ABSTRACT

We study the properties of nuclear matter within the framework of a modified and generalized statistical bootstrap model in which the volume of a fireball grows with its mass. We find that the such described nuclear matter can exist in two phases. In particular we consider in a numerical example the high temperature \( T \lesssim T_0 \approx 150 \text{ MeV} \) regime of the gaseous phase with a density of less than \( \sim 0.75 \) of normal nuclear density.
1. **INTRODUCTION**

In order to understand high-energy heavy ion collisions or even perhaps high-energy hadron-nucleus scattering, we must study the equations of state of nuclear matter. From the point of view of a theoretical physicist, the inverse statement is even more natural: our ideas about the properties of nuclear matter at high and low densities and temperatures can be tested in high-energy nucleus-nucleus and hadron-nucleus collisions. Moreover, this knowledge is certainly essential in order to understand the properties of hadronic many-body objects in astrophysics, such as neutron stars, the Universe at early time, stellar collapse and perhaps even quasars.

While we are aware of the possible richness of the nuclear matter properties, in our approach to these problems we will concentrate on the gross features of nuclear matter that follow when we incorporate into the description the following basic properties:

1) conservation of baryon number and clustering of nucleons (i.e., attractive forces leading to many-body clusters with well-defined baryon number);

2) nucleon (isobar) excitations and internal cluster excitations (i.e., internal degrees of freedom that can absorb part of the energy of the system at finite temperature, thus transforming kinetic energy into mass);

3) approximate extensivity of nuclear matter (volume roughly proportional to baryon number, i.e., effectively a short-range repulsion);

4) co-existence of a pion gas when the temperature is not equal to zero (and behaving properly even in the absence of nuclear matter);

5) baryon-antibaryon pair creation;

6) "chemical" equilibrium between all constituents of the system (nucleons, isobars, clusters, pions ...).