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Temperature fluctuations in a relativistic gas: Pressure corrections and possible consequences in the deconfinement transition

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Content

In this work, we study the effects of random temperature fluctuations on the equation of state of a noninteracting, relativistic fermion gas by means of the replica method. This picture provides a conceptual model for a non-equilibrium system, depicted as an ensemble of subsystems at different temperatures, randomly distributed with respect to a given mean value. We then assume the temperature displays stochastic fluctuations T = T0+δT with respect to its ensemble average value T0, with zero mean δT = 0 and standard deviation δT 2 = Δ. By means of the replica method, we obtain the average grand canonical potential, leading to the equation of state of the fermion gas expressed in terms of the excess pressure caused by these fluctuations with respect to the ideal gas at uniform temperature. We further extend our results for the ideal Bose gas as well. Our findings reveal an increase in pressure as the system's ensemble average temperature T0 rises, consistently exceeding the pressure observed in an equilibrium state. Finally, we explore the implications for the deconfinement transition in the context of the simple Bag model, where we show that the critical temperature decreases.

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