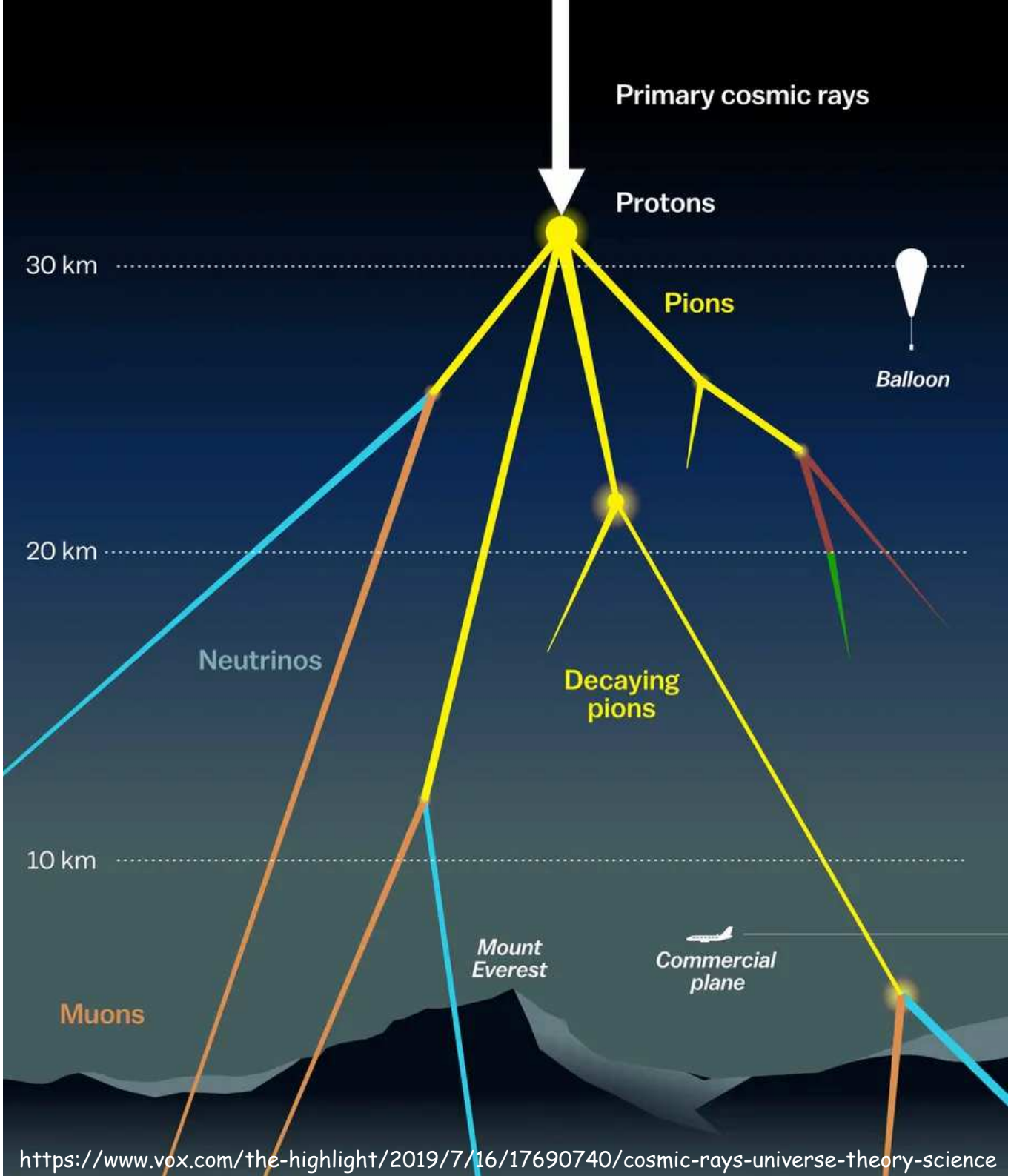
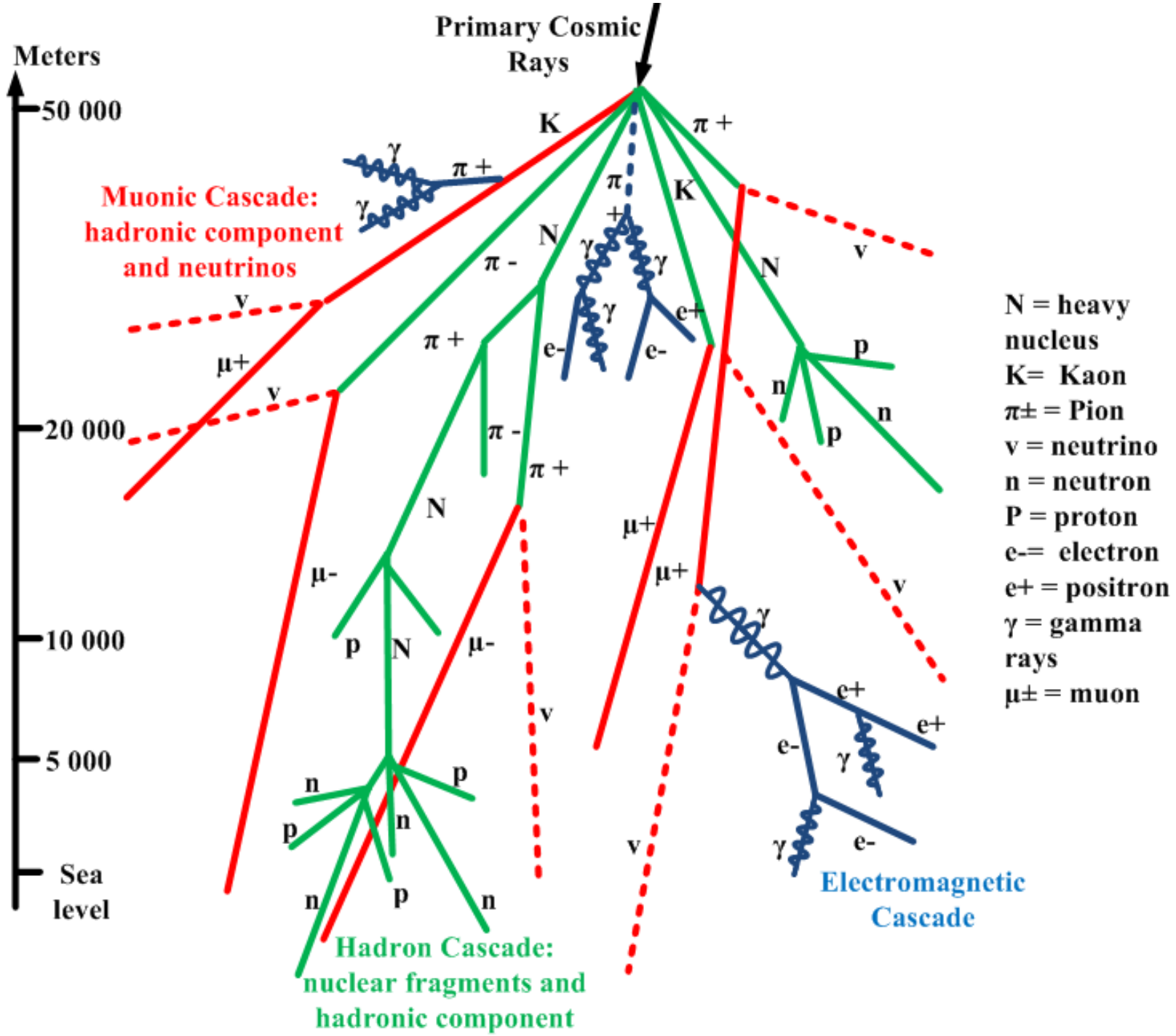
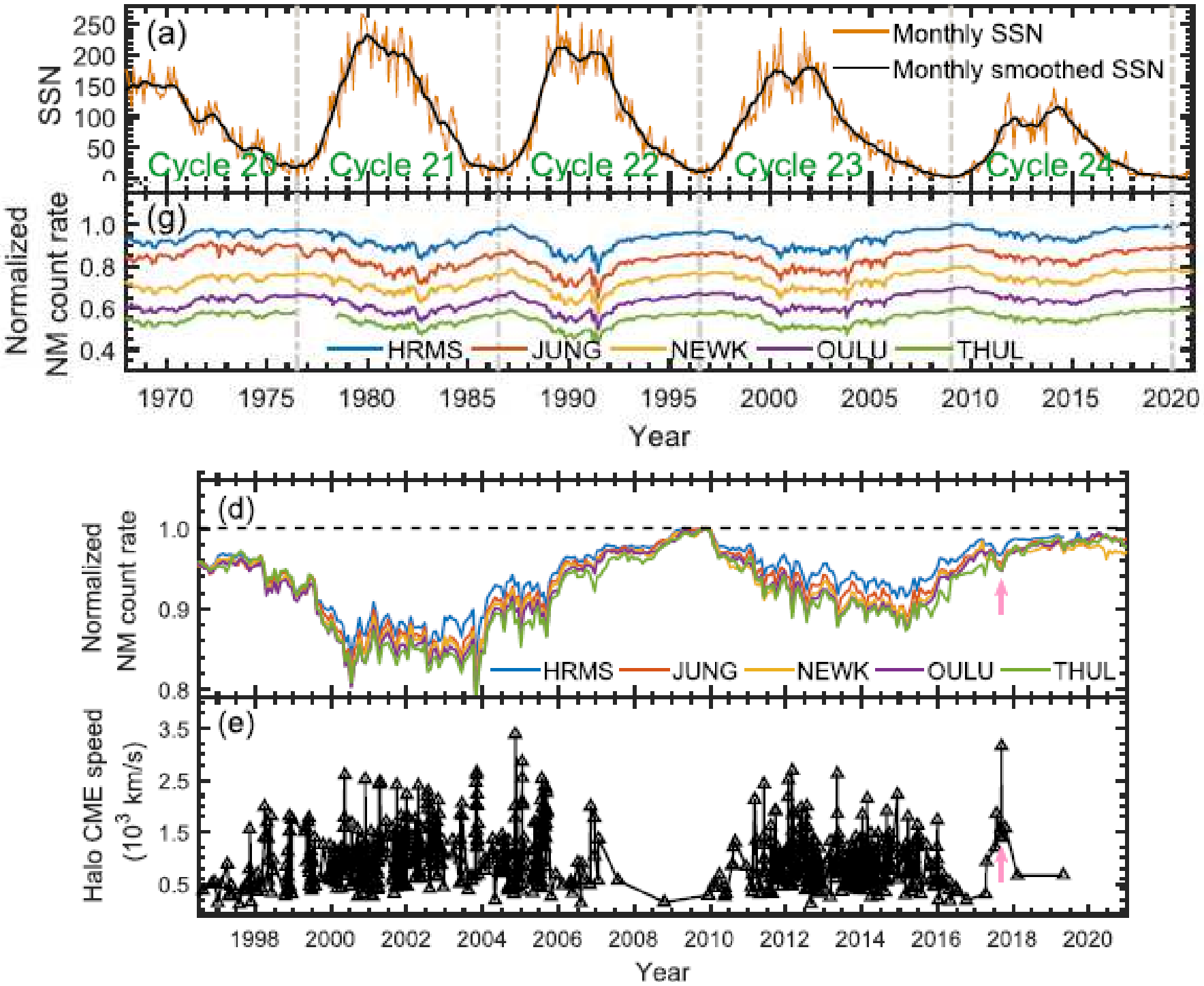


