Neural Networking (N-N) Model in Relativistic Heavy Ion Collisions

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Introduction

The recent studies of relativistic heavy-ion collisions are of extensive scientific attention. This is for two reasons: First, they propose an exclusive testing ground for newly developed methods to study the behavior of strongly interacting quantum systems with finite particle number far from the ground state. Secondly, one hopes that the hot and dense nuclear matter can be extracted from the experimental data. This knowledge is essential for an understanding of the collapse of supernovae, for neutron-star stability, and for the onset of a possible phase transitions from hadron matter to the quark-gluon plasma (QGP).

In the world of technology where theory and experiment agreed completely and where there were no experimental acceptance cuts, the technique named neural network (N-N) model would be a perfect tool to determine some experimental observables and/or facts. In high energy physics, the neural network (N-N) model / technique is often used for identification of particles [1], reconstruction of particle tracks and classification of decays pattern [1] quite successfully. A brief detail of neural network model is mentioned in next section.

In this paper an attempt has been made to investigating some feature of non-thermal phase transitions during the relativistic heavy ion collisions. The collisions are occurred such as a beam of ^{28}Si (projectile) hits the heterogeneous mixture of nuclear emulsion (fixed target) @ energy 14.6A GeV and we have recorded 951 events / collisions. Thereafter for the final statistical study we made three different groups of data sets such as ^{28}Si+CNO, ^{28}Si+Emulsion and ^{28}Si+AgBr. The experiment results have been compared with neural network (N-N) model and found a good agreement between the theory and experiment of relativistic heavy ion collisions.

Neural Network (N-N) Model

Neural network (N-N) model is nothing but an approximate functional fitting to any experimental data. For this purpose, one wants to construct a mapping "M" between a set of observable quantities S_i (where i = 1, . . . , n) and category variable "N" by fitting "M" to a set of "Q" known "training" samples $\left(S_i^{(p)}, N_k^{(p)}, i = \cdots . n; k = 1 \ldots r\right) (p = 1 \ldots . Q, N_k \in N)$. Once the parameters in "M" are fixed, then it uses for parameterization to interpolate and find the category of "test" samples not included in the "training" set. A schematic diagram of N-N Model has been depicted in Fig. 1.

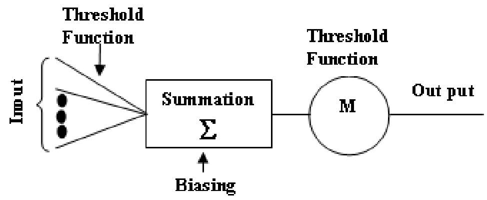

Fig. 1 A Schematic diagram of Neural Network (N-N) Model.

A typical multilayer neural network (N-N) programming model is also represented in Fig. 2. It consists of an input layer and an output layer with various numbers of nodes, so called neurons in each layers. In the present study we use the multilayer perceptron program developed in the MATLAb. Here, we have applied three inputs parameters: the lab momentum(P_L), the mass numbers of the projectile nuclei (A) and the average values of pseudo rapidity($<\eta>$). After the completion of computer programming we get one output parameter that is simulated values of the pseudo-rapidity (η) corresponding to the experimental data.

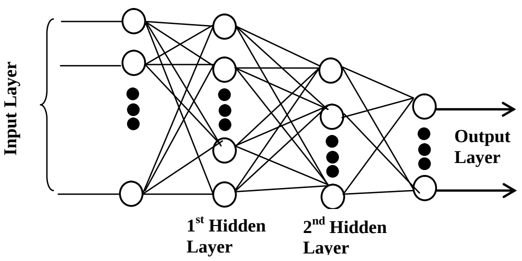

Fig. 2 A sketch of multilayer Neural Network (N-N) Model.

Results and Discussions

A complete mathematical description related to the present statistical analysis has been given in our recent paper accepted for final publications in the Urk. J. Phys. 2013[2]. From both type of Pseudo-rapidity (η) values (Exp. & simulated by N-N model), first we applied it to Scaled Factorial Moments (SFMs) for the intermittency. By doing this we get the values of intermittency index, α_q, which is the slope values of graphs plotted between the $\ln\langle F_q\rangle^{corr}$ Vs. lnM for all the data sets. These plots are also not mentioned here. With the knowledge of intermittency index, α_q, the possibility of detecting a non-thermal phase transition can be obtained by relation: $\lambda_q = (\alpha_q+1)/q$, where q is the order of SFMs (q = 2-6) .

It has been observed [2] that if the dynamics of intermittency is due to self-similar cascading, then there is a possibility of observing a non-thermal phase transition, which is believed to occur during the relativistic heavy ion collisions. The variation of λ_q as a function of q for all data sets along with the prediction of N-N model has been shown in Fig. 3(a-c). From the figure it may be noted that no clear-cut minimum value of λ_q for certain value of q has been observed in the present experimental work as it is reported by other workers. However, a weak intermittency effect has been found in ^{28}Si+AgBr & ^{28}Si+Em collisions (experimentally along with N-N model). To get more unambiguous evidence, the analysis should be done upto q = 8 with large statistics at high energies and with different projectiles.

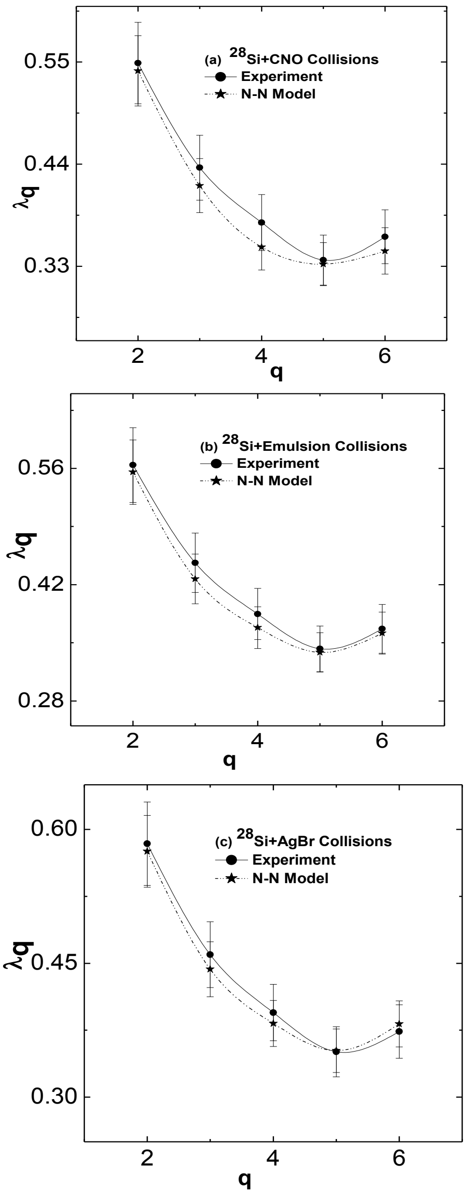

Fig. 3 (a-c) Variation of λ_q as a function of q for all data sets along with N-N model.

References

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