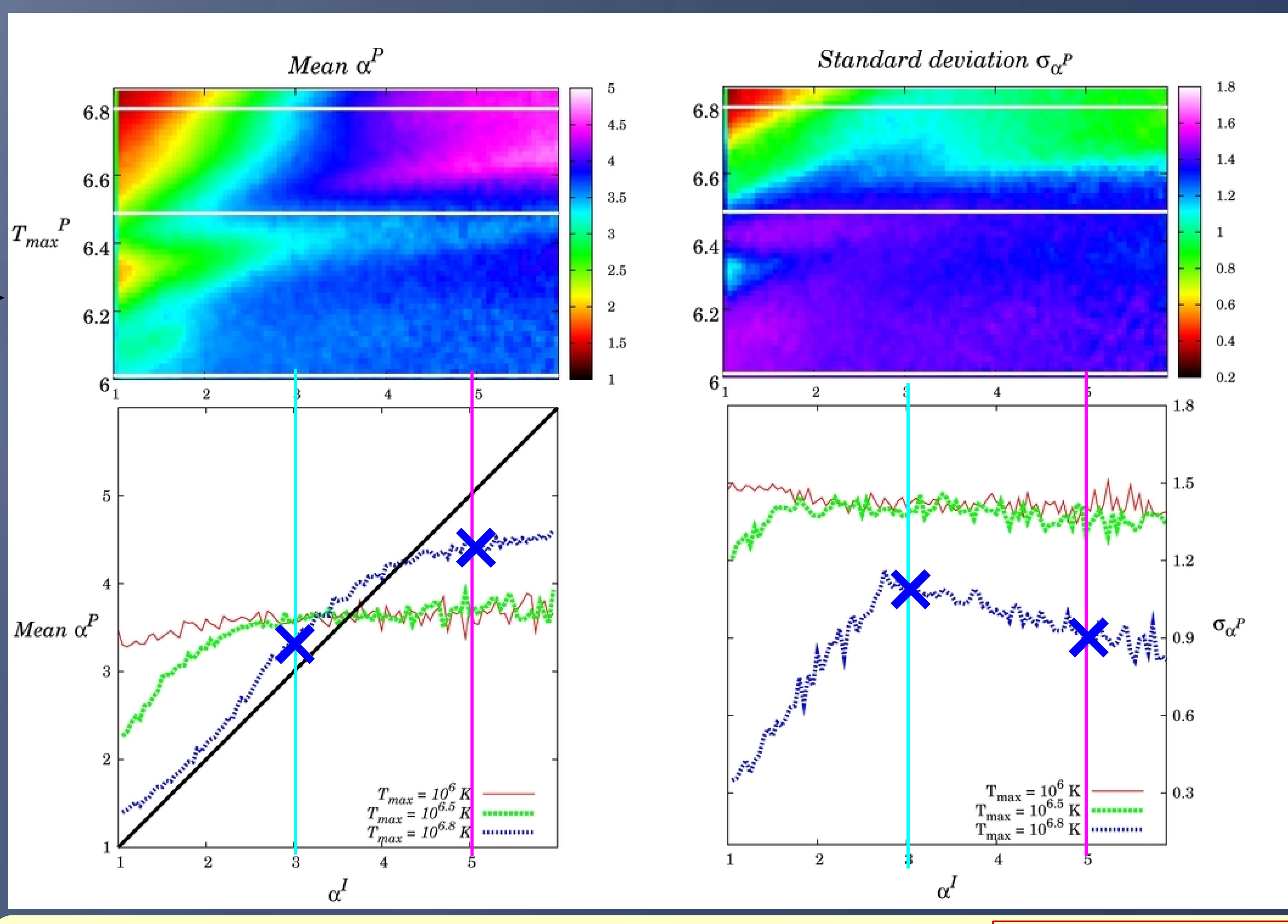
For $T_p = 10^{6.0}$ K to $T_p = 10^{6.9}$ K



Bradshaw et al. (2012) : Low frequency nanoflares *model* → $0.8 \leq \alpha \leq 2.5$

observations : 22 AR cores* (inter moss regions) *36 % matching* + $\Delta\alpha = \pm 1.0$ → *0 % vs 77 % matching*

*Schmelz & Pathak (2012)
Tripathi, Klimchuk, & Mason (2011)
Warren, Brooks, & Winebarger (2011)
Warren, Winebarger, & Brooks (2012)
Winebarger et al. (2011)

5 Conclusions

In this work, we carefully assess the errors in the DEM slopes determined from Hinode/EIS data, taking into account both random and systematic errors. We paid particular attention to the description of the systematic errors related to the atomic physics process and abundances. The most main important point of this work is that the uncertainty in the measured slope may be too large to definitively exclude or corroborate a given heating scenario in many cases.