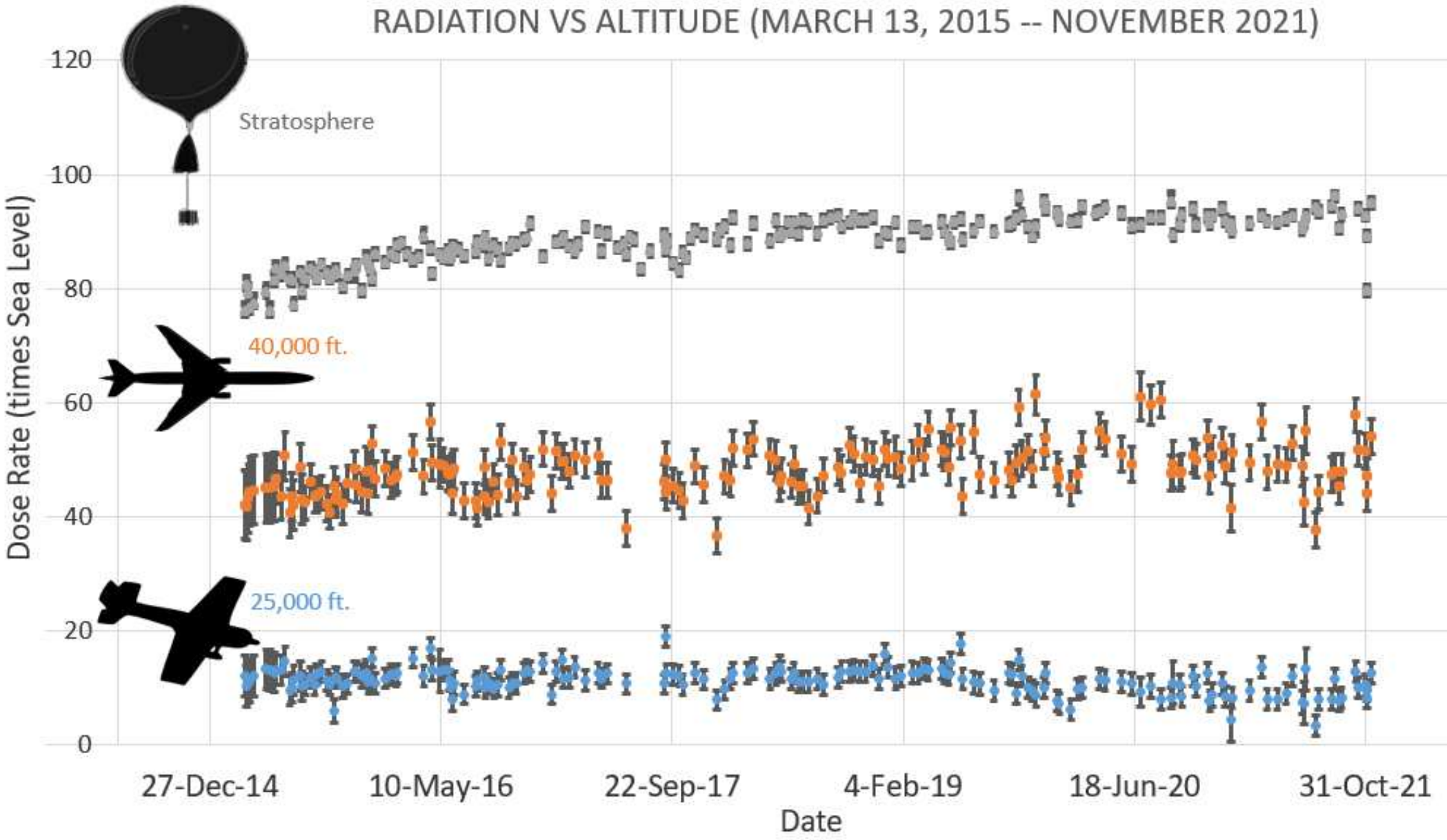
https://www.vox.com/the-highlight/2019/7/16/17690740/cosmic-rays-universe-theory-science



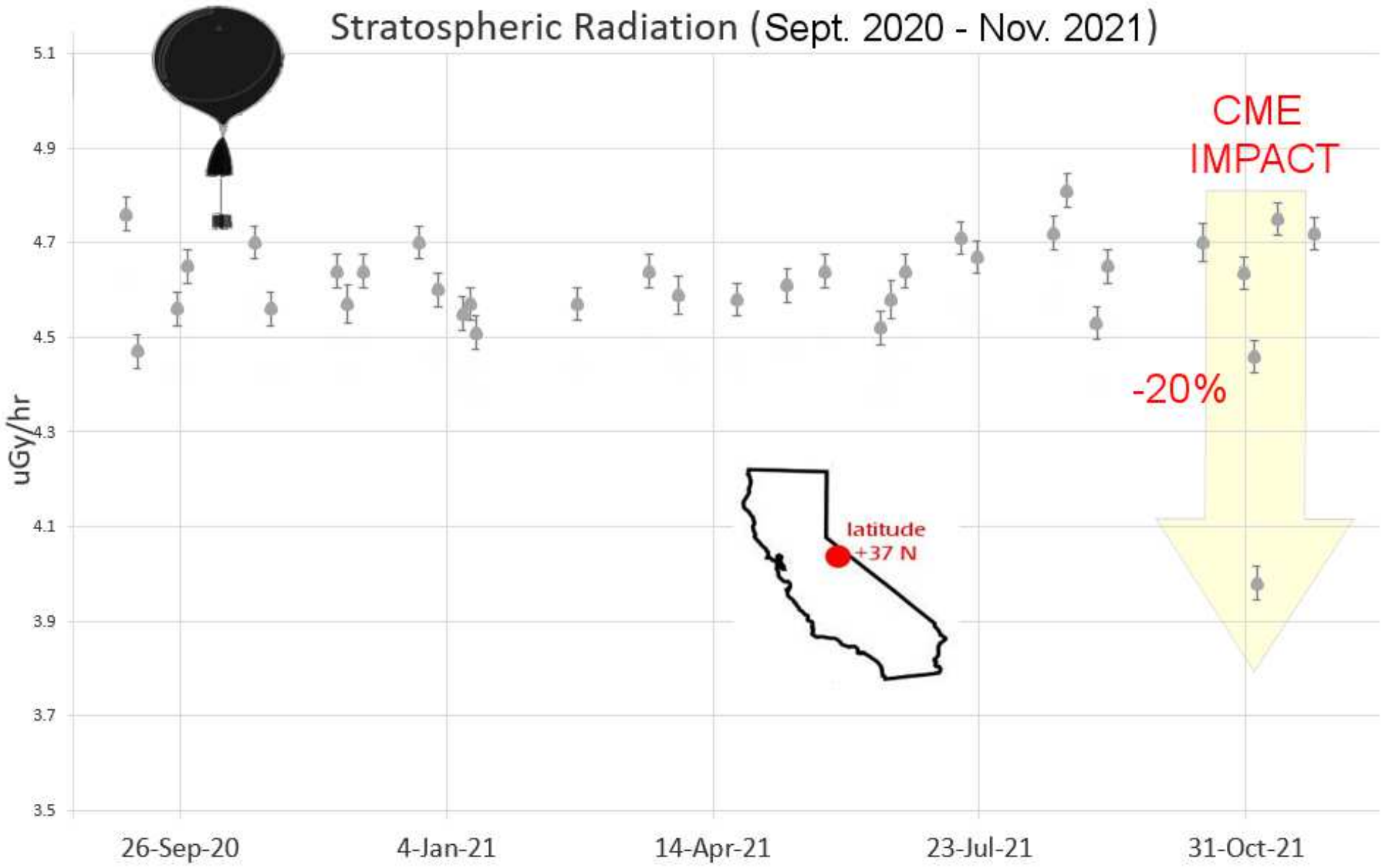
https://www.researchgate.net/figure/Showers-of-cosmic-ray-reactions-with-particles-of-the-atmosphere-Clo02_fig9_272826408


