Leading nucleon and the proton-nucleus Inelasticity

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Abstract

We present in this paper, a calculation of average proton-nucleus inelasticity. Using an iteractive leading particle model and the Glauber model, we relate the leading particle distribution in nucleon-nucleus iteractions with the respective one in nucleon-proton collisions. To describe the leading particle distribution in nucleon-proton, we use the Regge-Mueller formalism.

We calculate the average proton-nucleus inelasticity. Using an Iterative Leading Particle Model (Frichter et al., 1997) and the Glauber model (Glauber, 1959; Glauber et al., 1970), we relate the leading particle distribution in nucleon-nucleus interactions with the respective one in nucleon-proton collisions. In this model the leading particle spectrum in $p + A \rightarrow N$(nucleon)$+X$ collisions is built from sucessive interacions with ν interacting proton of the nucleus A and the behaviour is controlled by a straightforward convolution equation. It should be mentioned that, strictlly speaking, the convolution should be 3-dimensional. Here we only considered the 1-dimension approximation. In a recent paper (Bellandi et al., 1999) we have used this model to describe the hadronic flux in the atmosphere, showing that the average nucleon-nucleus elasticity, $< x >_{N-A}$, is correlated whit the respective average nucleon-proton elasticity, $< x^{\gamma} >_{N-p}$, by means of the following relation

$$(1- < x >_{N-A}) = \frac{1}{\sigma_{in}^{N-ar}} \int d^2b \, [1 - \exp[-(1- < x >_{N-p})\sigma_{tot}^{pp} T(b)]] \quad (1)$$

where $T(b)$ is the nuclear thickness and given by means of the Woods-Saxon model (Woods, & Saxon, 1954; Barrett, & Jackson, 1977). Introducting the inelasticity given by $< k >= 1- < x >$, this expression can be transformed in

$$< k >_{N-A}= \frac{1}{\sigma_{in}^{N-A}} \int d^2b \, [1 - \exp[- < k >_{N-p} \sigma_{tot}^{pp} T(b)]] \, . \quad (2)$$

It is clear from this relationship that only in small σ_{tot}^{pp} limit is $< K >_{N-A} \simeq < K >_N$. In general, $< K >_{N-A} \geq < K >_N$ and the effect increasing with the increase of σ_{tot}^{pp}. If $< K >_N \rightarrow 0$, one also has $< K >_{N-A} \rightarrow 0$. On the other hand, if $< K >_N = 1$, then $< K >_{N-A} = 1$, and Eq. (2) reproduces the Glauber model relationship between σ_{in}^{N-A} and σ_{tot}^{pp}. In order to calculate $< K >_{N-A}$ we use for $< K >_N$ the values calculated by means of the Regge-Mueller formalism (Batista et al., 1998) and as input for σ_{tot}^{pp} we have used the UA4/2 parametrizations for the energy dependence (Burnett et al., 1992). In the Fig. (1) we show the results of this calculations for the following nuclei: C, Al, Cu, Ag, Pb and air ($A = 14.5$). In this figure we also show recent experimental data for p-Pb, $< K >= 0.84 \pm 016$ (Barroso et al., 1997) and for p-C, $< K >= 0.65 \pm 0.08$ (Wilk & Wlodarczyk, 1999).

In the Fig. (2), we compare the calculated $< K >_{p-air}$ with results from some models used in Monte Carlo simulation (Gaisser et al., 1993); the Kopeliovich *et al.* (Kopeliovich et al., 1989) (KNP) QCD multiple Pomeron exchanges model; the Dual Parton model with sea-quark interaction of Capella *et al.* (Capella et al., 1981); the statistical model of Fowler *et al.* (Fowler et al., 1987) and with calculated values derived from cosmic ray data by Bellandi *et al.* (Bellandi et al., 1998). We note that the calculated $< K >_{p-air}$ (Bellandi et al., 1998) was done assuming for the $T(b)$ nuclear thickness the Durand and Pi model (Durand & Pi, 1988), which gives small values for the average inelasticity. In the Fig. (2) we also show the average inelasticity values as calculated by means of this model.

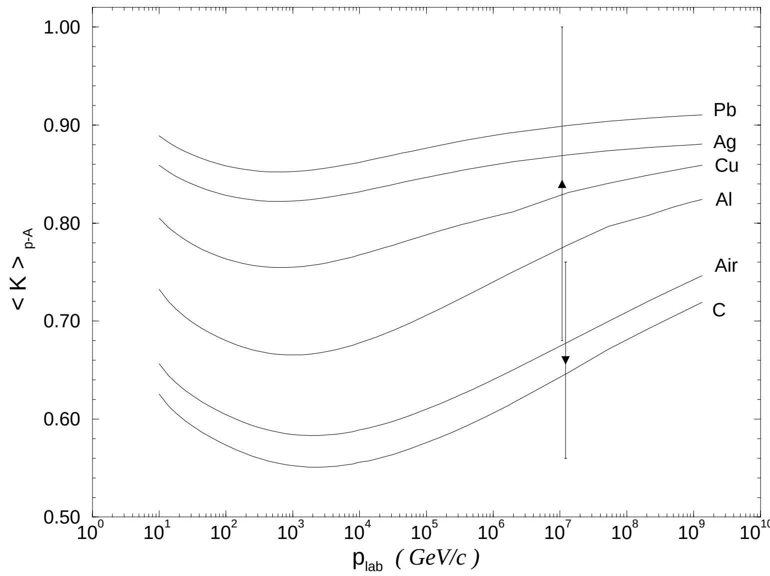

Figure 1: Proton-nucleus inelasticities calculated. The up triangle is Pb data (Barroso et al., 1997) and down triangle is C data (Wilk & Wlodarczyk, 1999) .

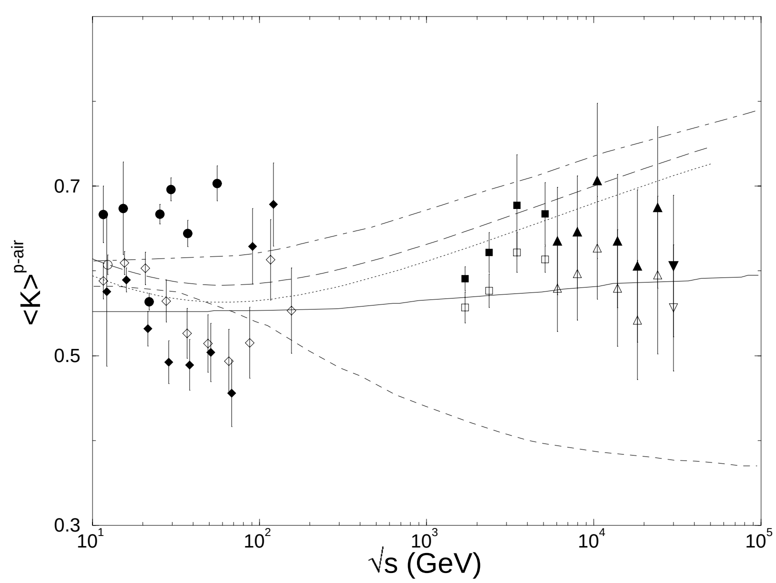

Figure 2: The $< K >^{p-air}$ as a function of $\sqrt{s}$ in GeV. The experimental data from (Bellandi et al., 1998). Dash line from (Fowler et al., 1985). Solid line from (Capella et al., 1981). Dot-dash line from (Kopeliovich et al., 1989). Dot line from Eq. (2) with Woods-Saxon model (Woods & Saxon, 1954; Barrett, & Jackson, 1977). Long-dash line from Durand-Pi model (Durand & Pi, 1988).

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