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What are solar gamma-ray spectra actually telling us?

Alec MacKinnon

Solar gamma-ray spectrum

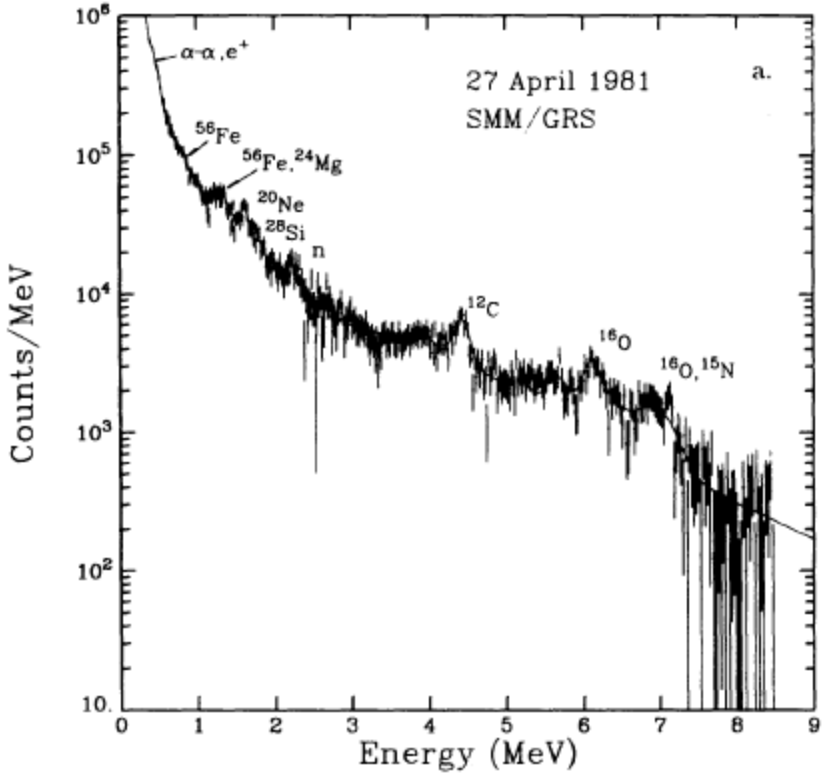

FIG. 2.—(*a*) Observed count spectrum of the 1981 April 27 flare fitted

Murphy et al. (1991)