(a)
SSN
Monthly SSN
Monthly smoothed SSN
Cycle 20
Cycle 21
Cycle 22
Cycle 23
Cycle 24
(g)
Normalized NM count rate
HRMS
JUNG
NEWK
OULU
THUL
Year
(d)
(e)
Halo CME speed (10^3 km/s)

Fu et al. (2021)

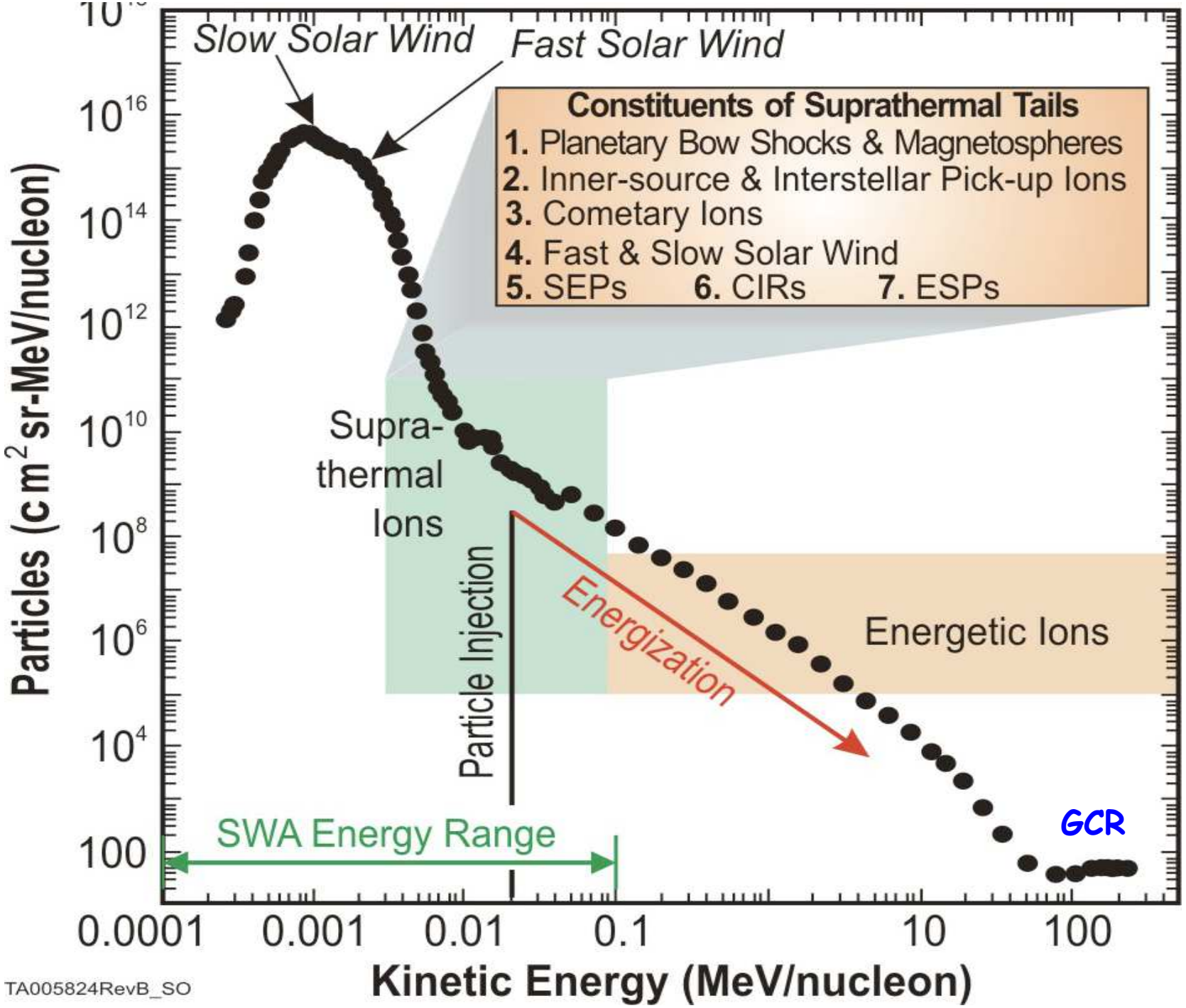


https://www.spaceweather.com/



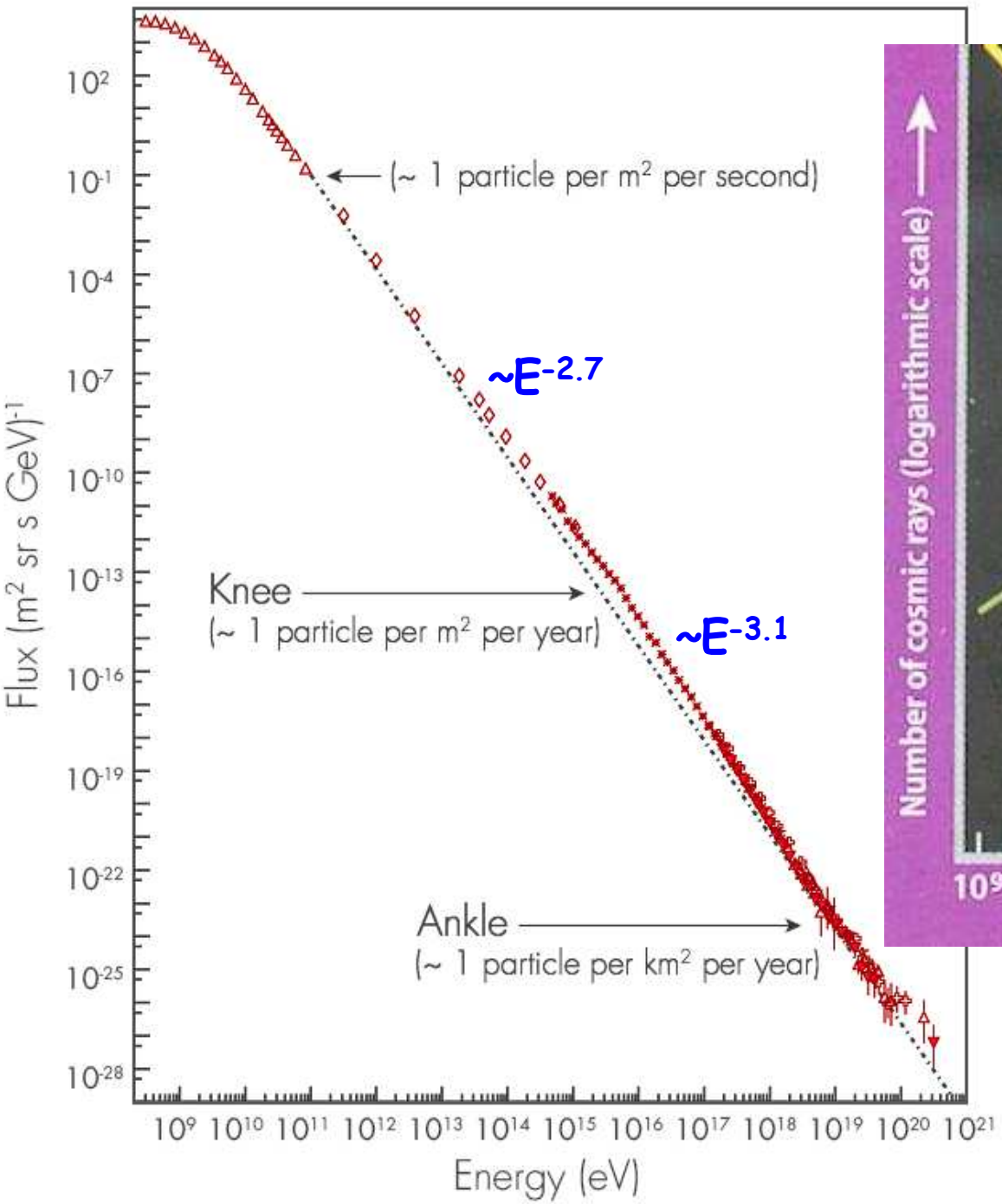
https://www.spaceweather.com/

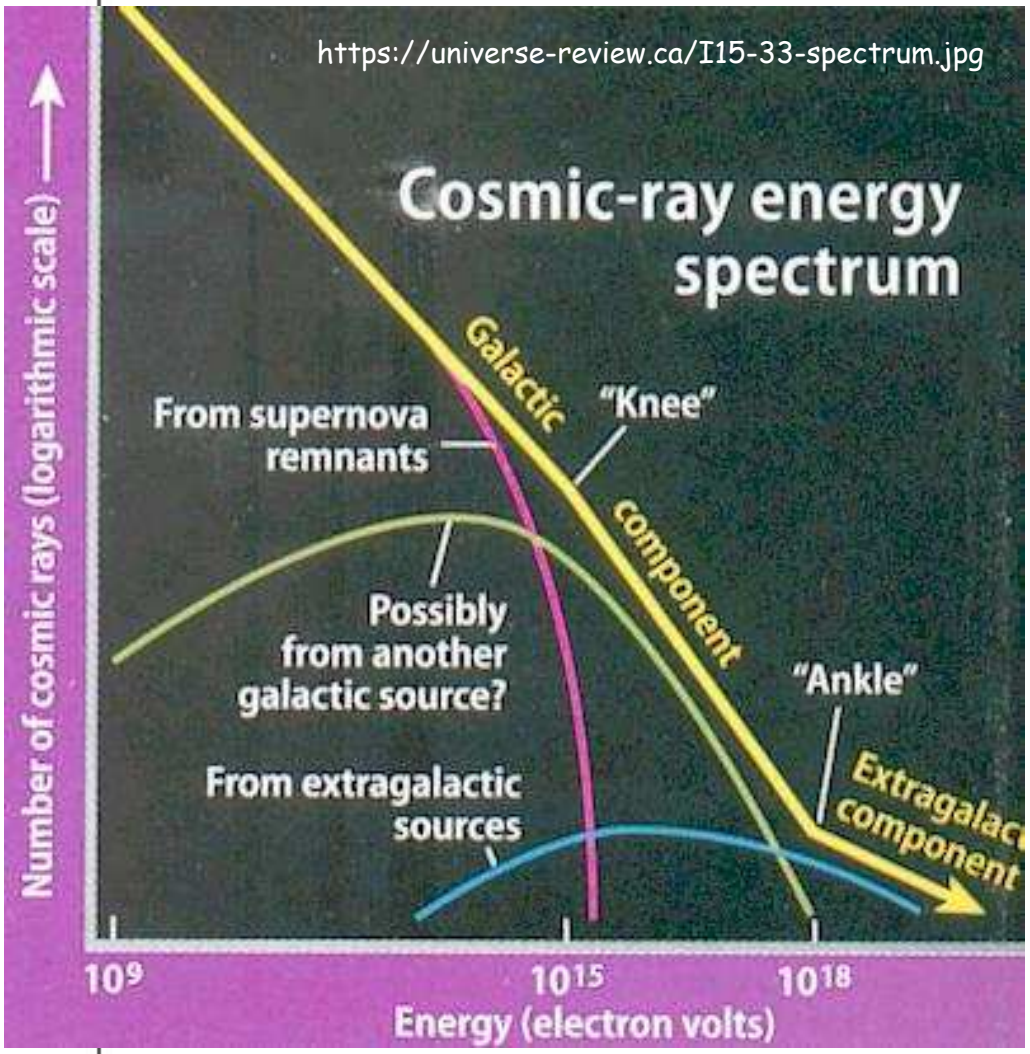
