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An evidence for the hadron-quark-gluon mixed phase formation in nuclear collisions

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With the help of an advanced version of the hadron resonance gas model we have found remarkable irregularities of relativistic heavy ion collisions at chemical freeze-out. They include an abrupt change of the effective number of degrees of freedom at laboratory energies 8.9-11.6 AGeV and plateaus in the collision energy dependence of the entropy per baryon, pion number per baryon, and a sharp peak in the dimensionless trace anomaly at at chemical freeze-out laboratory energy 11.6 AGeV [1,2]. On the basis of the generalized shock-adiabat model we demonstrate that these observations give evidence for the anomalous thermodynamic properties of the mixed phase at its boundary to the QGP [2]. We argue that the trace anomaly peak and the local minimum of the generalized specific volume observed at a laboratory energy of 11.6 AGeV provide a signal for the formation of a mixed phase between the QGP and the hadron phase. This is also supported by an independent meta-analysis [3]: we compare the quality of hadron spectra and multiplicities description from 10 different models in the range of $\sqrt{s_{NN}}$ from 2.1 GeV to 17.3 GeV and find that at 5-10.8 GeV and above 12 GeV models assuming QGP perform notably better, while at 4.4-4.87 GeV and 10.8-12 GeV QGP models perform as good as purely hadron ones.

Based on these findings, the practical suggestions for the collision energies of the future experiments on RHIC, NICA and FAIR are formulated.

1\. K. A. Bugaev, A. I. Ivanytskyi, et al Thermodynamically Anomalous Regions As A Mixed Phase Signal, Phys. Part. Nucl. Lett. 12, 238245 (2015).

2\. K. A. Bugaev, A. I. Ivanytskyi, et al Thermodynamically Anomalous Regions and Possible New Signals of Mixed Phase Formation, arXiv:1412.0718 [nucl-th].

3\. V. A. Kizka, V. S. Trubnikov, K. A. Bugaev and D. R. Oliinychenko, A possible evidence of the hadron-quark-gluon mixed phase formation in nuclear collisions, arXiv:1504.06483 [hep-ph].

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