A Calculation of Mean Normalized Multiplicity For Hadron-Hadron Collisions

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Introduction

Last several decades, the main concern of High Energy Physics is the study of elementary particles. After developing the main knowledge of the properties of elementary particles and the laws governing their interactions, physicists can apply these to more complex system of elementary particles [1-3].On the basis of last few decades, one physicist finds that there has been a increasing realization that nuclear targets can give the conclusions of the space-time development of a story interaction process. Hence, it was thought that interactions of hadrons with nuclei may provide some information regarding fundamental particles and their collisions which can never be known using a simple carbon, Nitrogen and Oxygen (CNO) target.

Earlier Parameterization

An important aspect which distinguishes different models of multiparticle production in hadronic collisions is the dependence of the parameter mean normalized multiplicity (R_A) on the energy of the incident particle (E), and the mass number of the target nucleus (A_T). The parameter R_A, called mean normalized multiplicity, is defined as the ratio of the number of particle produced in hadron-nucleus collisions to the average number of such particles produced in hadron-hadron collisions at the same energy, i.e.

$$R_A = \frac{< n_s >_{hA}}{< n_{ch} >_{hh}}$$

Otterlund et al., have suggested that the ratio R_1,

$$R_1 = \frac{< n_s >_{hA}}{< n_{ch} >_{hh} - 0.5}$$

Babecki et al., has introduced that ratio R_2

$$R_2 = \frac{< n_s >_{cr}}{< n_{ch} >_{cr}} = \frac{< n_s >_{hA} - 1}{< n_{ch} >_{hh} - 2}$$

Aziz et al. have pointed out the ratio R_3

$$R_3 = \frac{< n_s >_{pA}}{< n_{ch} >_{pp}} = \frac{< n_s >_{hA} - 0.67}{< n_{ch} >_{hh} - 1.33}$$

H. Khushnood et al., suggested the dependence of the mean normalized multiplicity of created charged particles, R_4,

$$R_4 = \frac{< n_s >_{hA} - \alpha_A}{< n_{ch} >_{hh} - \alpha_H}$$

Different physicists gave the value of mean normalized multiplicity (R_A) by different formula such as R_1, R_2, R_3 and R_4.

Present Parameterization

In the recent study, an attempt has been made to compile the data regarding the multiplicities in hadron-hadron [3,4] and hadron-nucleus interactions in the energy of different range in GeV and with the help of these results it has been tried to establish the energy, mass number and number of nucleons dependence of multiplicities. An important parameter in this respect is the mean normalized multiplicity R_A, which has been thought to be a good measure of development of mutiparticle production. The present parameterization may be defined as

$$R_A = \frac{< n_s >_{hA}}{< n_{ch} >_{hh}} + 0.25$$

Where $< n_s >_{hA}$ the average number of particles is created in the collisions of hadron with the nucleus of mass number A at different range of centre of mass energy in GeV and $< n_{ch} >_{hh}$ is the mean charged multiplicity in the case of hadron-hadron collisions. In particular, an energy independent value of mean normalized multiplicity (R_A) may be taken as ruling out the possibilities of instantaneous production and to favour the particle production through intermediate stages. However, completely unambiguous separation is not possible with these facts in mind we proceed estimate the mean normalized multiplicity (R_A).

Leading particle effect i.e. the incident Hadron retains on an average half of its initial energy.

Table 1 Mean Normalized Multiplicity for hadron-nucleus collisions (Light Nuclei)

S. No	$\sqrt{s}$ in GeV	$<n_{ch}>_{hh}$	$<n_s>_{hA}$	R_A Cal.	R_A (Exp)
1	2	2.59	1.95	0.98	--
2	4.95	3.62	3.23	1.12	0.99 ± 0.12
3	10.25	4.81	5.03	1.24	1.15 ± 0.19
4	25	6.28	6.57	1.29	1.18 ± 0.25
5	50	7.58	7.79	1.24	1.24 ± 0.14
6	100	9.05	9.77	1.32	1.27 ± 0.34
7	150	10.29	10.72	1.31	1.22 ± 0.38
8	500	13.09	14.19	1.33	1.24 ± 1.2
9	1000	12.99	16.98	1.50	--
10	1500	13.59	17.86	1.65	1.31 ± 1.4

