THE IONIZATION INTEGRAL IS PREFERABLE TO THE TRACK-LENGTH INTEGRAL FOR ANALYSIS OF EAS AIR FLUORESCENCE

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The ionization integral is just the total number of ions resulting from an EAS, integrated over the affected space and over the time required for secondary electrons to have their effect. Multiplied by 35 eV, the experimentqlly determined energy required for producing an ion pair, the total electromagnetic energy of the primary particle (the original energy minus energy given to neutrinos and energy dissipated underground by high energy muons. Because atmospheric fluorescence is an after-effect of ionization, the ionization integral is precisely the correct intermediate quantity for relating the number of fluorescent photons collected in a given EAS event and the electromagnetic energy. The track-length integral yields the electromagnetic energy much less directly and with correspondingly greater uncertainty. After all, the tracks of EAS particles in the atmosphere are not observed. If they could be observed it would be seen that roughly half of the ions result from electrons with such low energy that their paths are far from straight. Important steps in the conversion of primary energy to ions are practically impossible to calculate by Montecarlo methods, even with the most elaborate codes run on the largest computers. Of course, the expression above for the electromagnetic energy must be divided by the fluorescence efficiency; i.e, the number of photons with suitable wavelengths per unit deposited energy. The efficiency depends strongly on the air density (and somewhat on the air temperature), so a necessary first step is to reconstruct the EAS trajectory. In the ideal case of observation from above, using a satellite, the signal increments from successive horizontal laters of air can be given proper weights by means of an atmosphere model for the time and place of the observation. This is not the place to go into many important problems about signal attenuation, or about subtraction of unwanted light from the Cerenkov effect, or about extrapolation to allow for EAS energy dissipated in the earth crust. I only point out that in an idealized situation where all of the energy has a chance to contribute, and all required corrections have been made, the total electromagnetic energy can be written as simply a sum over the layers of atmosphere, without any fitting of observed points with a gamma pdf or other profile formula.