

Scientific report

Purpose of the visit

The purpose of the visit was to kickstart the writing stage for the upcoming article “Finite temperature holographic V-QCD”. As a large part of the numerical work and other computations had already been carried out, the visit was seen as useful in order to start the writing the paper.

Description of the work and main results

On their previous article “Holographic models for QCD in the Veneziano limit” (JHEP 1203 (2012) 002), Järvinen and Kiritsis established a holographic model of QCD and QCD-like theories in the Veneziano limit, where both the rank of the gauge group N_c and the number of fermion flavors N_f become infinite, in such a way that N_f / N_c stays finite. The model is based on adding a tachyon action, describing the flavor branes, to the improved holographic QCD –model action previously introduced by Kiritsis et al (Lect.Notes Phys. 828 (2011) 79-146). By solving the full set of coupled gravity-scalar-tachyon equations, this becomes a holographic model of QCD with fully back-reacted fermions. As the model is a hybrid between the top-down and bottom-up approaches, it has four functions that determine the details of the model, which can be constrained but not unambiguously determined by physical considerations.

During fall 2011 and spring 2012 I, together with K. Kajantie and K. Tuominen, have worked in collaboration with Kiritsis and Järvinen on computing the thermodynamics resulting from this model. The model has a complicated finite temperature structure, consisting of a thermal gas solution, which has the background geometry of the vacuum, a chirally symmetric black hole solution and a chirally non-symmetric black hole solution. Using numerical methods, we have been able to explicitly compute these solutions and their free energies, allowing us to essentially fully solve the thermodynamics and the phase structure of the model.

As the choices of the potentials are not fully determined from first principles, we have scanned over a number of plausible choices, including those in (JHEP 1203 (2012) 002), and we have already been able to narrow out the selection of potentials which are physically meaningful, based on their thermodynamical properties.

During my visit to Crete, we identified, with Kiritsis and Järvinen, some further boundary cases for the choice of potentials, for which we intend to compute the thermodynamics, and we were also able to understand some details on how the thermodynamics of this model approaches that of the IHQCD model in the limit when the number of flavors goes to zero. The writing of the section of the upcoming article that describes the numerical results was put to a good start, and we now have a clear plan and distribution of work for carrying that writing to completion. In addition we discussed and found methods to represent the somewhat complicated thermodynamical solutions in clear and understandable plots.

Publications

The work carried out during the visit lead to significant progress towards publishing our results on the thermodynamics of the model, and we expect to publish “Finite temperature holographic V-QCD” during this summer.

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