(Mewaldt et al., 2001)



Gang Li in 2014 iSWWS

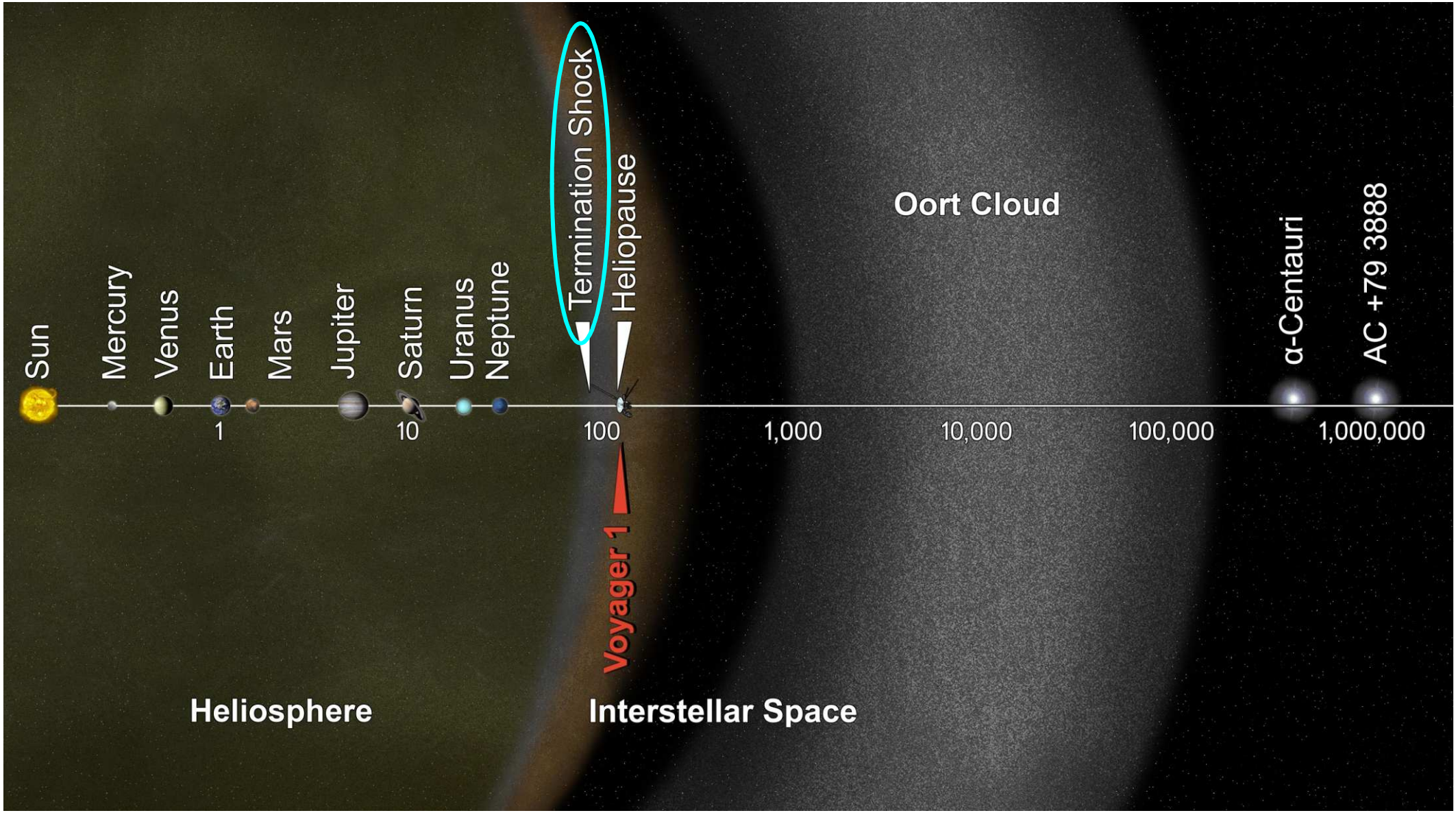
FLUXES OF COSMIC RAYS





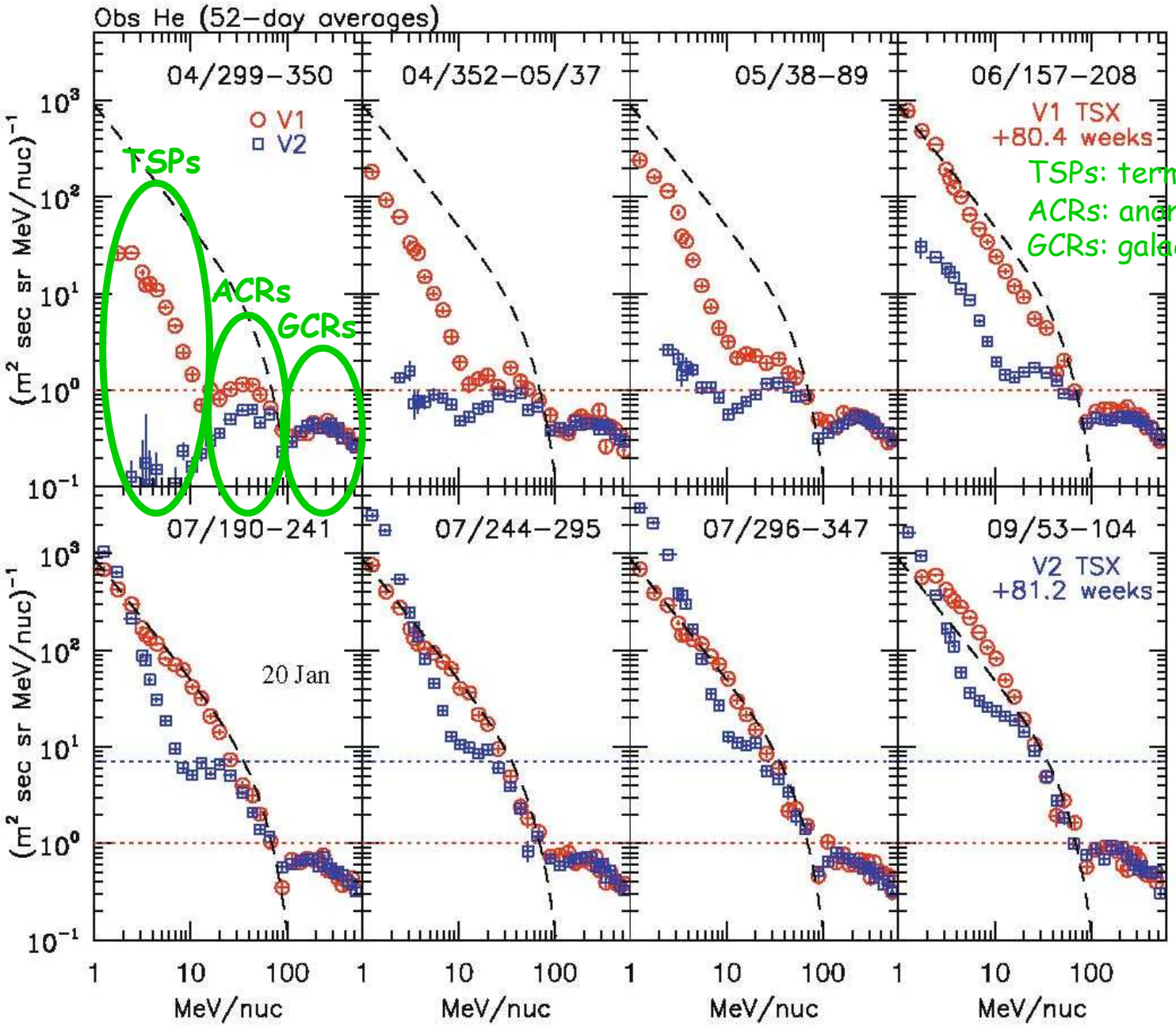
https://www.quantamagazine.org/wp-content/uploads/2015/05/SwordyCosmicRaySpectrum_v1.jpg

Before the Voyager TS encounters, the TS was thought to be the source of the anomalous cosmic rays (ACRs), …….