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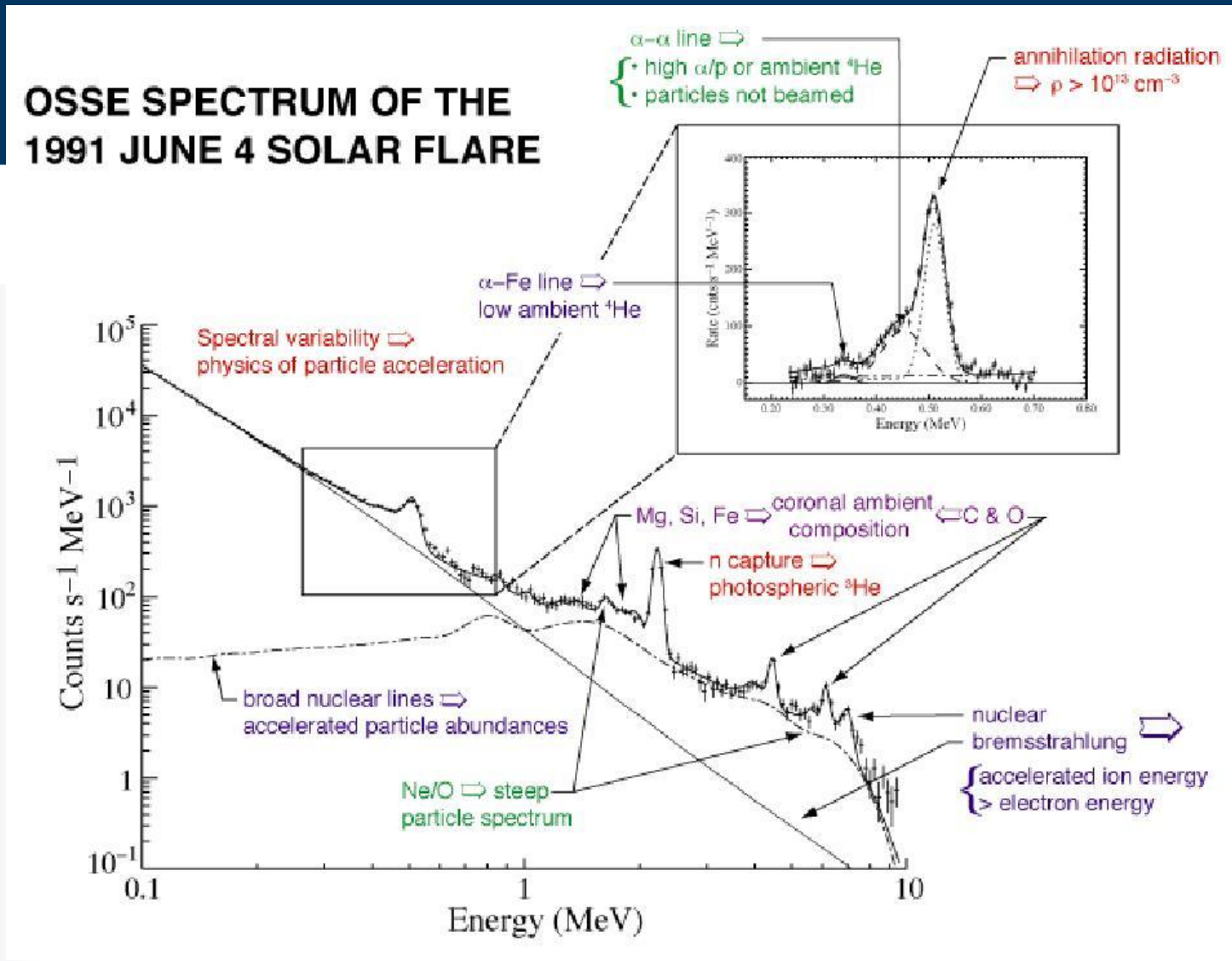
