

Xmax Uncertainty from Extrapolation of Cosmic Ray Air Shower Parameters.

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Recent measurements at the LHC of the p-p total cross section have reduced the uncertainty in simulations of cosmic ray air showers, in particular of the depth of shower maximum. However, there is a remaining uncertainty due to the total cross section, multiplicity, and elasticity. Uncertainties due to extrapolations from accelerator data in the p-p center of mass, to 250 TeV (3×10^{19} eV in a cosmic ray proton's lab frame) introduce significant uncertainties in predictions of the depth of shower maximum. In this paper we estimate a lower limit on these uncertainties. At the full energy of the LHC, which is equivalent to $\sim 1 \times 10^{17}$ eV in the cosmic ray lab frame, our calculation of the extrapolation is less than the difference among the models. On the other hand, at 3×10^{19} eV in the cosmic ray lab frame, our calculation of the uncertainty in Xmax is approximately equal to the difference among the modern models being used in the field.

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