Voyager 1 crossed the termination shock in December 2004 at 94 AU.
Voyager 2 crossed the termination shock in August 2007 at 84 AU.

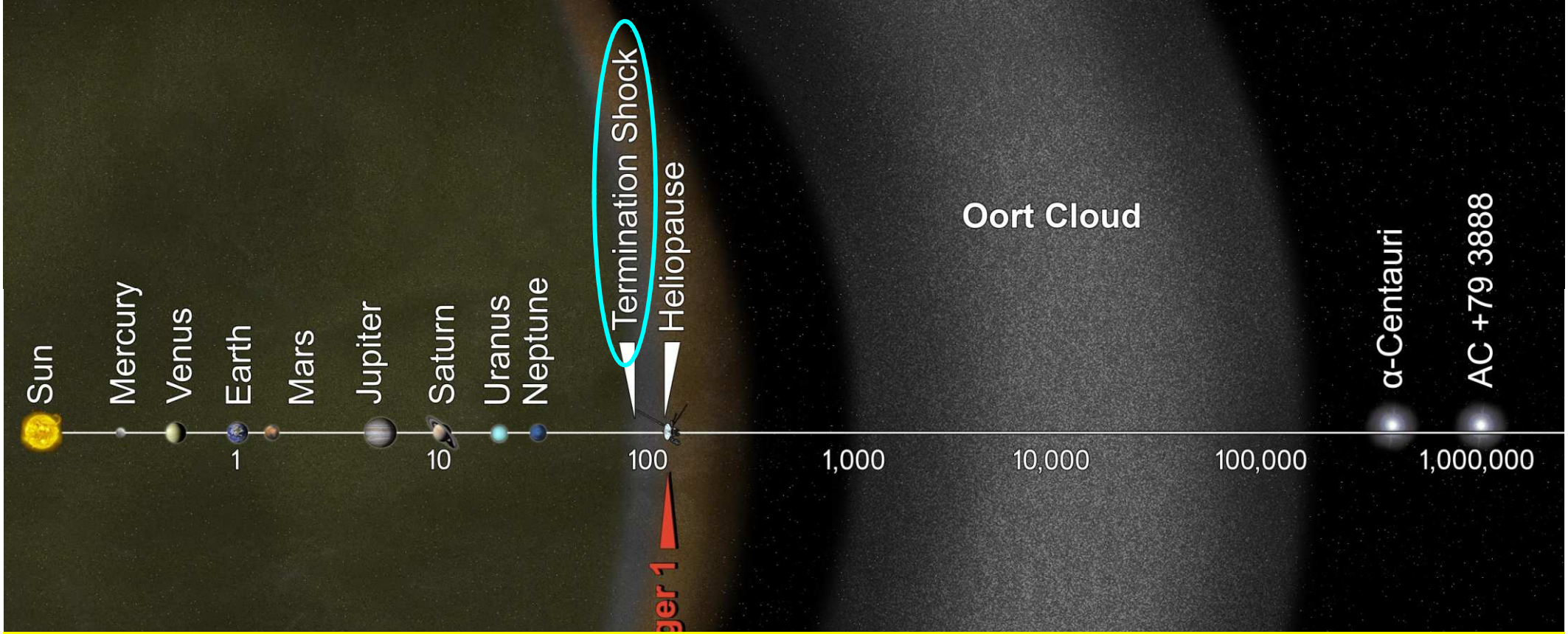
https://upload.wikimedia.org/wikipedia/commons/d/da/PIA17046_-_Voyager_1_Goes_Interstellar.jpg



TSPs: termination shock particles
ACRs: anomalous cosmic rays
GCRs: galactic cosmic rays

The lowest energy TSP fluxes increase across the TS, but the ACR particle intensities do not change. The ACR fluxes have continued to increase with distance, and the power spectra have continued to unroll towards a power law. At the highest energies the ACRs are not modulated.

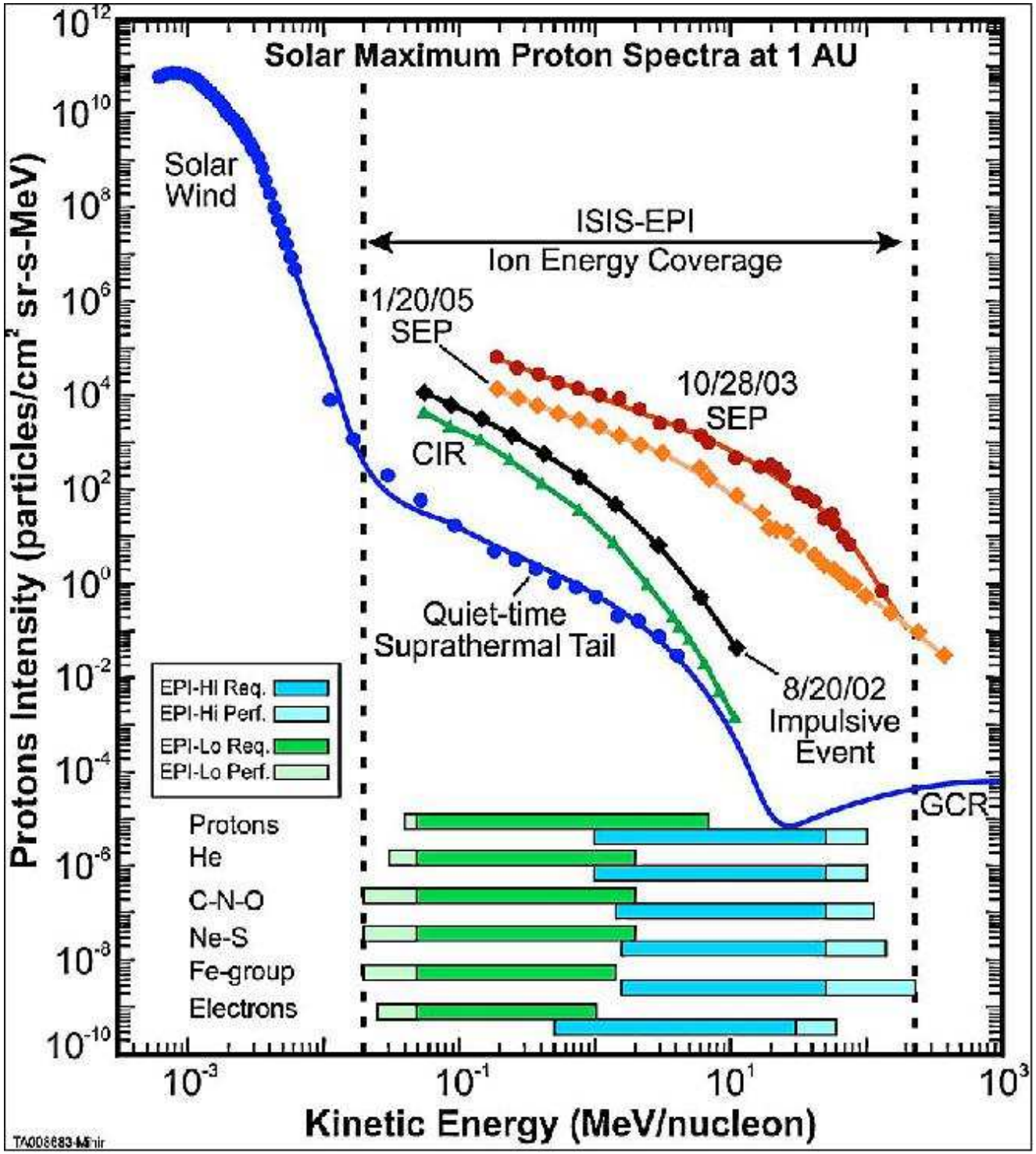
Fig. 13.7 in M. P. Miralles and J. Sánchez Almeida (2011)