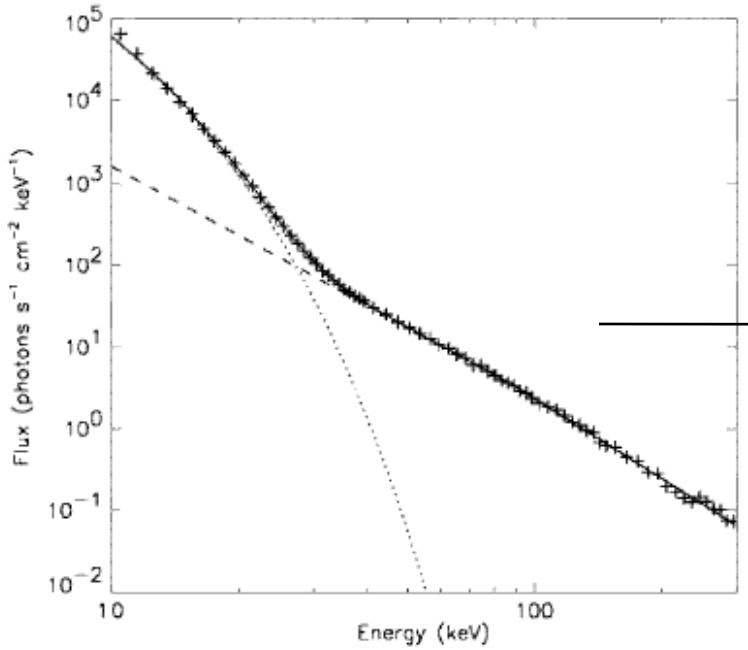
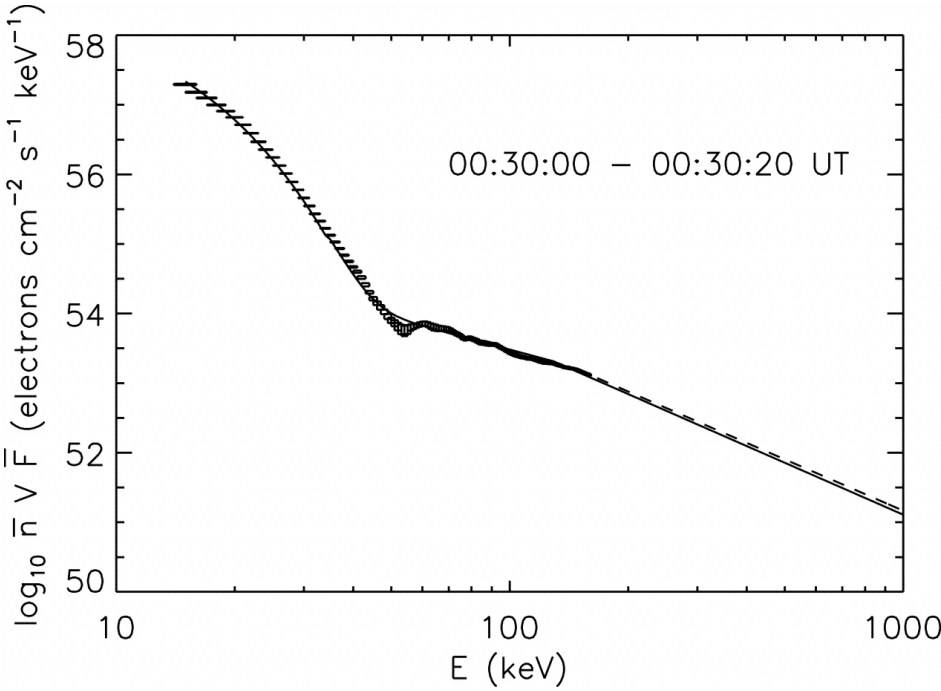


