Research Networking Programmes

Short Visit Grant ☒ or Exchange Visit Grant ☐

(please tick the relevant box)

Scientific Report

The scientific report (WORD or PDF file – maximum of eight A4 pages) should be submitted online within one month of the event. It will be published on the ESF website.

Proposal Title: Blackfolds in general backgrounds

Application Reference N°: 6593

1) Purpose of the visit

The visit had the main purpose of actively working on the collaboration with Niels Obers and his group and developing the blackfold techniques necessary to deal with background spacetimes with fluxes and dilatonic fields. These techniques can then be applied in order to construct different black hole configurations in settings pertinent to the holographic characterization of condensed matter systems.

2) Description of the work carried out during the visit

During the visit we have mainly focused on understanding how black branes in the probe limit couple to external dilatonic fields. Backgrounds with dilatonic fields and fluxes are found in spacetimes in string theory such as those with Schrodinger or Lifshitz symmetries. In order to be able to probe these spacetimes at finite temperature one needs to understand how the probes couple to the possible fields present in the background. Two different analysis of these issues are required to match: on one hand one should understand from a general point of view how a generic probe couples to these fields in the far region (away from the black hole horizon) and on the other hand, one needs to be able to derive directly from gravity, how perturbations of black branes in the near zone region (close to the horizon) couple to these fields. This type of couplings can also be obtained via reduction techniques, e.g. one can start in M-theory where there are no dilatonic fields and reduce over one dimension to find couplings to dilatonic fields. Because the dynamics of probe branes can be derived from an action when the configurations are stationary, it is also important to understand how to include these couplings in such actions. This visit had these issues in mind as the main goal.

3) Description of the main results obtained

During the visit we have been able to delineate concrete avenues in order to solve the above issues. We have been able to understand from Einstein equations as well from reduction techniques how black branes in the probe limit couple to external fields in a simple and beautiful way. At the same time we were able to pinpoint the precise issues with the same derivation in the far region. This we could solve by introducing a dilatonic charge current which can also be expanded in a pole-dipole way. This dilatonic charge current for different black brane configurations in string/M-theory is fixed by the other charges in the solutions and hence does not constitute an independent current or charge. However, in general grounds it could be present. This allowed us to match the two calculations we had set out to do. We have also been able to generalize our results to different types of bound states.

4) **Future collaboration with host institution (if applicable)**

This project introduces several avenues of research that can be followed in the future. Namely, the application to spacetimes with Schrodinger or Lifshitz asymptotics which are highly relevant for condensed matter applications. We our new techniques we will be able to probe gauge theory operators at finite temperature in these spacetimes and also to construct perturbatively new black hole solutions with these asymptotics.

In the same visit I have also worked on related projects with Troels Harmark, where a new understand of the thermodynamic properties of these objects was achieved, even beyond the leading order probe approximation. It will be a future challenge to be able to include the effect due to background dilatonic fields and non-trivial fluxes.

5) **Projected publications / articles resulting or to result from the grant** ***(ESF must be acknowledged in publications resulting from the grantee's work in relation with the grant)***

Blackfolds in General Backgrounds, by Jay Armas, Jakob Gath, Niels A. Obers, Vasillis Niarchos and Andreas Vigand Pedersen

Thermodynamics of Stationary Fluid Branes, by Jay Armas and Troels Harmark

6) Other comments (if any)