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ISSN 1340-374[illegible]

ICRR

ICRR-Report-390-97-13

Contribution to 25th ICRC (Durban, 28 Jul -8 Aug, 1997) by CHACALTAYA Cosmic-Ray Collaboration

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(July, 1997)

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Content

INELASTICITY DISTRIBUTION OF HADRON-PB COLLISIONS, ESTIMATED BY THICK LEAD EMULSION CHAMBERS AT THE PAMIRS

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ABSTRACT

The inelasticity distribution of hadron-lead collisions in the energy region exceeding 10^{14} eV is estimated by 74 events of hadron interaction, observed by thick lead chambers at the Pamirs. Approximately distribution as a flat g(K)dK = dK and g(K)dK = a(1-K)^n + b K^n dK (with n=a+b-1, a = -0.25 ± 0.50 and b = 3.1 ± 1.7) were adopted. Through this second distribution we got the mean inelasticity < K > = 0.83 ± 0.17, consistent with < K > = 0.82, obtained by one of us (M.Tamada), by a simulation calculation made under the assumptions of geometrical model for intra-nuclear cascade and of UA5 algorithm, for hadron collisions. Hence, from that, it is inferred that the average value of hadron-nucleon collision inelasticity, in the energy region exceeding 10^{14} eV, is smaller than 0.5.

INTRODUCTION

From 1988 till 1991, 4 thick lead chambers (60 cm thickness, integrated area of 57 m^2) was exposed to Cosmic Radiation firing Pamir station (4,300 m, Tadjikistan). From 234 photosensitive layers of Russian made X-ray films, 74 successive interactions was sampled for the analysis of inelasticity distribution of hadron-Pb collisions.

Experimental data is presented in Figures 1 and 2, together with an analytical distribution as:

$$Z(z)dz = Cdz\int \delta(z-\frac{y_1K_1}{q})g(K_1)dK_1 g(K_2)dK_2 h(y_1)dy_1 h(y_2)dy_2 \frac{f(x)}{m+1}dx\gamma E_0^{-\gamma-1}dE_0 \qquad (1)$$

where a) C and m are normalization constants

b) the indices 1 and 2 refer to the first and successive collision, respectively

c) E_0 is the energy of the incident hadron

d) $\gamma = 1.8$ is the slope of ΣE_i spectrum of hadron energy spectrum

e) $y \equiv \Sigma E_{\pi^0} / \Sigma(E_{\pi^0} + E_{\pi+} + E_{\pi-})$ and h(y) = 1/2c (with c = 1/3) is their uniform distribution, between y = 0 and y = 2c, as that < y > = c

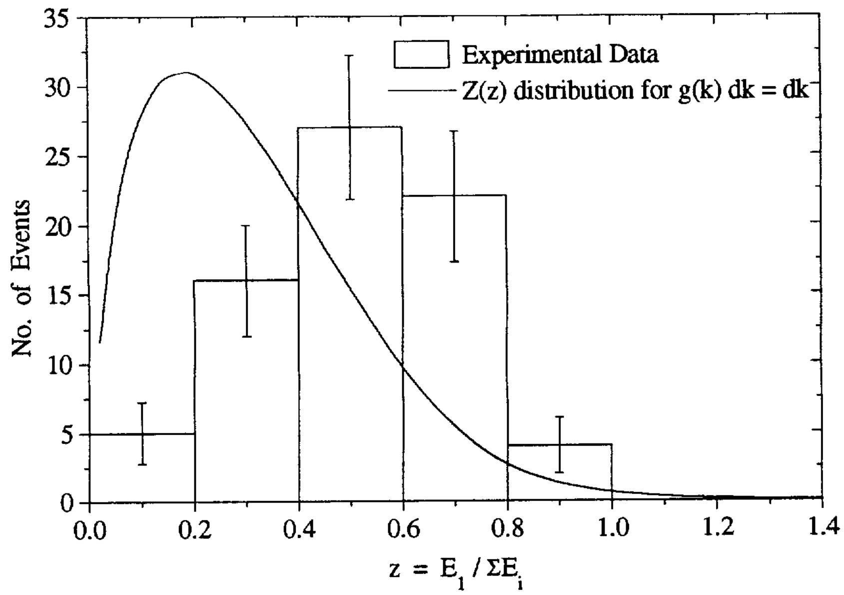

Fig. 1. Analytical-fitted and experimental data for Z(z) using g(k) dk = dk.

