THE EAS ENERGY SPECTRUM

AS A FUNCTION OF ENERGY-PER-NUCLEUS FROM AIR SHOWER MEASUREMENTS

By Particle Data Group 2017 phenomenological description

The Extensive Air Showers (EAS) flux energy spectrum approximation is constructed hereinafter on the basis of the EAS energy estimations available (the figure below) up to year 2017.

The data on the EAS flux dependence on the shower's energy E (energy-per-primary-nucleus) are approximated by a spectrum function of the piecewise-power form:

$$\text{Spectrum}_{\text{EAS}}(E) = J_{\text{EAS}} \cdot \text{f}_{\text{EAS}}(E); \qquad \int_{E_{\text{lb}}}^{E_{\text{ub}}} \text{f}_{\text{EAS}}(E)\, dE = 1;$$

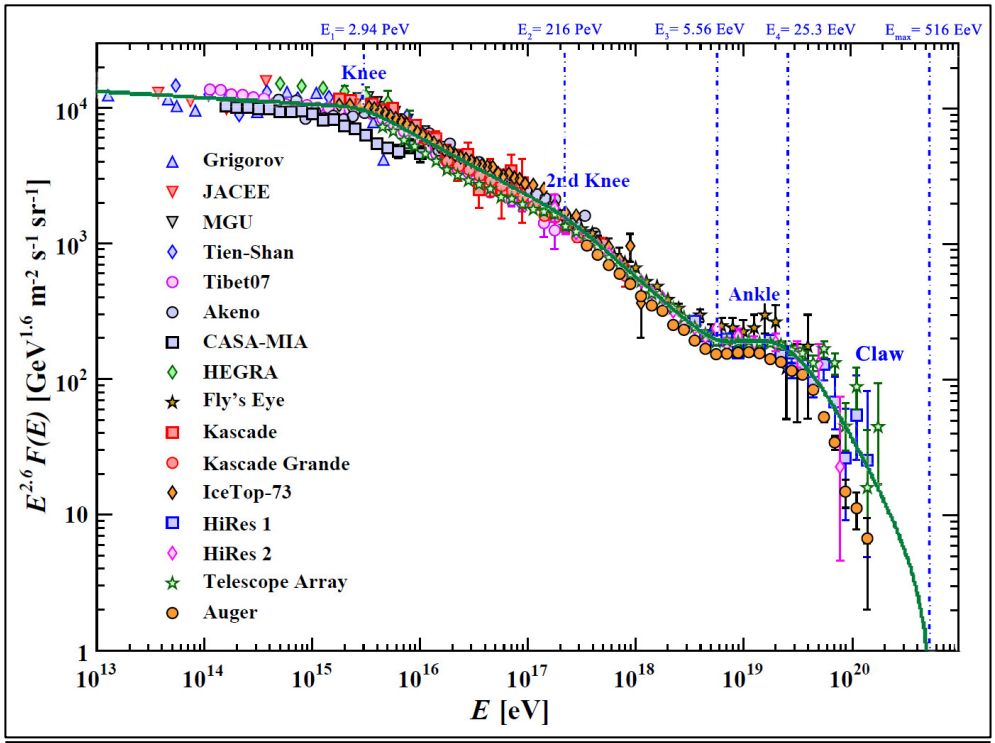
$$\text{f}_{\text{EAS}}(E) = \frac{1}{E^*} \cdot \left(\frac{E}{E_{\text{lb}}}\right)^{-2} \cdot \left(\frac{E_{\text{lb}}}{E} - \frac{E_{\text{lb}}}{E_{\text{ub}}}\right)^{\gamma_0 - 1} \cdot \left(1 + \left(\frac{E}{E_1}\right)^{\nu_1}\right)^{\frac{\gamma_0 - \gamma_1}{\nu_1}} \cdot \left(1 + \left(\frac{E}{E_2}\right)^{\nu_2}\right)^{\frac{\gamma_1 - \gamma_2}{\nu_2}} \cdot \left(1 + \left(\frac{E}{E_3}\right)^{\nu_3}\right)^{\frac{\gamma_2 - \gamma_3}{\nu_3}} \cdot \left(1 + \left(\frac{E}{E_4}\right)^{\nu_4}\right)^{\frac{\gamma_3 - \gamma_4}{\nu_4}}$$

Here:

- factor J_{EAS} – is the total flux of the EAS-s with the energies above E_{lb};
- factor E^* – is the normalization energy of the probability density function $\text{f}_{\text{EAS}}(E)$.
- energy E_{lb} – is the *conditional* **l**ower **b**ound of the EAS energies;
- energy E_{ub} – is the **u**pper **b**ound of the *observable* EAS energies;
- energies E_1, E_2, E_3, E_4 – are the inflection positions of the energy spectrum;
- spectrum powers' exponents at five intervals of energy are $\gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4$;
- parameters $\nu_1, \nu_2, \nu_3, \nu_4$ describe the inflections' form;

The next values are estimated in accordance with the 2017 y. data on the EAS energies:

$J_{\text{EAS}} = 0.140\ (m^2 \cdot sec \cdot sr)^{-1}$; $E^* = 607\,GeV$;					
$E_{\text{lb}} = 1.0\,TeV$	$E_1 = 2.94\,PeV$	$E_2 = 216\,PeV$	$E_3 = 5.56\,EeV$	$E_4 = 25.3\,EeV$	$E_{\text{ub}} = 516\,EeV$
$\gamma_0 = 1.65$	$\gamma_1 = 2.03$ $\nu_1 = 5.18$	$\gamma_2 = 2.29$ $\nu_2 = 4.97$	$\gamma_3 = 1.31$ $\nu_3 = 4.38$	$\gamma_4 = 2.95$ $\nu_4 = 2.51$	



The EAS energy spectrum is shown as a function of energy-per-nucleus from air shower measurements. Every flux value is multiplied by the correspondent energy in the power 2.6. The green line represents the spectrum function defined above.