GIL: A FORMULA FOR EAS LONGITUDINAL PROFILES

John Linsley
Dept of Physics and Astronomy, Univ of New Mexico
jlinsley@astro.phys.unm.edu, and
Istituto di Fisica Cosmic ed Applicazioni dell'Informatica del CNR, Palermo, Italy ;
linsley@pa.cnr.it

GIL stands for Greisen Il'ina Linsley. It is an analytical formula with an obvious resemblance to a formula by Greisen that is well-known: Greisen's formula for average profiles of EAS due to given-energy gamma rays. GIL is not only simple mathematically, also it has the advantage of being phenomenological and model-independent: The quantity it returns is the shower size $N(E_o,A,t)$, where E_o and A are the energy and mass number of the primary particle, and t is the atmospheric depth in units of the radiation length. GIL resembles the Greisen formula by employing the shower age, s, as an intermediate variable; in GIL, however the role of hadronic cascades in nucleus-EAS is expressed by an altered relation between s and t. The property is retained, that the shower size is maximum for s=1. Values of two GIL parameters are chosen to express the elongation-energy relation; i.e, the slope of the semilogarithmic dependence of t_{max} (and x_{max}) on primary energy, and the intercept for A=1. The dependence of average size on the primary mass number relies on validity of the superposition principle for average cascades. An important parameter is E_1, defined by $N_{max} = E_o/E_1$. This is compatible with energy conservation (the condition, track-length integral=electromagnetic energy E_{EM}) because some fraction of the initial energy is given to muons, neutrinos, and low-energy hadrons. An inconvenience of GIL is that some properties; i.e, E_{EM}, the average t, and the profile width s_t, must be found by numerical integration rather than from closed-form expressions. But modern hand-held calculators can easily be programmed to provide, when needed, those less often used quantities.