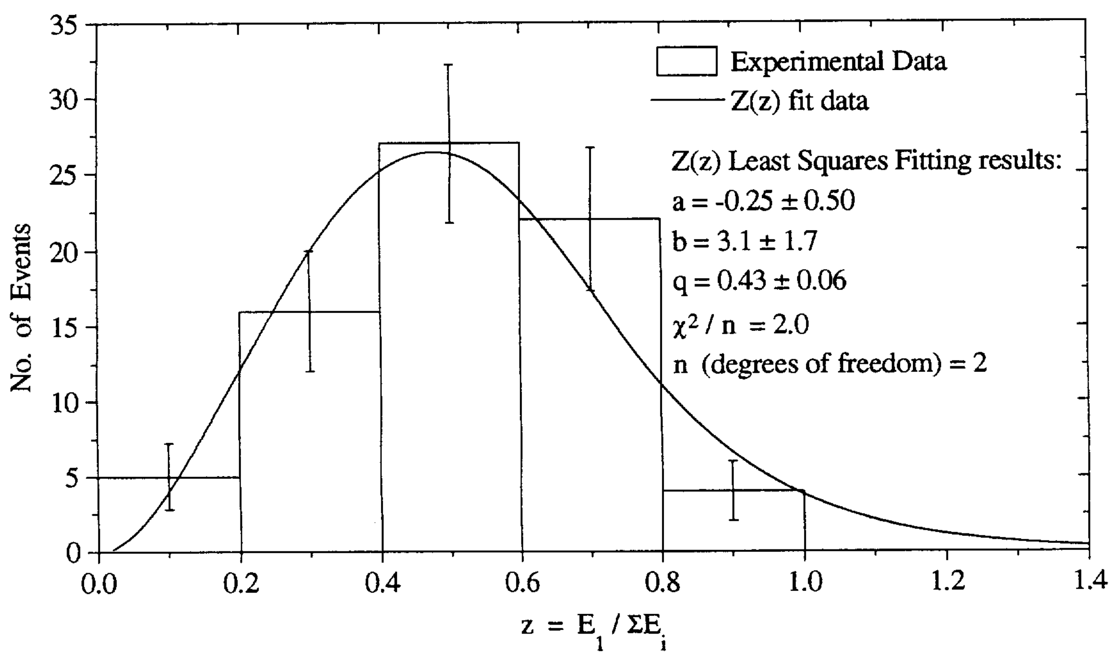

Fig. 2. Analytical-fitted and experimental data for Z(z) using $g(k)\,dk = a(1-K)^{a+b-1} + bK^{a+b-1}dK$

