ESF Program "HOLOGRAV": Short Visit Grant
Title: Conformal Field Theory
Benefiaciary: Anastasios C. Petkou, University of Crete

Final Report

From 14-27April 2012 I visited Prof. Hugh Osborn at DAMTP, University of Cambridge.

The purpose of the visit was, among other things, to discuss with Prof. H. Osborn two specific computations related to Conformal Field Theories (CFTs) and initate, hopefully, a concrete collaboration. Both computations are related to extending the Zamolodchinkov's C-theorem in three-dimensional Quantum Field Theories (QFTs), in view of the recent progress related to the so-called a-theorem in four-dimensions.

Our computations would attempt to understand better whether the parameters in the 3-pt function of the energy-momentum tensor in three-dimensional QFTs could play the role of a C-function. In previous work, with Prof. Osborn, we have shown that in three dimensions there are only two independent parameters in the 3-pt function of the energy-momentum tensor in generic CFTs. This is to be contrasted with the 3 parameters present in the corresponding quantity in four-dimensions, two of which are related to the conformal anomalies. One of the parameters in three-dimensions is related to the coefficient in the 2-pt function of the energy momentum tensor via a Ward identity. The other parameter is more mysterious.

Since there is no conformal anomaly in three-dimensions, the parameters in correaltion functions constitute the only possible way to extract information from a three-dimensional CFT. Our first focus would be the coefficient C_T in the 2-pt function of the energy momentum tensor. The only non-trivial calculation in three-dimensions so far for this quantity was done in my PhD thesis, a long way back. I had calculated the 1/N correction to C_T in the O(N) Vector Model. The result shows the expected behaviour: namely this quantity is smaller in the IR fixed point of the model. However, this is by far conclusive regarding the possibility that C_T is related to a C-function. Hence, the new idea is the following: calculate C_T to 1/N in the three-dimensional U(N) Gross-Neveu model. The interesting twist here is that the non-trivial fiexed point of this model is in the UV, hence one would expect that C_T actually increases. The calculation is rather technically demanding, but well defined as a problem.

The other quantity in the 3-pt function of the energy-momentum tensor is, as said, more mysterious. Our first task would then be to construct an effective action in three-dimensions that reproduces it. It is quite probably that one has to invoke the parity non-invariant Cotton tensor which is a special quantity in three-dimensions. Then, it would be very nice if this quantity could be calculated, even to leading order in 1/N, in both the O(N) Vector and the Gross-Neveu models above.

In conclusion, my visit was preparatory for a possible collaboration with Prof. Osborn, which is expected to lead to at least one scientific publication in the near future.