Table 2 Mean Normalized Multiplicity for hadron-nucleus collisions (Intermediate Nuclei)

S. No	$\sqrt{s}$ in GeV	$<n_{ch}>_{hh}$	$<n_s>_{hA}$	R_A Cal.	R_A (Exp)
1	2	2.59	1.95	1.08	--
2	4.95	3.62	3.23	1.28	1.15 ± 0.17
3	10.25	4.81	5.03	1.53	1.46 ± 0.15
4	25	6.28	6.57	1.59	1.71 ± 0.32
5	50	7.58	7.79	1.57	1.72 ± 0.11
6	100	9.05	9.77	1.63	1.99 ± 0.39
7	150	10.29	10.72	1.72	1.90 ± 0.31
8	500	13.09	14.19	1.89	2.18 ± 2.1
9	1000	12.99	16.98	1.99	--
10	1500	13.59	17.86	2.02	2.13 ± 1.4

Table 3 Mean Normalized Multiplicity for hadron-nucleus collisions (Heavy Nuclei)

S. No	$\sqrt{s}$ in GeV	$<n_{ch}>_{hh}$	$<n_s>_{hA}$	R_A Cal.	R_A (Exp)
1	2	2.59	1.95	1.37	--
2	4.95	3.62	3.23	1.57	--
3	10.25	4.81	5.03	1.68	
4	25	6.28	6.57	1.91	2.15 ± 0.39
5	50	7.58	7.79	1.94	2.30 ± 0.22
6	100	9.05	9.77	2.12	2.41 ± 0.29
7	150	10.29	10.72	2.07	2.10 ± 0.83
8	500	13.09	14.19	2.17	--
9	1000	12.99	16.98	2.37	--
10	1500	13.59	17.86	2.43	--

Fig 1 Variation of Mean Normalized Multiplicity for hadron-nucleus collisions (Light Nuclei)

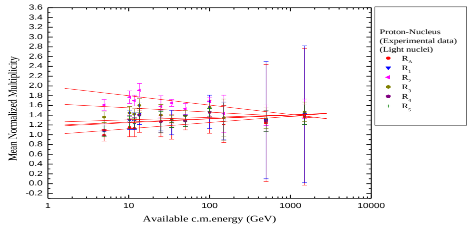


Fig 2 Variation of Mean Normalized Multiplicity for hadron-nucleus collisions (Inter. Nuclei)

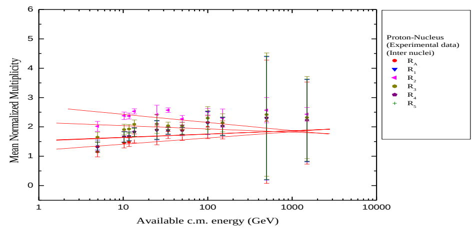
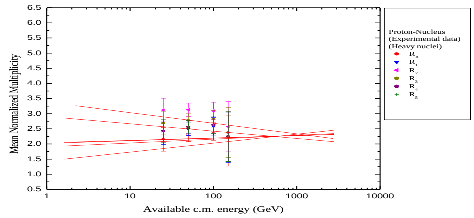


Fig.3 Variation of Mean Normalized Multiplicity for hadron-nucleus collisions (Heavy Nuclei)



Result

The results of the present parameterization are presented in the following Table.1, 2 & 3 and Figs. (1-3) and found to be unambiguous and applicable for the entire energy range. In the present work we conclude that the present parameterization of the mean normalized multiplicity with complex nuclei; minimize the limitations of earlier parameterization. Our approach can be applied to all the nuclei including light, intermediate and heavy nuclei over the entire energy range.

References

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