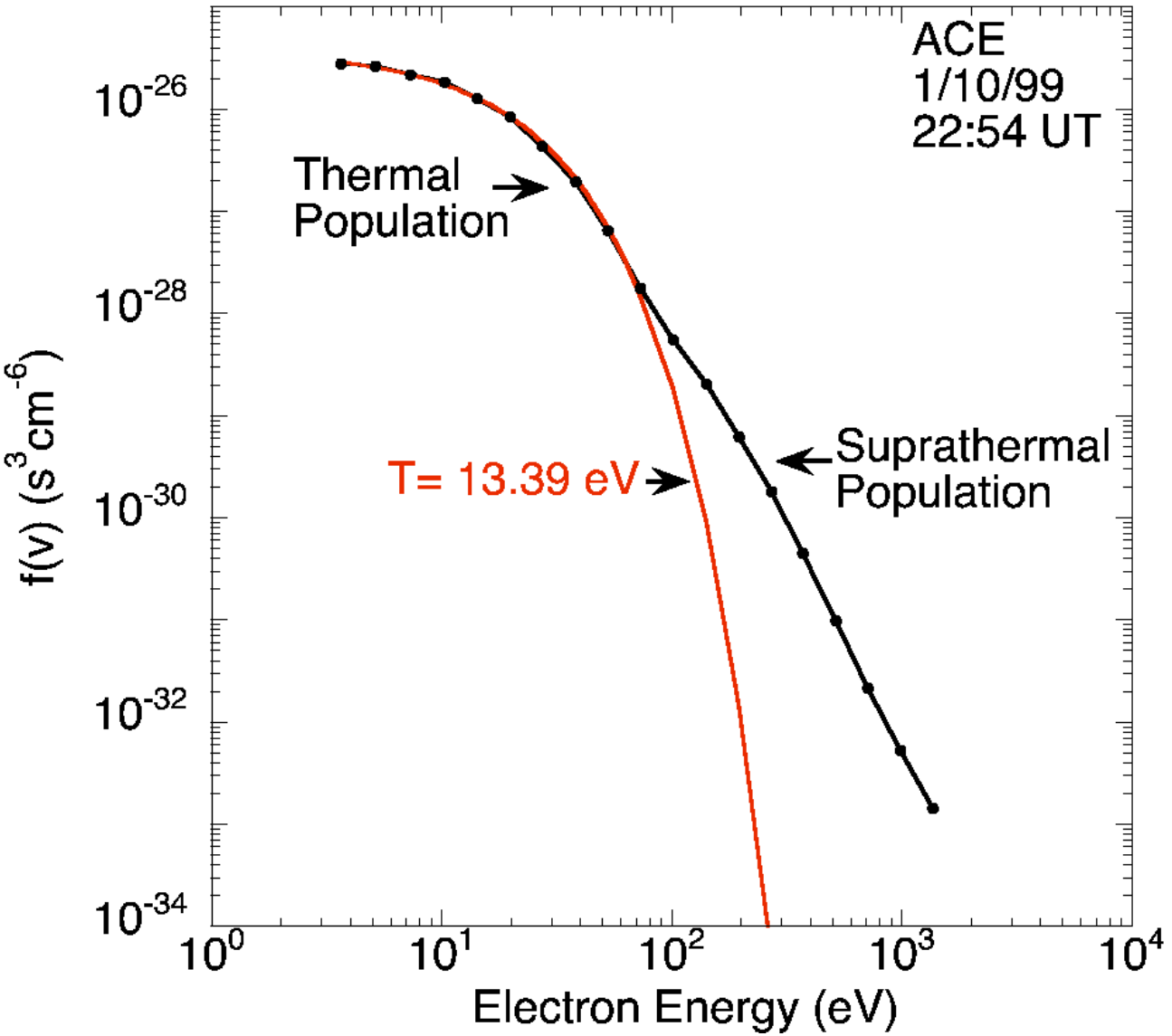
Before the Voyager TS encounters, the TS was thought to be the source of the anomalous cosmic rays (ACRs), but at the Voyager crossing no evidence of the ACR source was observed, so these particles must be accelerated elsewhere on the TS or elsewhere in the heliosphere.

ACRs increase in intensity with radial distance from the Sun, indicating that this component probably originates in the interaction of the solar wind with the interstellar medium.

https://upload.wikimedia.org/wikipedia/commons/d/da/PIA17046_-_Voyager_1_Goes_Interstellar.jpg

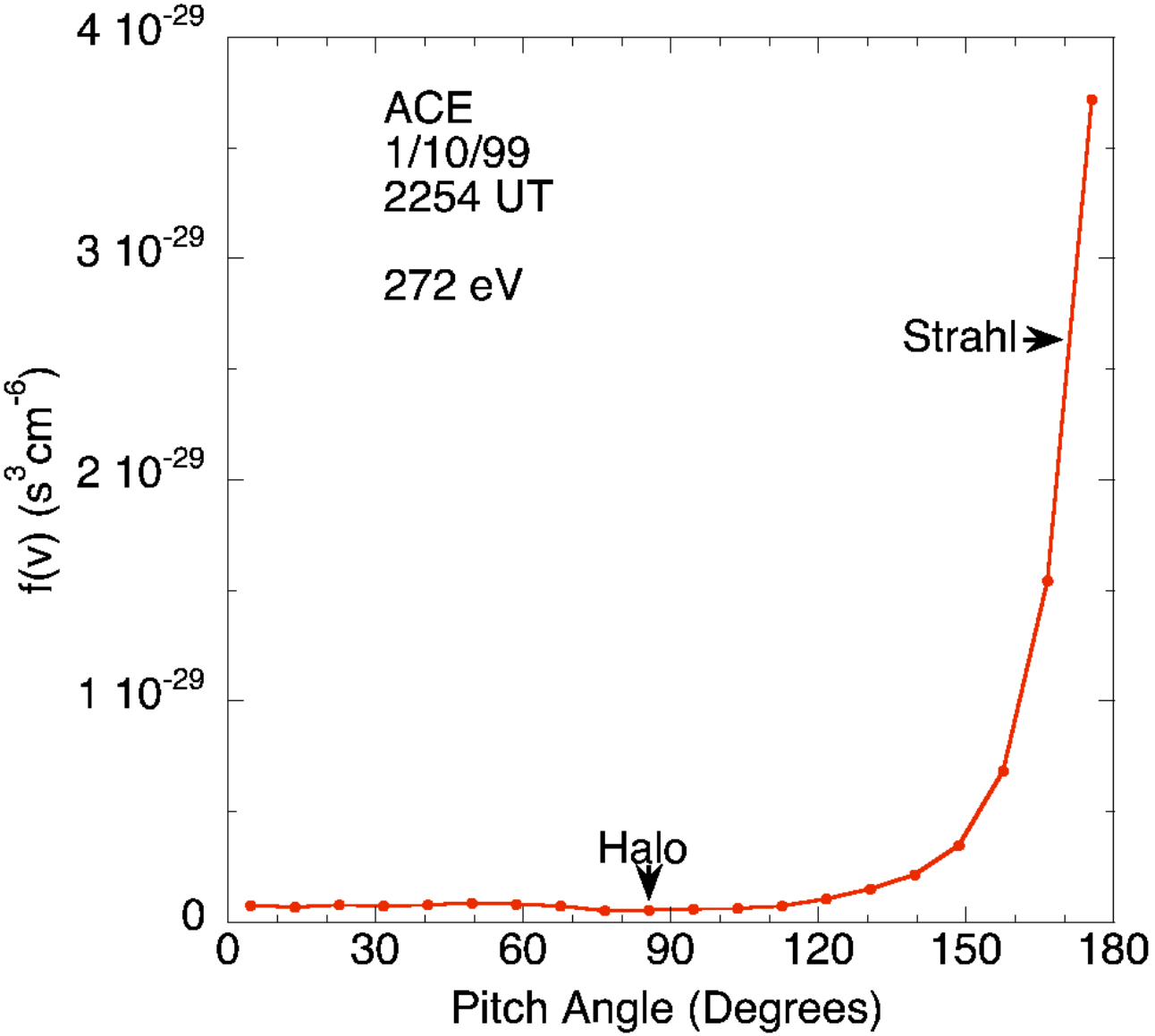


https://directory.eoportal.org/web/eoportal/satellite-missions/s/spp#vOpZN12f8Herb



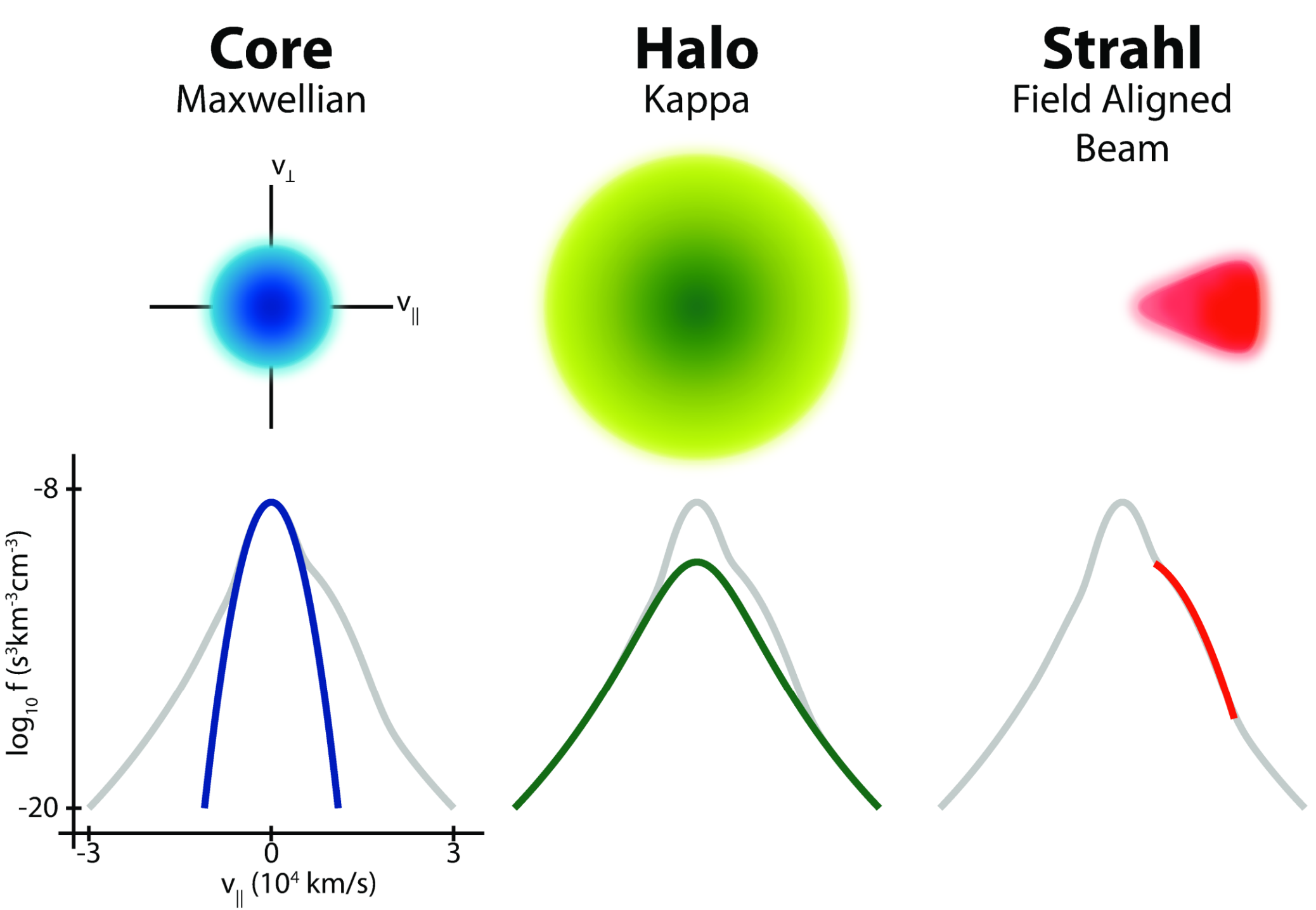
Measurements of electron energy distributions in the solar wind reveal the presence of both thermal and suprathermal populations.

