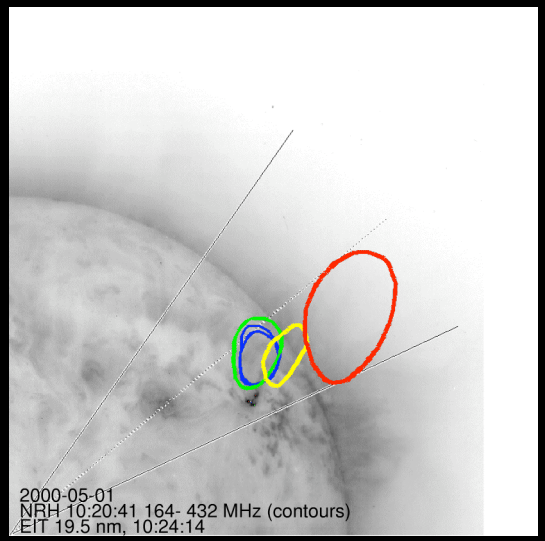
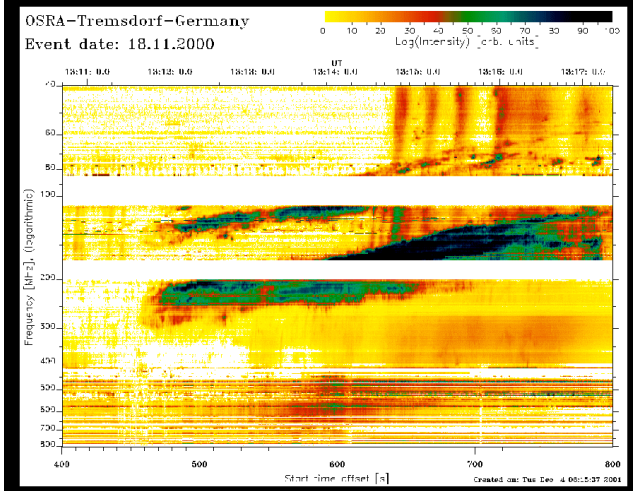
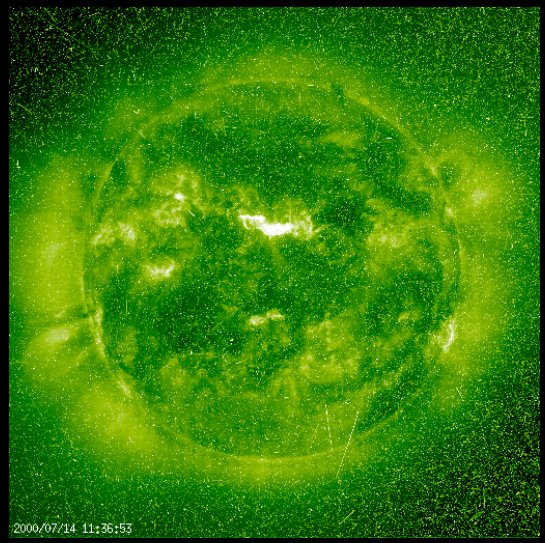
Suprathermal particles at and from the Sun, coronal magnetic field







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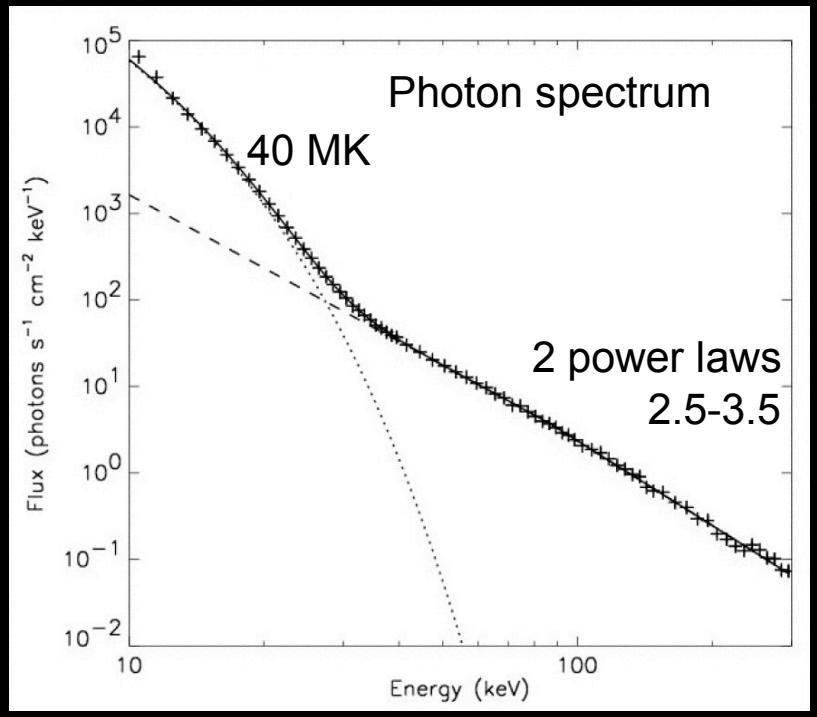
Non-maxwellian particle populations at and from the Sun