(from the OSSE public outreach web pages); Share and Murphy; Reuven Ramaty

HXR spectrum





Lin et al. (2003);
23 July 2002 flare, 0028:15 UT

Piana et al. (2003)

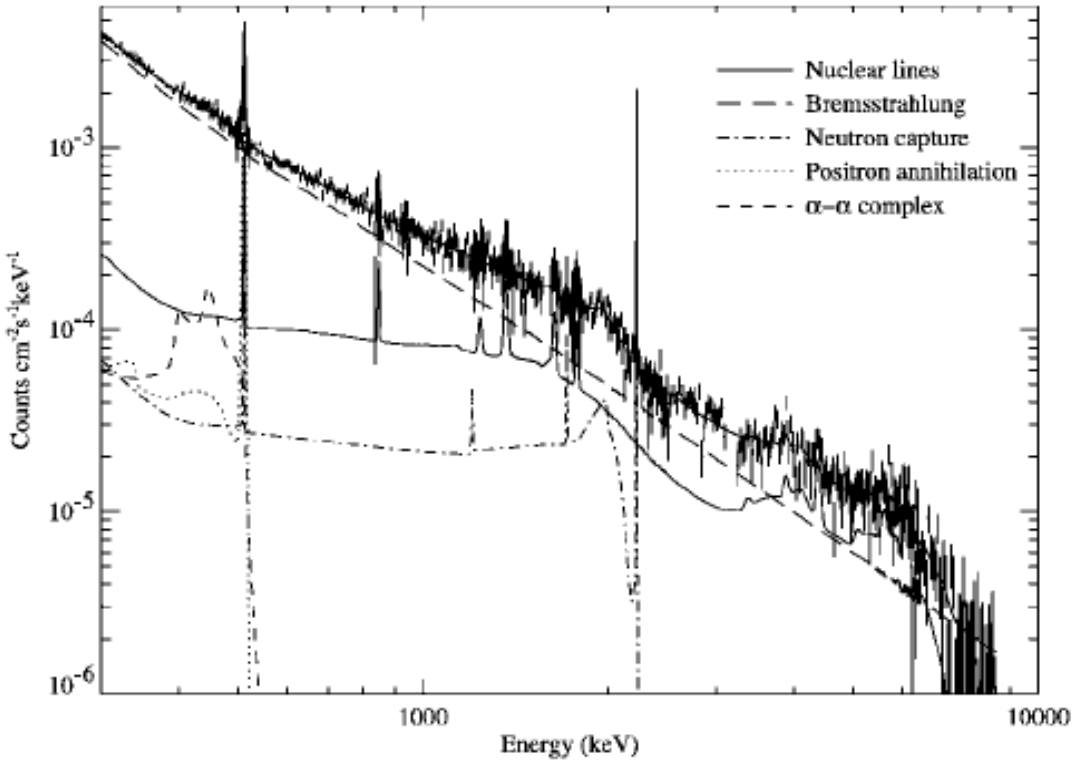
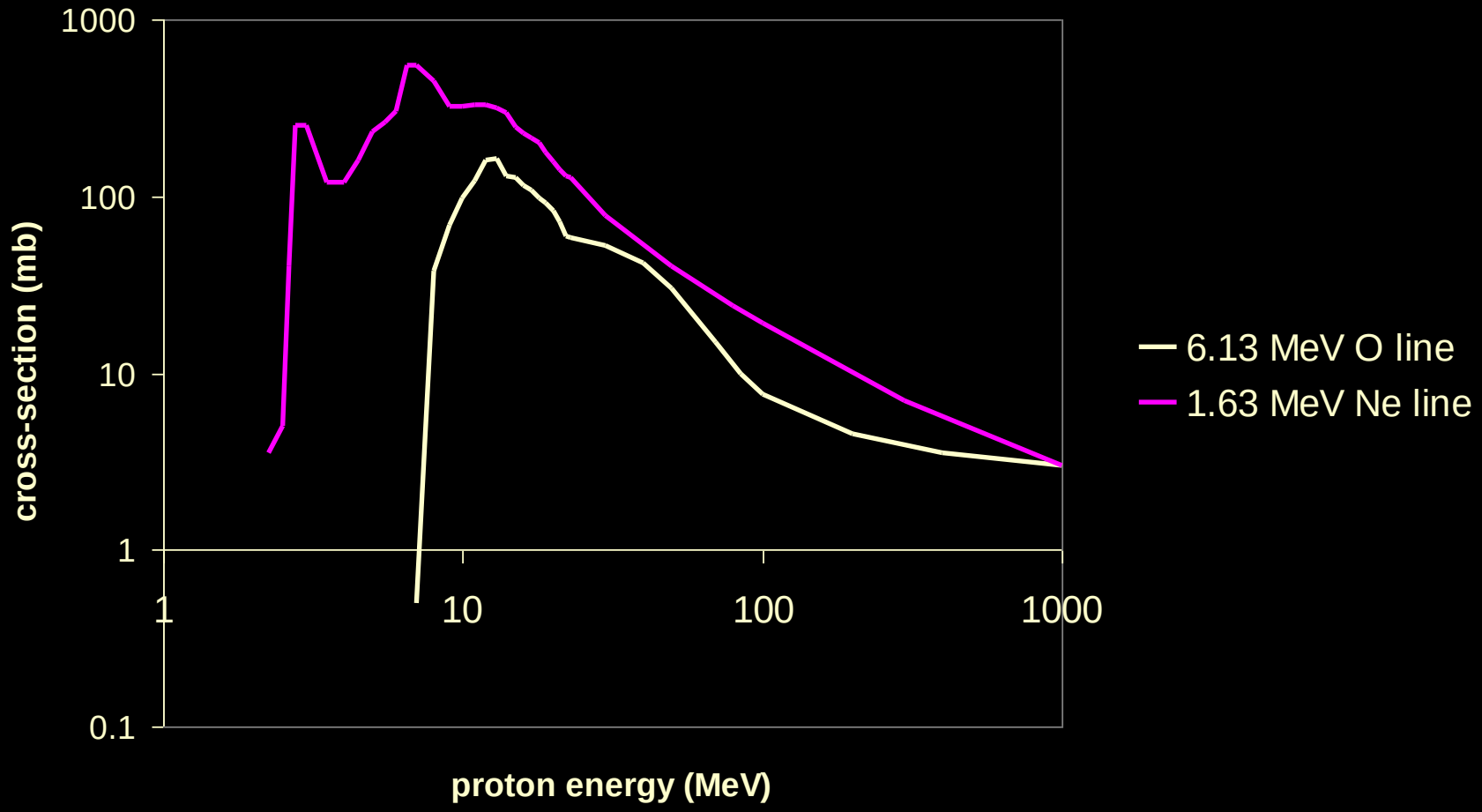


FIG. 3.—*RHESSI* γ-ray count spectrum from 0.3 to 10 MeV, integrated over the interval 0027:20–0043:20 UT. The lines show the different components of the model used to fit the spectrum.

→ ?

Lin et al. (2003), ApJL **595**; 23 July 2002 flare

E.g. 1.63 MeV ^{20}Ne line



$$\Phi_\epsilon = \frac{a_X}{4\pi D^2} \sum_i \int_{E_{0i}}^{\infty} \frac{\sigma_{i,\epsilon}(E)}{|\mathrm{d}E_i/\mathrm{d}N|} \Psi_i(E)\mathrm{d}E$$