"The Solar Wind" by J. T. Gosling, 2009



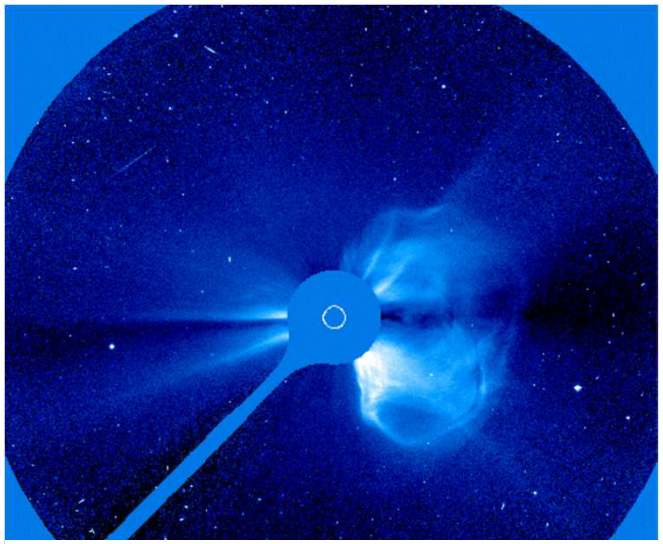
The suprathermal population is nearly collisionless, carries the solar wind heat flux, and includes both a field-aligned "strahl" (or beam) and a roughly isotropic "halo".

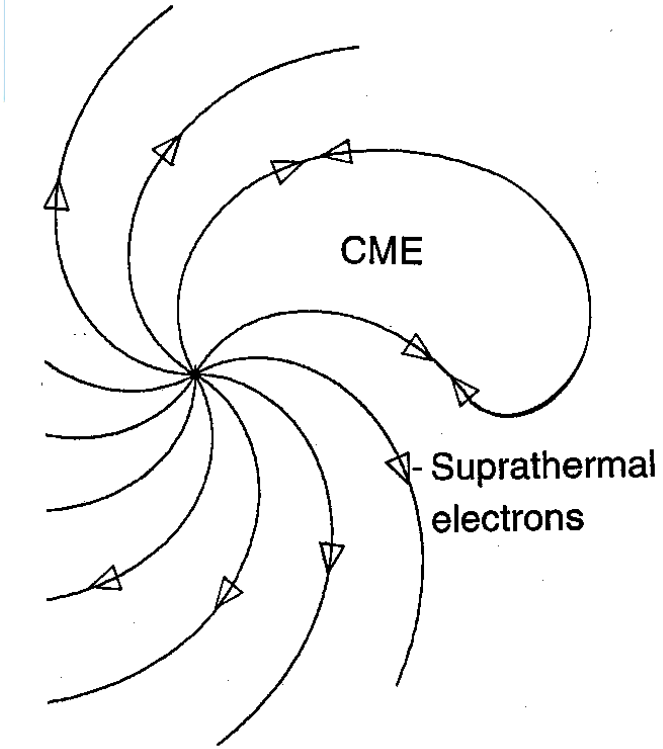
"The Solar Wind" by J. T. Gosling, 2009

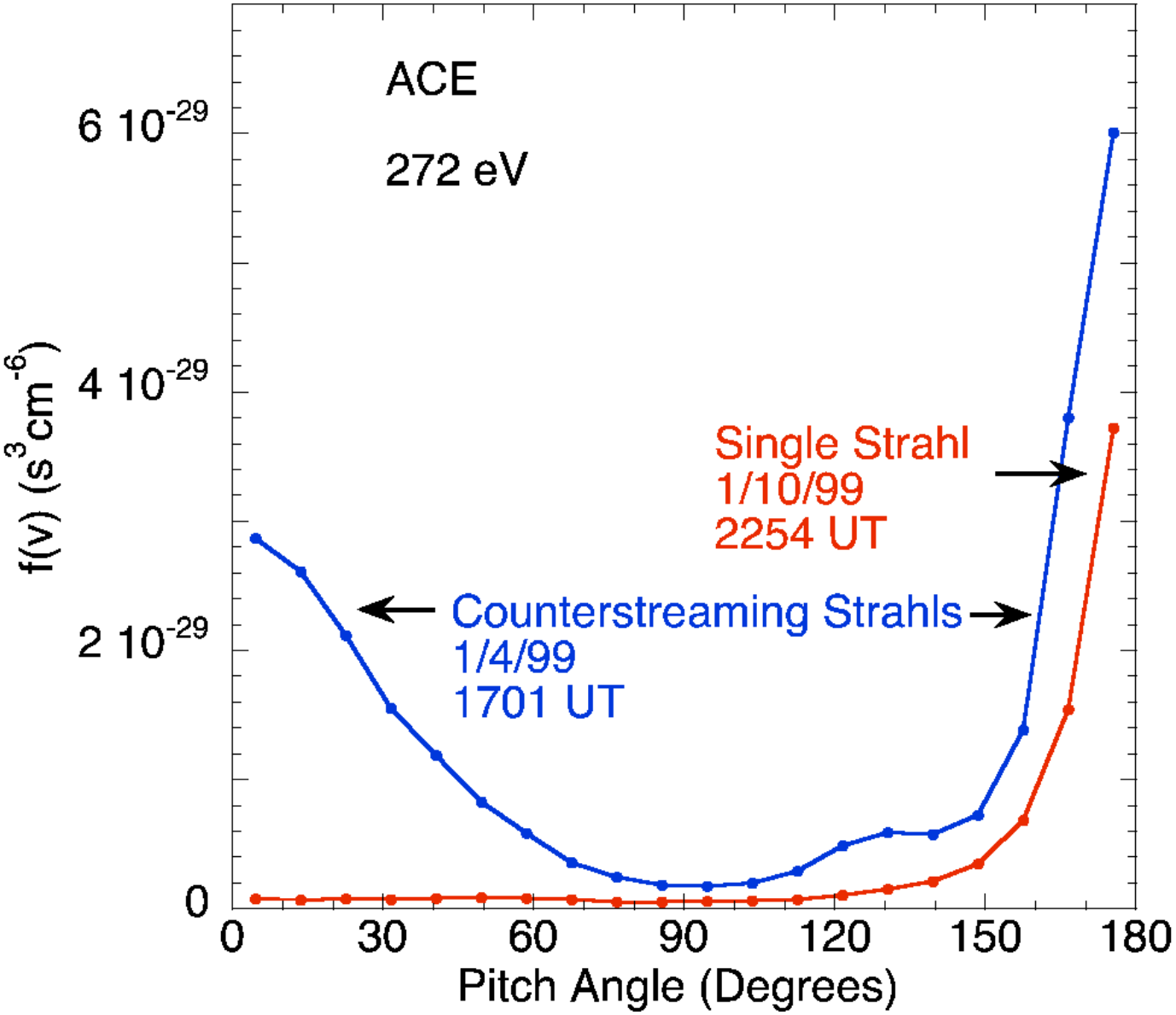


http://sprg.ssl.berkeley.edu/~pulupa/illustrations/electrons/elects.png

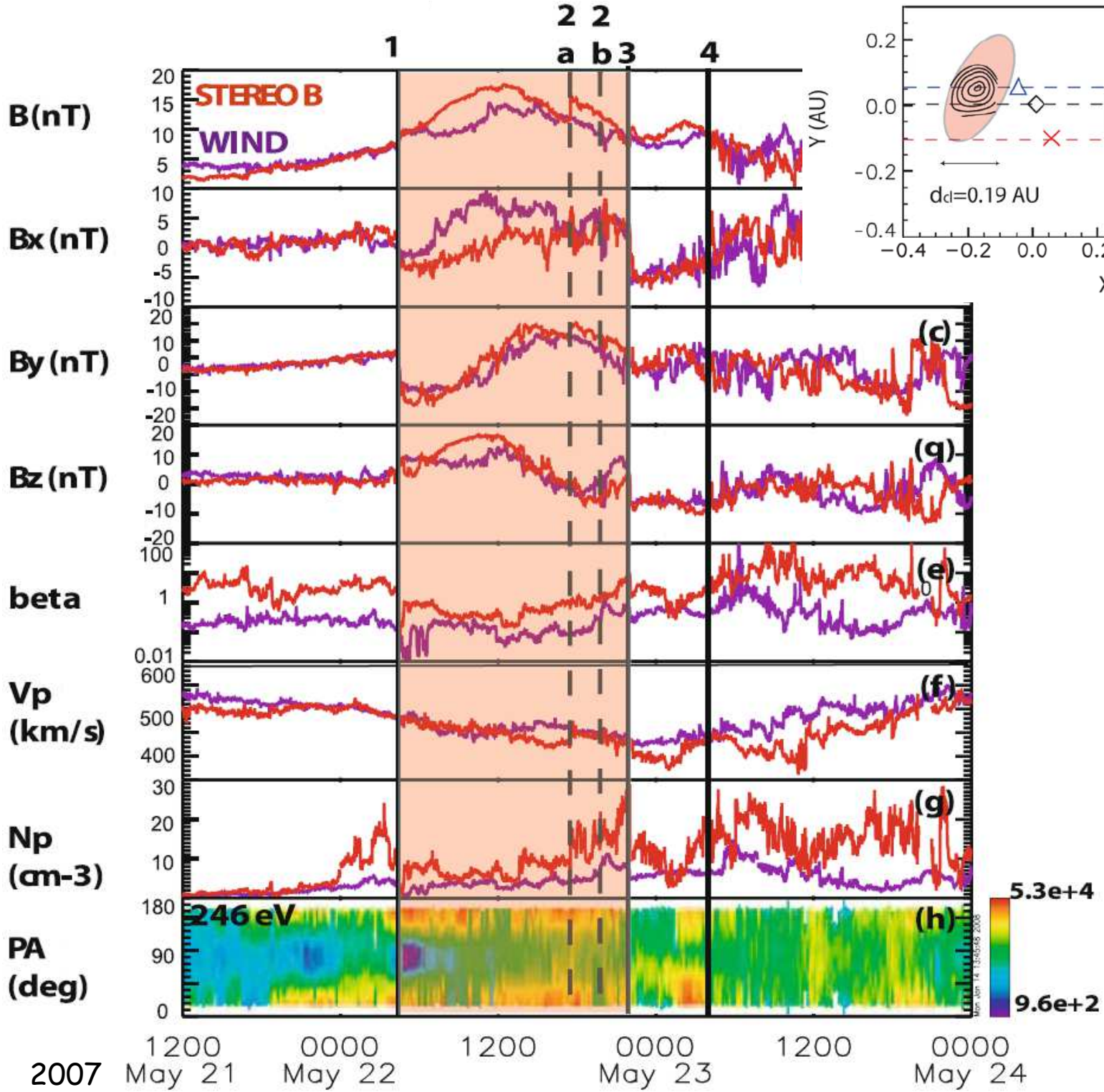
Counterstreaming Suprathermal Electrons as Tracers of Closed Magnetic Field Lines in CMEs



