Glueballs and statistical mechanics of the gluon plasma

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Describing the gluon plasma as a gas of free transverse gluons with a temperature-dependent mass $m(T)$ allows to reproduce its thermodynamical features (energy, pressure, etc.), that have been computed in quenched lattice QCD [1,2].

In standard statistical mechanics, particle masses are constants: Introducing temperature-dependent masses thus demands a particular care since one has to build a new formalism which is still thermodynamically consistent. We propose a general way to obtain such a formalism from the first principles of statistical mechanics. A particular solution is to keep the standard form of the energy, while the entropy of the system becomes nonextensive. This framework leads to an excellent agreement with lattice QCD provided that $m(T)$ has two basic features: linear asymptotical increase and strong decrease near the critical temperature T_c [2].

We then argue that the peculiar behavior of $m(T)$ is due to color interactions between the gluons in the deconfined medium near T_c. Using an effective glueball model with a lattice QCD-derived screened color interaction, we indeed show that the lightest glueballs remain bound in the gluon plasma up to 1.6 T_c. Consequently, the thermodynamical properties of the gluon plasma can be understood by describing it as a mixture of free gluons and glueballs, the glueball abundance becoming negligible after 1.6 T_c [2].

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[2] G. Boyd *et al*, Phys. Rev. Lett. **75**, 4169 (1995).
[3] F. Brau and F. Buisseret, arXiv :0902.4836.