

Description of Funded Research Projects

1<sup>st</sup> Call for H.F.R.I. Research Projects  
to support Post-Doctoral Researchers



**H.F.R.I.**  
Hellenic Foundation for  
Research & Innovation

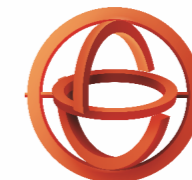
Research Project Title:  
**Non-perturbative Gauge  
Dynamics from Integrability and  
Gauge/Gravity Dualities**

**Principal Investigator:**  
**George Georgiou**

**Popular Title:**  
**Study of the behavior of elementary  
particles at strong coupling**

**Scientific Field:**  
**Natural Sciences, Physics, Fundamental Sciences,  
Constituents of Matter**

**Host Institution:**  
**N.C.S.R. “Demokritos”**



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One of the longstanding problems in theoretical physics is that of the quantitative description of strongly coupled gauge theories. During the last two decades new ideas and methods have been developed giving us a better understanding of the structure of gauge field theories. One of the most useful tools for exploring gauge theory is the celebrated AdS/CFT correspondence, one of the most fascinating discoveries in modern theoretical physics.

The purpose of the proposed work is to shed some light to the non-perturbative dynamics of gauge field theories. The present project will deploy in two parallel directions. In the first one, we shall focus on the construction and study of integrable multi-parameter deformations of conformal field theories (CFTs) of the WZW type. Emphasis will be given to the key feature of integrability of the resulting theories and not to other aspects, such as supersymmetry. Subsequently, we will embed these models to type IIA or type IIB supergravity, identify the dual gauge theories and study the role of the deformation parameters in their strongly coupled dynamics through the AdS/CFT correspondence. These novel realisations of the AdS/CFT correspondence will be closer to quantum chromodynamics (QCD) since the deformations will break supersymmetry down to  $N=1$ , or even  $N=0$ .

In the second direction we will focus on the non-perturbative regime of the maximally supersymmetric theory in four dimensions,  $N=4$  SYM, as well as on the non-perturbative regime of the ABJM theory. The necessary tools for the non-perturbative treatment of the aforementioned theories, are coming from the recent developments of the AdS/CFT correspondence combined with integrability techniques to obtain information at both the weak and strong coupling regime.

The unifying theme of the proposed research is the study of the non-perturbative regime of gauge theories through gauge/gravity duality exploiting the role of integrability.

The development of fundamental research may not have the purpose of producing direct applications. Its purpose is to investigate the fundamental principles governing the primary thematic fields. In the medium term, as has been demonstrated by historical experience, there will be tangible benefits for society at large. Our primary goal is to contribute to the production of front-line research results in modern cutting-edge topics in theoretical high-energy physics. The realisation of the research proposal will contribute to further strengthening the scientific projection of the NKUA and the financial support of the younger scientists. In that aspect, it is of the utmost importance to reverse the brain drain of younger scientists observed the last years in Greece.

Due to the dominant role of strong interactions in LHC physics, it is beyond doubt that the coming years will see an increased focus on understanding the theoretical properties of QCD, and I trust that the present project will contribute in keeping Europe at the forefront of this worldwide effort.

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The funding of this project will give my research group the opportunity to conduct high quality research in theoretical physics in my home country. As such, it is a first step from preventing high qualified researchers from leaving Greece. However, if this attempt of funding scientific research is temporary and is not accompanied by a long-term vision which should, among other things, include openings of permanent academic positions, not much will be achieved. In this respect the effort of the Greek State to finance research through H.F.R.I. is of the outmost importance.

*The Principal Investigator,  
George Georgiou*

## Funding

Amount: **200,000 €**

Duration: **36 months**

Foundation: **H.F.R.I.**





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