

SCIENTIFIC REPORT FOR ITGP - SHORT VISIT GRANT OXFORD MAY-JUNE 2013

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1. PURPOSE OF THE VISIT

The purpose of my research visit to the Mathematical Institute at Oxford was to work on the following two problems:

- (P1) The study of $U(p, p)$ -Higgs bundles and the geometry of their moduli space.
- (P2) The study of Higgs bundles and 3-manifolds.

During the last months I successfully completed my DPhil examination, and now is the ideal time for me to prepare the results in the thesis for publication. After discussing with my examiners, Prof. Peter Newstead and Prof. Frances Kirwan, I was advised to produce at least 2 papers with results of Chapters 6 (on $U(p, p)$ -Higgs bundles) and 7 (on $Sp(2p, 2p)$ -Higgs bundles) of the thesis [Sch13]. Some discussions on a subtle point of (P1) highlighted by my examiners will require further work on results for $U(p, p)$ -Higgs bundles to give closure to this research. Hence, the visit to Oxford, where I was able to interact with Prof. Nigel Hitchin was very fruitful for this research.

One of the aims of (P2) is to understand the relation between (A, B, A) -branes and the spectral data of classical Higgs bundles involved in (P1), and relate this to the work of Witten and Kapustin [KaWit06], and of Gukov [Guk09]-[Guk11]. I have recently visited Dr. David Baraglia (University of Adelaide) to collaborate on this project, and we are currently making very interesting advances in the area.

2. DESCRIPTION OF THE WORK CARRIED OUT DURING THE VISIT

During my visit to the University of Oxford, the work carried out in order to tackle the above problems was done in two different ways:

2.1. Current advances. With respect to the research related to (P1), in the last months I finished a draft of [Sch13a], which I was able to discuss about with Prof. Nigel Hitchin. Moreover, since in his current research he has used the results in the draft and [Sch13] to relate $SU(m, m)$ -Higgs bundles and (B, B, B) -branes through mirror symmetry, I was able to stay updated on the state of the art of these developments. The work in [Sch13a] shall be made available online very soon.

As for the projects coming from studying (P2), last month my collaborator Dr. David Baraglia and I finished our first paper on the subject [BaSch13], and we are currently looking into natural continuations of the research, as well as applications of our current results. In particular, during my research visit to Oxford I was able to discuss about our current project [BaSch13a] and get insightful comments from other mathematicians and physicists.

2.2. Work on open problems. Further to communicating my current research, I also dedicated the visit to continue my research on open problems related to Higgs bundles for real forms. In particular, together with Prof. Nigel Hitchin we begun a new project on a related problem to **(P1)** and **(P2)**:

- (P3)** The study of the relation between the moduli space of stable rank 2 vector bundles, parabolic rank 2 bundles and Higgs bundles for real forms.

Following the ideas I developed in [Sch13] for $Sp(2p, 2p)$ -Higgs bundles, Prof. Nigel Hitchin and I have realised that there is a bigger class of Higgs bundles whose moduli space is closely related to the space of parabolic rank 2 bundles defined in [AG06], and we are currently preparing a paper together on the subject.

3. DESCRIPTION OF THE MAIN RESULTS OBTAINED

There are at least three papers which will result from my visit to the University of Oxford, and the main ideas in each work are as follows:

- (1) [Sch13a] Here I will describe the spectral data associated to $U(p, p)$ and $SU(p, p)$ -Higgs bundles, where the Jacobian and Prym varieties of quotient spectral curves are used. Moreover, I will give a new interpretation of topological invariants associated to the moduli spaces of these objects, as well as describe some applications of the new methods developed in the paper (mostly following [Sch13]).
- (2) [BaSch13a] Together with Dr. David Baraglia, we will expand on the ideas originated in [BaSch13], and in particular on the open questions described in the last section. We will give a relation between the moduli space of representations of the fundamental group of a 3-manifold which are extension of representations for the boundary, and the (A, B, A) -branes described in [BaSch13].
- (3) [HitSch13] Together with Prof. Nigel Hitchin, we will describe the relation between the moduli space of Higgs bundles for certain real forms, and the moduli space of stable rank 2 vector bundles and admissible parabolic bundles as defined in [AG06]. In particular, we will expand on the methods developed in [Sch13] for the symplectic group with signature.

REFERENCES

- [AG06] J. E. Andersen, J. Grove, *Automorphism fixed points in the moduli space of semi-stable bundles*, Q J Math 57 1 (2006) 1-35.
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- [Guk09] S. Gukov, *Surface Operators and Knot Homologies*. New Trends in Mathematical Physics (2009) pp 313-343.
- [Guk11] S. Gukov, *Quantization via Mirror Symmetry*. Japanese Journal of Mathematics (2011), 6 2, pp 65-119.
- [HitSch13] N. Hitchin, L. P. Schaposnik. *Work in Progress*
- [KaWit06] A. Kapustin and E. Witten, *Electric-Magnetic Duality And The Geometric Langlands Program*, 2006. hep-th/0604151
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		Travel cost
		Euros
	Plane ticket	241
	Heidelberg-Frankfurt	24.5
	Heathrow-Oxford	34
	Oxford-Heathrow	77
	Frankfurt-Heidelberg	21
	Total	397.5



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LH 903 operated by: LUFTHANSA	09 June	LONDON GB HEATHROW TERMINAL 1	FRANKFURT DE FRANKFURT INTL TERMINAL 1	09:50 h	12:30 h	Economy Class (T) confirmed

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