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Significance of the (quark-) gluon plasma finite size for the equation of state, and related thermodynamic stability of thermal Casimir systems

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We first motivate the need for an improved equation of state, accounting for the finite size of hot, quantum and relativistic quark-gluon plasmas, such as created in modern Heavy Ion Collisions (HIC). We then focus on finite size corrections by means of relevant spatial compactifications, while considering a single non-interacting massless scalar field as a toy model. Consequently, we present various thermodynamic quantities, including subsequent statistical energy fluctuations for different finite volumes. Such thermal "Casimir" systems seemingly convey thermodynamic instability which, however, can be overcome by means of general and physically motivated additional mechanisms. We then present how such a mechanism permits for reconciling the second law of thermodynamics with the thermal Casimir effect, including our implementation of finite size corrections. This work can potentially affect future calculations and interpretations of physical observables, which characterize the presence of a quark-gluon plasma in HIC.

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