THE PHYSICAL CONTENT OF THE STATISTICAL BOOTSTRAP AND HIGH ENERGY HADRON INTERACTION

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The essential results of the statistical bootstrap model (SBM) are: a) a level density linearly exponential in total energy and b) an asymptotically bounded average energy per secondary. It could be shown however that these results follow from much more general considerations than the usual assumptions of the statistical bootstrap model. Namely, once the concept of coordinate space volume is modified such as to justify a free gas picture, the linearly exponential level degeneracy appears. This leads to the generalized statistical bootstrap model [1], the basic postulates of which are the following:

I) Any hadronic system at rest decaying into N constituents can be represented as a free gas contained in a volume NV_0, with $V_0 \sim \mu^{-3}$ determined by the range of strong interactions.

II) The level density $\bar{\tau}(M^2)$ for any hadronic system at rest and of mass M is for $M > \mu$ equal to the mass spectrum $\bar{\rho}(M^2)$ of its constituents

$$\bar{\tau}_1(M^2) = \bar{\rho}(M^2) - \delta(M^2-\mu^2) .$$

It is also possible to use an alternative approach to obtain the fundamental results a) and b): the composition picture. A hadron here is not a system of free constituents as in the decay picture of SBM; nevertheless, introducing the Regge pattern of resonance distribution, we get again the a)-result. From this point of view, the SBM is a Fermi model in Regge (M^2) space. [2]

The problem now arises, in the framework of the dynamical description provided by the dual resonance model (DRM), to study under what conditions a statistical approach can be valid. It turns out to be that a purely statistical description and in particular the implications of an exponential mass spectrum can be completely altered through the introduction of interaction dynamical features. Namely, the formation dynamics decouples the initial state from a wide class of in principle possible final states ("dynamical selection rules" [3]).

The first generation system produced in the multiparticle production process in hadron-hadron collisions has then a memory of its formation, a memory leading eventually to an anisotropic jet structure decay. The corresponding calculations show that this first generation system is highly non-equilibrium and anisotropic. [2]

We are led thus to ask if fireballs are at all produced in the DRM or in any similar dynamical model of hadron-hadron collisions? This is possible in the proposed two-stage picture of multihadron production: a non-equilibrium stage of fireball formation is followed by an equilibrium stage of statistical fireball decay.

The interesting problem of the ultimate temperature T_o existence [4] in this picture is then solved as follows: for the equilibrium (fireball decay) stage of the process where the SBM approach is justified such ultimate temperature indeed exists. But it must be considered not as a general upper bound to temperature in all hadronic interactions but as a specific ultimate temperature for statistical decay of clusters formed, and is therefore reached from above as a result of cooling a certain dynamical system. [2]

It is possible also to get an explanation for the experimental evidence of anomalously high creation probabilities of particles with large transverse momenta. To this end in our two-stage picture we propose some generalization of Landau hydrodynamical model [5], making an assumption that the secondary particles can appear not only on the decay stage $(T=T_o)$ but also due to the evaporation of some amount of particles on the hydrodynamical expansion stage, $T_o \ll T \leq T_{in}$ ("leakage process"). The details of these calculations will be published elsewhere.

References

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