- Physics of the photosphere and interior : collisional plasmas, large scale, MHD (see SVWG document)
- The solar atmosphere and wind display a wide range of parameters : n, T, β
- Many recent observations, as well as modelling, show the importance of non-MHD (multi-T or kinetic) phenomena : « quiet » corona & wind, high-energy particles

Hard X-ray spectra



- HXR from thermal and non thermal electron populations can be separated (RHESSI)
- Time sequence : power law, then increasing contribution from very hot plasma

(Lin et al. 2003, ApJL)

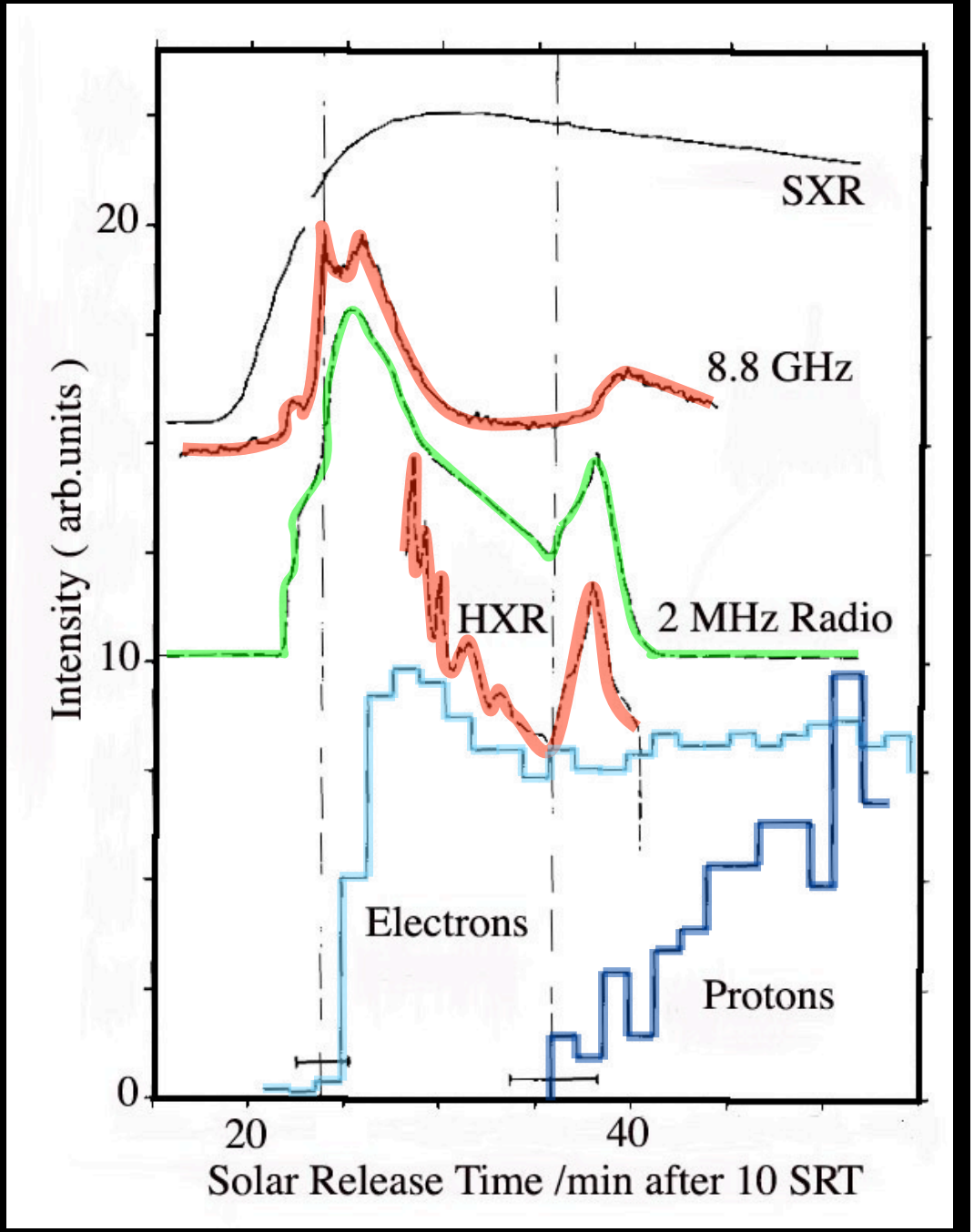
- Non thermal e^- (particles) : significant fraction of the released energy
- Energy transport → chromosphere (Hα, white-light) and photosphere (seismic waves)
- To understand flares : MHD for the overall magnetic structure, kinetic theory for energy conversion & transport.