$$\Psi_i(E) = \int_E^{\infty} F_i(E)\mathrm{d}E$$

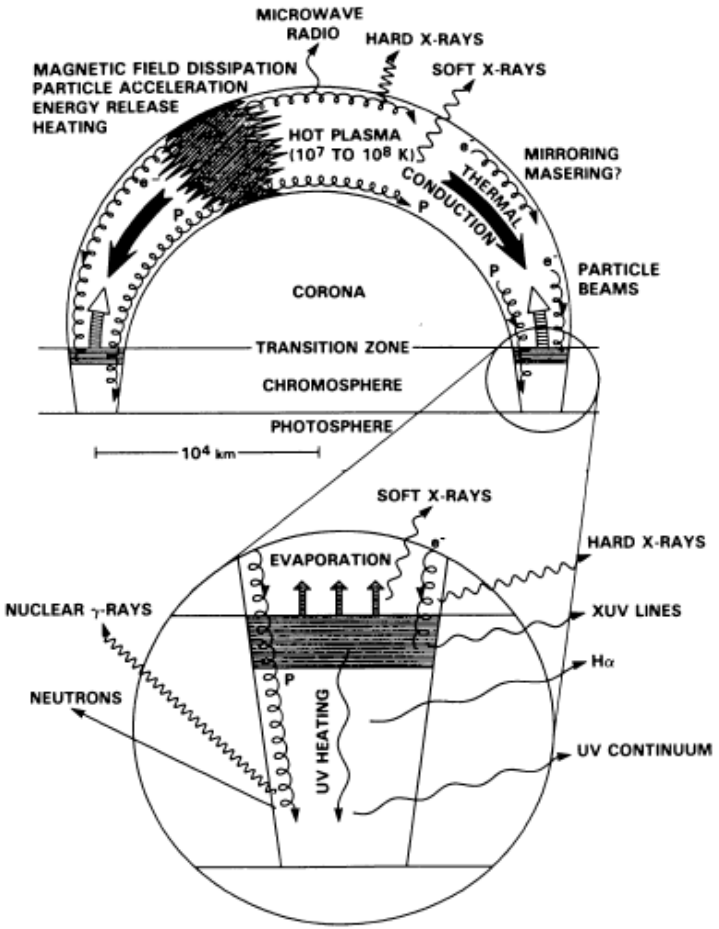
De-excitation lines

- Usually interpreted via e.g. power-law parametrisation of ion energy distribution
- Toner and MacKinnon (2004) – decouple proton and alpha distributions but still in this parametric way
- Non-parametric deduction of ion energy distribution?
- SVD etc. – information content of de-excitation line spectrum
- (Murphy, Emslie…)

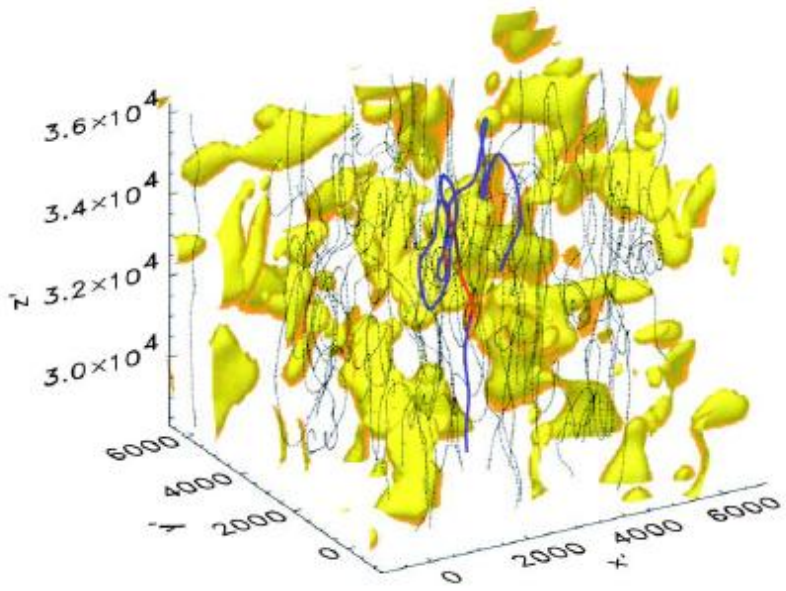
$$\Phi_\epsilon = \frac{a_X}{4\pi D^2} \sum_i \int_{E_{0i}}^{\infty} \frac{\sigma_{i,\epsilon}(E)}{|\mathrm{d}E_i/\mathrm{d}N|} \Psi_i(E)\mathrm{d}E$$

cold, thick target
What if not?

Cf. Brown et al. (2009), acceleration + interaction region



Dennis and Schwartz (1987)



Arzner and Vlahos (2004)

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Conclusions

Attempt to define information content of de-excitation lines in a non-parametric way

May bear on specifying the capacities of the next generation of gamma-ray detectors

Relax the thick target separation of acceleration and interaction regions

Effects on broad to narrow line flux ratios? Total ion energy content?