

## Solar wind suprathermal electrons

L. Wang

Institute of Space Physics and Applied Technology, Peking University, Beijing, China

The solar wind electrons observed near 1 AU consist of three components: a thermal ( $\sim 10$  eV) Maxwellian core, a much hotter ( $\sim 50$ – $80$  eV) halo/strahl, and a power-law superhalo at energies above  $\sim 2$  keV. Solar wind suprathermal particles carry important information on the common particle acceleration/transport processes at the Sun and in the IPM. We present a statistical survey of solar wind suprathermal electrons measured at  $\sim 0.1$ – $200$  keV by the WIND 3DP instrument at 1 AU during quiet times in solar cycles 23 and 24. All the strahl, halo and superhalo electron populations show no obvious correlation with the solar wind core population.

The halo electron population has an isotropic angular distribution, while the strahl population, predominantly observed in fast solar wind, is antisunward beaming along the interplanetary magnetic field. The observed energy spectrum of both strahl and halo electrons at  $\sim 0.1$ – $1.5$  keV generally fits to a Kappa distribution function, with an index  $\kappa$  and effective temperature  $T_{eff}$ . We find a strong positive correlation between  $\kappa$  and  $T_{eff}$  for both strahl and halo electrons and a strong positive correlation between the strahl density and halo density, likely reflecting the nature of the generation of these electron populations. In both solar cycles,  $\kappa$  is larger at solar minimum than at solar maximum for both strahl and halo electrons, while the halo  $\kappa$  is generally smaller than the strahl  $\kappa$ .

For the superhalo electron population at quiet times, the observed pitch-angle distribution is generally isotropic, and the observed omnidirectional differential flux generally fits to a power-law function,  $J \sim E^{-\beta}$ . The spectral index  $\beta$  ranges from  $\sim 1.6$  to  $\sim 3.7$ , with a broad maximum between 2.4 and 2.8 (2.0 and 2.4) in solar cycle 23 (24). Both  $\beta$  and the integrated superhalo density show no obvious correlation with the sunspot number, solar flares, CMEs, etc.

These results suggest that solar wind suprathermal electrons have a different origin from the solar wind core: the strahl could originate from the Sun, e.g., due to the escaping electrons from the hot corona, to form a strong positive correlation between  $\kappa$  and  $T_{eff}$ ; the halo may be due to some processes (including scattering and/or further acceleration) acting on the strahl in the IPM; the superhalo may originate from nonthermal processes related to the acceleration of the solar wind or could be formed in the IPM due to further acceleration and/or long-distance propagation effects.

- [1] L. Wang, et al., ApJ **753**, L23 (2012).
- [2] L. Wang, et al., ApJ **803**, L2 (2015).
- [3] L. Yang, L. Wang, et al., ApJ **811**, L8 (2015).
- [4] J. Tao, L. Wang, et al., ApJ **820**, 22 (2016).