Part II
The Hagedorn Temperature
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Part II addresses properties of hot hadronic gas (HG) matter and the proposal and characterization of the phase transformation between HG and quark-gluon plasma (QGP).

The opening Chap. 16 is a long-lost review, appearing for the first time in English. It describes the meaning of limiting (Hagedorn) temperature $T_{\rm H}$, the Statistical Bootstrap Model (SBM), and its role in the Big Bang and Universe evolution. Chapter 16 can be read by a general science-versed reader. Hagedorn's comprehensive technical 1995 retrospective of the experimental and theoretical developments that compelled introduction of $T_{\rm H}$ and SBM follows in Chap. 17.

Chapter 18 is a commentary on Chap. 19, Hagedorn's first unpublished 1964 paper introducing $T_{\rm H}$ and the exponentially growing mass spectrum $\rho(m)$. Chapter 20 presents the experimental 1968 data for $\rho(m)$, and Chap. 21 offers a contemporary discussion of this central result. Chapter 22 is Hagedorn's unpublished 1972 guide to SBM literature.

Chapter 23 is a 1979 unpublished conference paper which presents SBM in its covariant form, introducing finite sized hadrons, and allowing for finite baryon density characterized by a chemical potential. This work shows the transformation from hadron gas to a collapsed single fireball drop that we call QGP today.

This phase transformation is made mathematically more precise in the following Chap. 24. This is Hagedorn's 1981 unpublished resolution of a critisism of Chap. 23 as extended with the concept of the available volume, discussed further in the following Chap. 27. Chapter 25 is Hagedorn's 1984 retrospective about development of the SBM leading on to our work on the phase transition to quark-gluon plasma. Hagedorn explains in plain language and resolves many questions that arise in the study of the material of this book. Noteworthy for Part II are the two paragraphs below Eq. (25.16) which discuss the relation of the phase limit temperature with a limiting temperature.

A short quote from Chap. 16 explains this further: Hagedorn draws the parallel between boiling hadronic matter and boiling water: "... with increasing temperature, it becomes ever easier for a molecule to free itself from the liquid, and when the temperature approaches the boiling point, it is so easy for them to leave, they all want out and actually escape in a rapid manner. They absorb all the heat made available and leave the molecules still remaining behind no energy to increase their temperature." Hagedorn places emphasis on the fact that water cannot get hotter but vapor in principle, could. However the 1968 view was: "... boiling HG matter can never overcook, *because it is the supplied energy itself* which materializes and so ensures that more new particles are always being born. Therefore there can never arise the process corresponding to the continued heating the water vapor. ... $\mathbf{T_H = 1.8 \times 10^{12}}$ **K is the highest ever possible temperature** in a stationary thermodynamic equilibrium."

This position evolved with the development of the nuclear bootstrap model for the gas phase, incorporating a finite hadron volume, see Chap. 23. With the rise of QGP as the new phase of matter, the meaning of $T_{\rm H}$ expands to be the phase transformation condition. The new phase, QGP, can be heated—quark and gluon tempeature rises without limit, $T > T_{\rm H}$.