Francesco Nitti - ESF Short Visit Grant ref. 5007

Final Report

1 Purpose of the visit

During my visit I have worked in collaboration with Elias Kiritsis (University of Crete) towards the completion of our ongoing project, whose purpose is the definition of dressed spectral functions for the holographic description of the generalized Langevin diffusion of a heavy quark in a deconfined plasma. The purpose of this visit was to make progress in understanding how to construct the physical spectral density for the case when the zero-temperature background is confining.

2 Description of the work and main results

In two of our recent works, [1, 2], we had shown how to compute the correlation functions that drive the Langevin process of a heavy quark moving through a general non-conformal plasma, described holographically by a gravity dual asymptotically AdS black hole. The role of the heavy quark, in the dual picture, is played by a string stretching from the AdS boundary down to the black hole horizon, and trailing the boundary end which moves at constant velocity. The fluctuations of the string compute the correlators for the quark diffusion process.

In the article [2] we introduced a subtraction procedure to define dressed correlators which are well-behaved at large frequency, and satisfy the appropriate dispersion relations. This is achieved by subtracting the contribution of a straight string embedded in the zero-temperature background solution with no black hole in the bulk. However, we found that the dressing is well defined only in the case of bulk theories whose zero-temperature solutions are dual to non-confining gauge theories, and therefore cannot be used for phenomenological applications to the QCD plasma.

In the past few months we understood that, in the confining case, the subtraction must be defined with a modified, bended string configuration in the zero-temperature solution. This configuration, and the corresponding fluctuation equations, depend crucially on the direction that the string makes with the velocity of its endpoint. This makes the calculation of the correlators more involved than in the non-confining case, and *a priori* angle-dependent.

During my visit in Crete, we have worked towards understanding how to effectively perform the average over the angular variables which enter the equations, and we have written in a simple way the angular dependence of the quadratic action for the fluctuations of the zero-temperature string. We have set up the

procedure to diagonalize this action, which would allow to (numerically) solve the linear differential equations of motion and, after performing the average over the angular variables, compute the correlators.

Another related issues we discussed during the visit was the numerical computation of the subtracted correlators. The numerical procedure is in principle straightforward, but earlier attempts have revealed that some problems emerge that cause an unphysical oscillatory behavior to appear in the solution. During my time at Crete University we discussed possible strategies to refine the numerical computation in order to overcome this problem.

3 Projected publications

The research we have performed during my visit will result in at least one, and possibly two, scientific articles. From the theoretical point of view, the problem we are considering is fundamentally solved. What still needs to be done is to understand how to explicitly do the integral over the string angular variables to obtain a physical subtracted correlator. This is a technical issue, that we plan to solve in the near future. The other issue concerns the numerical aspect of the project. Regarding this aspect, we are putting in place strategies to obtain a physically reasonable numerical correlator. Depending on the time it will take to solve these two problems, we may write two separate articles, the first one discussing the theoretical and analytical aspects, the second one presenting the numerical results, or one longer article presenting both aspects of this project.

References

[1] U. Gursoy, E. Kiritsis, L. Mazzanti and F. Nitti, *"Langevin diffusion of heavy quarks in non-conformal holographic backgrounds,"* JHEP **1012**, 088 (2010) [arXiv:1006.3261 [hep-th]].

[2] E. Kiritsis, L. Mazzanti and F. Nitti, *"Dressed spectral densities for heavy quark diffusion in holographic plasmas,"* J. Phys. G G **39**, 054003 (2012) [arXiv:1111.1008 [hep-th]].