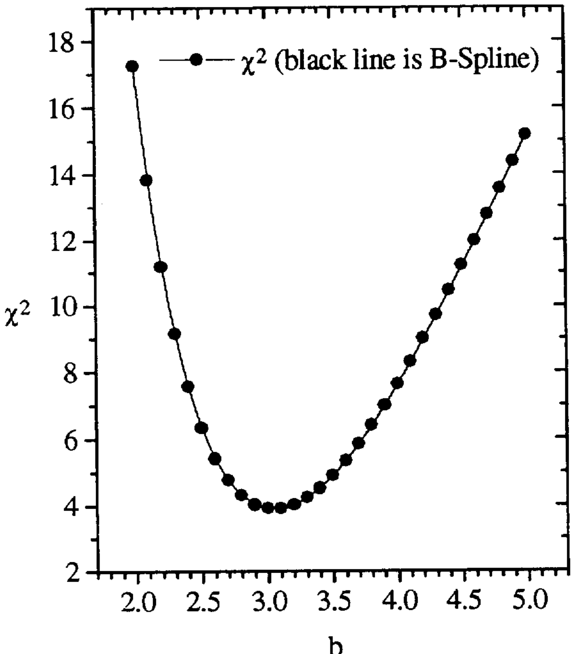

Fig. 3. χ^2 *x b correlation plot.*

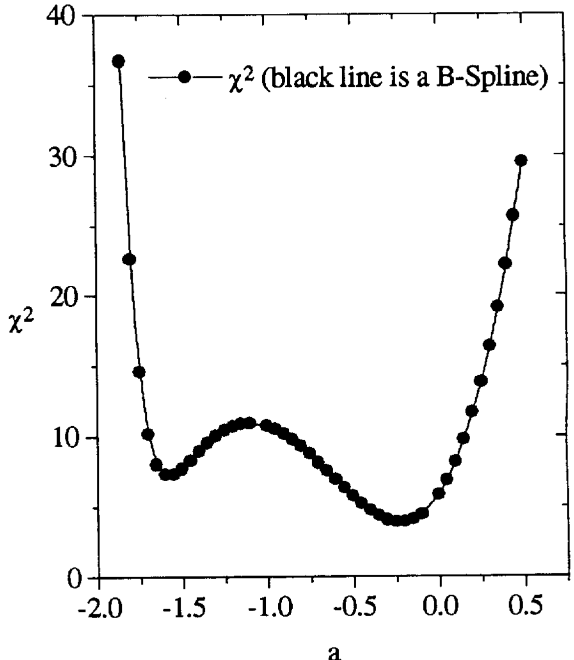

Fig. 4. χ^2 *x a correlation plot.*

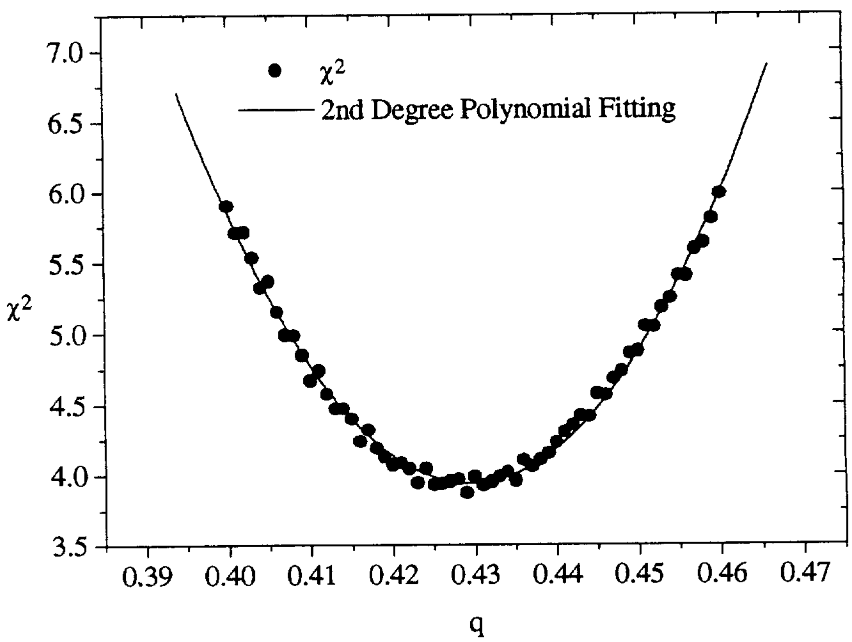

Fig. 5. χ^2 *x q correlation plot.*

g) $f(x) = \delta(x - (1-K) + K(1-y)[1/B(\varepsilon+1, 5)][(1-x)^4/x^{1-\varepsilon}]$ is the energy spectrum of charged pions with the inclusion of surviving hadron. From the data at $E_0=10^{14}$ eV we have $<m>\approx 30$ and $\varepsilon = 5.62 \times 10^{-2}$ using $< m > = (\varepsilon + 5)/3\varepsilon$. $B(\alpha,\beta)$ is a Beta function

f) $z \equiv E_1/\Sigma E_i$

h) $q = \Sigma E_i / E_0$ and $q = 0.43 \pm 0.06$

i) K is the inelasticity defined as $K \equiv \Sigma E_p / E_0 = 1 - E_s / E_0$ (E_p = energy of produced particle, E_s = energy of hadron after the collision) and $g(K)dK$ is the inelasticity distribution. We used two distribution forms of inelasticity:

i1) $g(K)dK = dK$

i2) $g(K)\,dK = a(1-K)^{a+b-1} + bK^{a+b-1}\,dK$

Clearly the flat distribution g(K) dK = dK (Figure 1) doesn't match with experimental data and we concerned on a better determination of the parameters q, a, b, these last two from the other distribution of inelasticity. In Figures 3, 4 and 5 are shown a "reduced χ^2" correlation with those parameters. Best fitting and error analysis, using CERN-MINUIT, "Function Minimization and Error Analysis" program yields the results $q = 0.43 \pm 0.06$, $a = -0.25 \pm 0.50$ and $b = 3.1 \pm 1.7$, with 99% confidence interval.

DISCUSSIONS

Figure 2 shows experimental data and an analytical curve with the before mentioned parameters values, obtained through least squares fitting. We obtained reasonable agreement between data and the fitted curve. From this curve we got mean inelasticity of hadron-lead collisions, $< K > = 0.83 \pm 0.17$, value consistent with $< K > = 0.82$ obtained by one of us (M.Tamada). This was calculated through simulation, with the assumptions of geometrical model for intra-nuclear cascade and UA5 algorithm for hadron collision .

In a near future we are going to derive the distribution Z(z)dz, using another energy spectrum of charged pions, to see how it changes with the adopted f(x).

ACKNOWLEDGMENTS

The authors would like to thank Pamir Collaboration and Moscow State University group for free use of data. They also express their gratitude to Prof.Y.Hama and to Prof.T.Kodama for their valuable discussions and comments. One of the authors (V.K.), would like to thank Prof.S.Hasegawa for this long term great support throughout the joint experimental work. Also we are grateful to the Brazilian agencies, FAPESP and CAPES for the financial support to (Y.F., V.K., A.O., E.H.S.) and S.L.C.B., respectively.