Symposium topic – multiparticle production

THE STUDY OF INITIAL CONDITIONS IN COLLISIONS OF LIGHT, INTERMEDIATE AND HEAVY NUCLEI

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0. Understanding of the initial and early stages of interactions is one of the key problems for heavy ion physics. The system size dependence for multihadron production processes in high energy nuclear interactions will be considered in the report.

1. In cosmic ray the collisions of light nuclei and protons with different targets have been studied in the previous FIAN–Fiz-Tech (Alma-Ata) "Stratosphere" experiment at TeV energies. The analysis of interactions shows that there is an essential difference in the dynamical multiplicity fluctuations for the events produced by protons and light nuclei. The patterns of the intermittency exponents φ(q), obtained from high order vertical (over events) analysis with rank up to 8, clear indicate two distinct regions of the q-behaviour. The additional analyses of the transverse momentum spectra of all γ-quanta in the soft region (up to 2 GeV/c) again demonstrated the large difference between proton/nuclei events. So, at cosmic ray energies the essential system size dependence in the production processes was obtained on the limited statistics [1].

2. The ever-increasing detailed approaches for development of the forward physics researches are suggested at present time. The precision inclusive PT-spectra for γ-quanta, neutral pions and neutrons [2, 3] have been studied at current Large Hadron Collider forward (LHCf) experiments. However, there are some different serious problems to compare directly the results of our exclusive cosmic ray data with current inclusive LHCf experiments [4]. The interactions of proton-proton, proton-Nitrogen, and Nitrogen-Nitrogen, Fe-Nitrogen, - as a future options, - will be analyzed in the new PHENIX-RHICf experiment [5]. The broadened data analyses will be performed in the new LHCf–ATLAS experiments, in which LHCf trigger will be used by ATLAS to study the whole interaction [6].

3. At accelerator energies the system size dependence for the initial stages of interactions has been investigated in the centrality selected collisions of light – (C, O, Ne) intermediate - (Si, S) and heavy – (Au, Pb) ions with heavy – (Ag/Br) and light – (C/N/O) nuclei on the data of JINR-AGS-SPS fixed target emulsion experiments. The new centrality selection solution has been suggested and realized, using correlations between multiplicity and sum of all charged, – light and heavy, - fragment-spectators [7]. It should be stressed that model of quantitative Glauber nuclear geometry for description of (near) right spherical nucleus collisions was not used. The overall analyses of distributions for multiplicities, fast proton-spectators, alpha-particle-spectators and heavy mass fragment-spectators have shown that there is a clear trend to the enhancement of fluctuations in initial conditions with system size decreasing [8].

The comparative analyses of the "most central" and "peripheral" collisions in the light-light - (C, O, Ne)+(C/N/O), intermediate-light - (Si, S)+(C/N/O) and heavy-heavy - (Au, Pb)+(Ag/Br) interactions open the way to the better understanding of the system size problems. In "peripheral" interactions of light nuclei the well-known results on maximal probability for alpha-jets was obtained. The study of "most central" collisions of light, intermediate and heavy nuclei shows the very significant trend: the width of the multiplicity distributions is inversely proportional to the volume of interacting systems. These results have been interpreted as the clear sign of intrinsic alpha-clustering in the multiparticle processes for the light nuclei [9].

4. There are some strong signs reflected the system size dependence for multihadron production processes. The intrinsic alpha-clustering in light nuclei can be one of the reliable sources of that dependence.

5. The new physical approaches and experiments with high resolution and statistics are needed in order to make the reliable inference on the initial condition problems. It should be pointed out the interesting patterns reflecting the cluster nature of the exited fireballs that have recently been computed for asymmetrical interactions of light-heavy nuclei at high energies [10, 11]. The system size studies are

being performed in the modern NA 61/SHINE experiments at SPS as a part of the wide program of a systematic search for the onset of deconfinement [12, 13]. The interesting and far-reaching results have recently been obtained in ALICE experiments at LHC. The comparative analysis of freeze-out radii in p-p, p-Pb and Pb-Pb interactions opened the way to the new interpretation of the initial stages and fireball evolution problems in heavy ion collisions [14]. The better understanding of the initial state characteristic can be obtained from small system interactions. The problems have been considered at QM 2014 [15], and at WWND 2016 [17] and more detailed at QM 2015 [16]. The new fixed target experiment BM@N, as the 1-st stage of the NICA project [18], will be launched in next year. Cardinally new approach to the initial and early stages problems in nuclear interactions, - hot glue scenario, - has considered in the recent work [19].

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