Non thermal particles are ubiquitous in astrophysics. The Sun provides a unique possibility to probe interacting (γ, HXR, radio) and escaping (*in situ*) energetic particles. Optimum diagnostics with observations from a close vantage point.

Energetic particle measurements within 0.4 AU

- Resolve time profiles of different particle species
- Compare with particle acceleration in the corona (γ, HXR, μ waves, NEUTRONS)
- Trace e^- escape from corona (type III, indicating open B configuration)

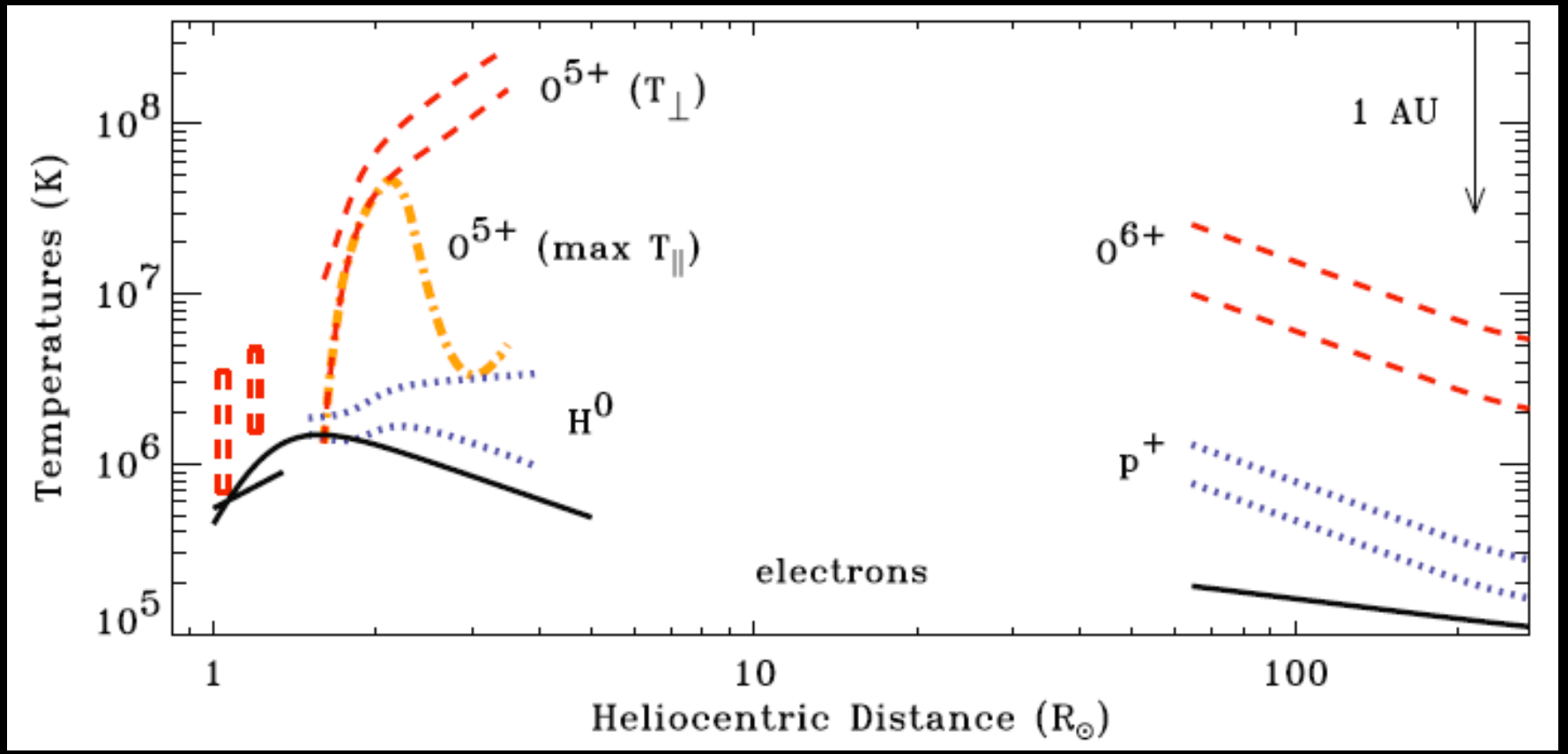
$\Rightarrow$ *Solar Orbiter* - a unique set of combined measure-ments to separate different accelerators (flare, CME)