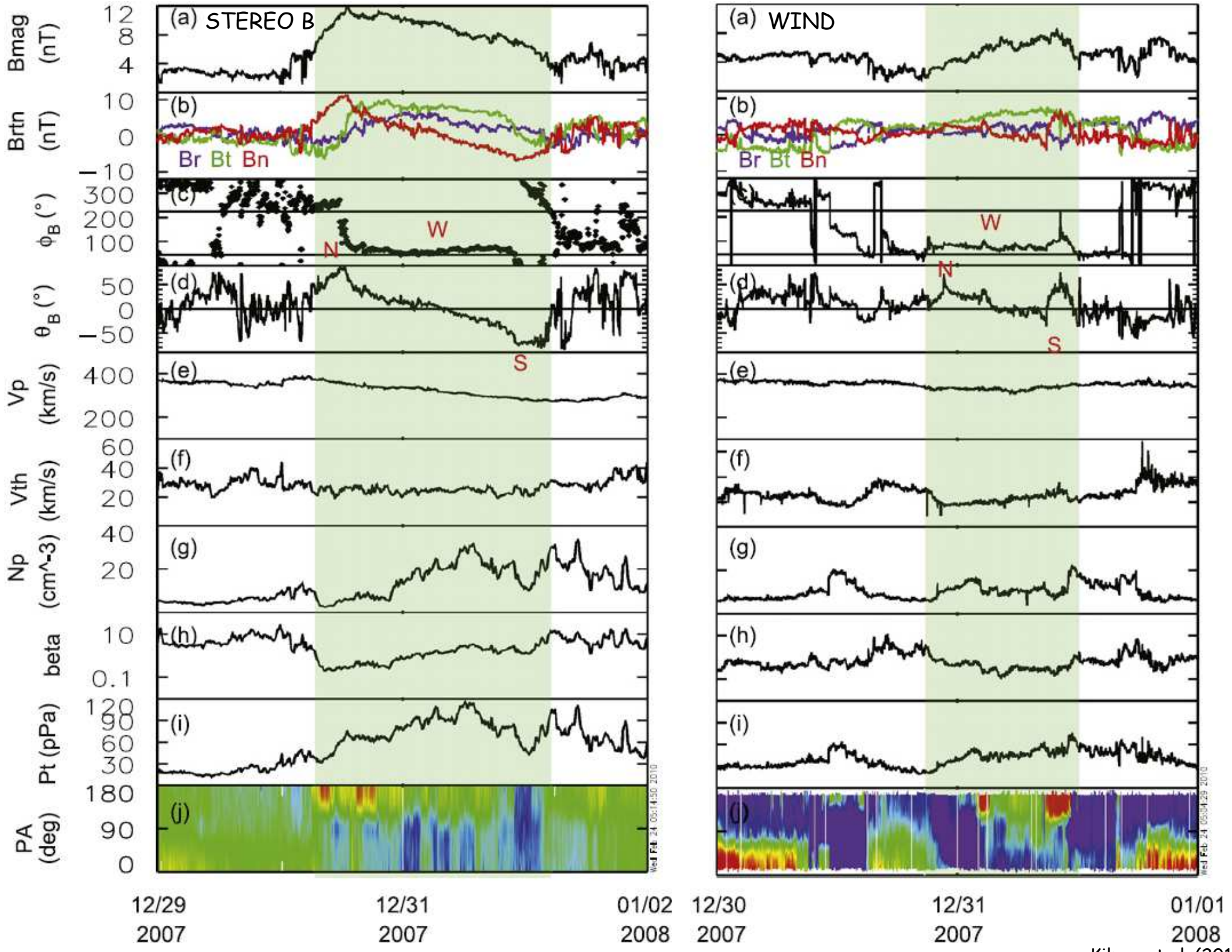




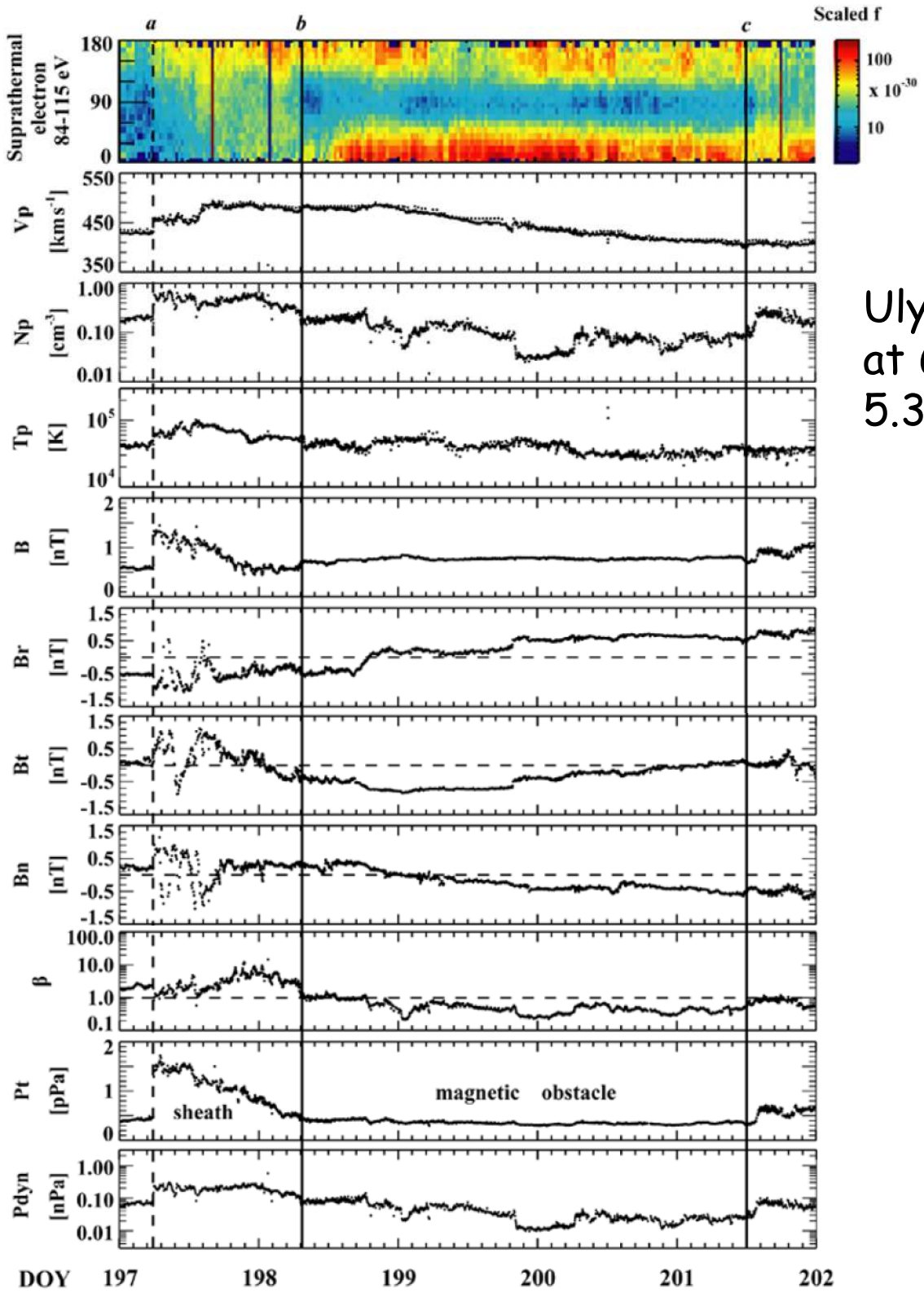
"The Solar Wind" by J. T. Gosling, 2009



Kilpua et al. (2009)



Kilpua et al. (2011)



Ulysses observation of an ICME at 6.8°S in SE coordinates at 5.32 AU in 1992 July 15-20.

Jian et al. (2008)