NON-SMOOTH CHEMICAL FREEZE-OUT AND APPARENT WIDTH OF WIDE RESONANCES AND QUARK GLUON BAGS IN A THERMAL ENVIRONMENT

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S u m m a r y

We develop a hadron resonance gas model with the Gaussian width of hadron resonances. This model allows us to treat the usual hadrons and the quark gluon bags on the same footing and to study the stability of the results obtained within different formulations of the hadron resonance gas model. We perform a successful fit of 111 independent hadronic multiplicity ratios measured in nuclear collisions at the center-of-mass energies $\sqrt{s_{NN}} = 2.7$–200 GeV. We demonstrate also that, in a narrow range of the collision energy $\sqrt{s_{NN}} = 4.3$–4.9 GeV, there exist the peculiar irregularities in various thermodynamic quantities found at the chemical freeze-out. The most remarkable irregularity is an unprecedented jump of the number of effective degrees of freedom observed in this narrow energy range, which is seen in all realistic versions of the hadron resonance gas model, including the model with the Breit–Wigner parametrization of the resonance width and the one with a zero width of all resonances. Therefore, the developed concept is called the non-smooth chemical freeze-out. We are arguing that these irregularities evidence the possible formation of quark gluon bags. In order to develop other possible signals of their formation, we study the apparent width of wide hadronic resonances and quark gluon bags in a thermal environment. Two new effects generated for the wide resonances and the quark gluon bags by a thermal medium are discussed here: the near-threshold thermal resonance enhancement and the near-threshold thermal resonance sharpening. These effects are also analyzed for the Breit–Wigner width parametrization. It is shown that, if the resonance decay thresholds are located far away from the peak of the resonance mass attenuation, then such a width parametrization leads to a stronger enhancement of the resonance pressure, as compared with the Gaussian one. On the basis of the new effects, we argue that the most optimistic chance to find experimentally the quark gluon bags may be related to their sharpening and enhancement in a thermal medium. In this case, the wide quark gluon bags can appear directly or in decays as narrow resonances that are absent in the tables of elementary particles and have the apparent width about 50–120 MeV and the mass about or above 2.5 GeV.