HELIOS : Kallenrode & Wibberenz 1991 ApJ 376, 787

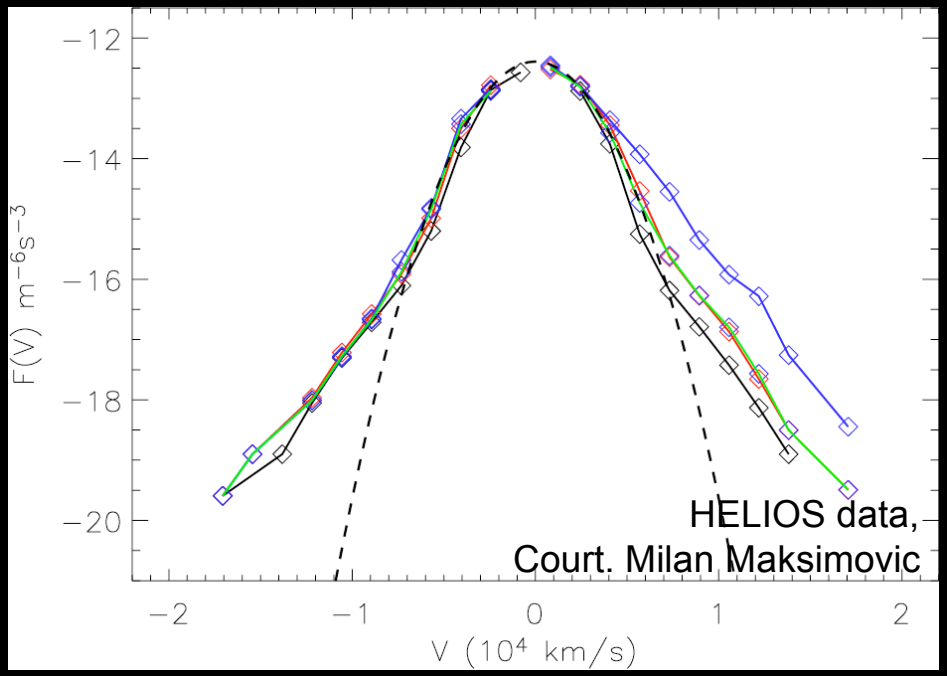
Multi-*T* and non-maxwellian particle populations are observed in the « quiet » solar wind - and may be a fundamental ingredient of the solar corona.

