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: Optical conductivities in anisotropic holographic superfluids

Application Reference N°: 6438

1) Purpose of the visit

The purpose of the visit to the Instituut-Lorentz for Theoretical Physics in Leiden, from the 24 until 28 of February, was to bring forward a joint project with Hansjörg Zeller (MPI Munich) and Dr. Steffen Klug (Instituut-Lorentz) about optical conductivities in holographic systems at finite temperature and density that undergo a phase transition to superfluidity.

2) Description of the work carried out during the visit

The questions addressed were first to find the Einstein relation in holographic systems with backreaction in arbitrary dimensions, second to understand the previously obtained behavior of the optical conductivities in the holographic p-wave model and third to potentially find a real world system that resembles their behavior.
We first studied the fluid dynamics of holographic systems described by a d+1 dimensional AdS-RN solution on the gravity side and compared results obtained from the fluid/gravity and the linear response approach.

Second we identified the main characteristics of the numerically obtained optical conductivity of the holographic p-wave model with a 5 dimensional gravity dual in the superfluid phase and compared them to the results of the holographic s-wave superfluid.
Furthermore we had the possibility to present our project in seminars to experts at the host institute leading to helpful discussions and new insight regarding the question whether the holographic p-wave superfluid describes properties of a real world system.

3) Description of the main results obtained

Starting with the normal phase of the holographic p-wave model we found an analytic expression for the DC-conductivity of d-dimensional field theories (d>2) that can be described holographically by a d+1 dimensional AdS-RN geometry on the gravity side. This result provides a thorough understanding of the Einstein-relation in those holographic systems allowing for backreaction of the charged fields on the geometry on the gravity side. The relation is crucial for relating holographically obtained results from the fluid/gravity and the linear response approach and can be regarded as a consistency check of holographic fluid dynamics. Transferring this result to the superfluid phase of the backreacted p-wave model would provide new insight in understanding its field theory dual. We plan to further investigate this.
The analysis of the optical conductivities of the holographic p-wave model in the superfluid phase showed that transversally isotropic part matches the behavior of the optical conductivity of the holographic s-wave superfluid whereas the anisotropic contribution shows a qualitatively different behavior.

4) Future collaboration with host institution (if applicable)

During the visit further questions were raised that we plan to address in the near future in collaboration with Dr. Steffen Klug at the Instituut-Lorentz in Leiden.

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)*

We plan to publish above results as soon as the open issues are solved.

6) Other comments (if any)