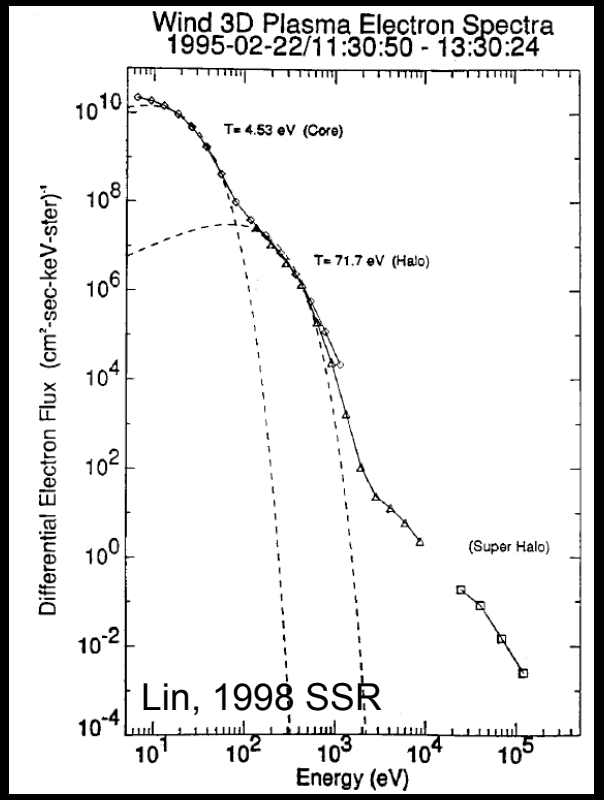
Non-MHD features in the solar corona



- Species-dependent *T* of e^- and ions in coronal holes & anisotropy (SoHO; Kohl et al 2006 AAR 13, 31)

Non-MHD features in the solar wind





Suprathermal tails, e^- distribution functions in the solar wind (& corona ?)

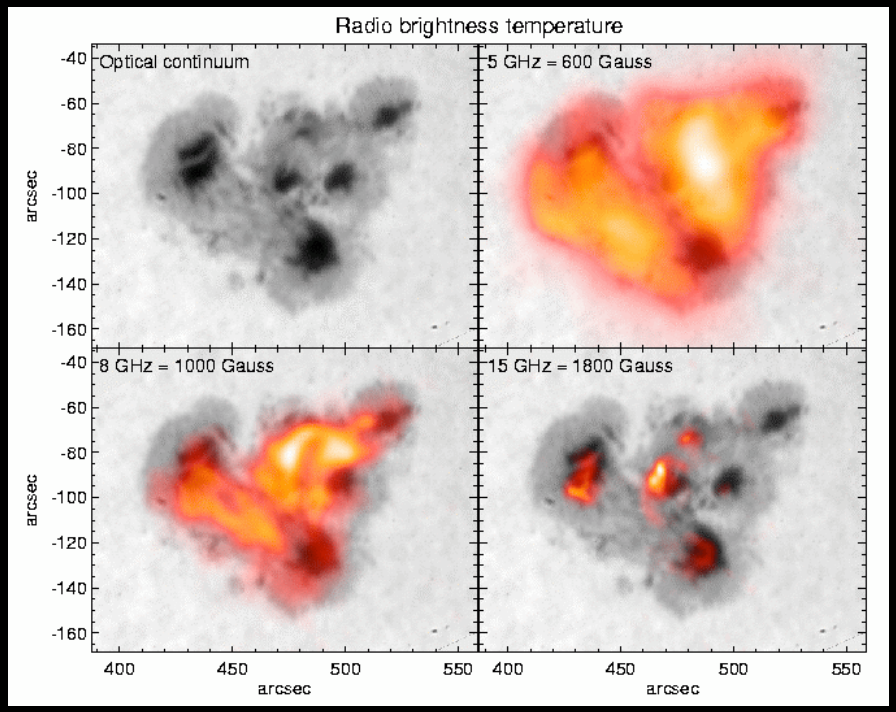
- Crucial : interpretation of spectral observations of the Sun (and other stars), energy transport in the corona and transition region
- Radio emission from the quiet corona (Chiuderi & Chiuderi-Drago 2004 AA 422, 231) ?

The importance of NT particle distributions

- Interpretation of spectroscopic observations of stellar coronae and other astrophysical objects (optical, X-rays …)
- Seed populations for particle acceleration in the corona
- Understanding of coronal heating and energetic particle production
- Understanding of energy transport in the solar and in stellar atmospheres (quiet & active)

Magnetic field measurements in the solar corona are possible through spectral imaging at cm-λ.

Coronal magnetic field measurements



Lee et al. 1998, ApJ 501, 853

- UV / EUV spectro-polarimetry
- Radio spectral imaging :
  - Gyroresonance $\tau_{gr}>1$: T_b on iso-*B* surfaces ($\nu=s\nu_{ce}$; *s=2, 3*) above sunspots (high *B*)
  - Circular polarisation of bremsstrahlung from active regions
- Perspective : FASR

Other techniques :

- Faraday rotation of (artificial or natural) radio signals upon traverrsing the corona (line-of-sight integrated)
- In situ measurements in the high corona ?

Additions to ASTRONET document

- Unique possibility of combined RS / in situ measurements of NT particles. *Solar Orbiter* perspective.
- Interface with magnetospheric physics
- Various techniques of coronal magnetic field measurements : spectral imaging at radio (cm) λ. *FASR* perspective.