Eloise Hamilton Research Fellowship Report (Oct 2021- April 2023)

A year and a half into my Research Fellowship at Newnham College, I continue to feel grateful and privileged to be a part of the community here. It has provided me so far with the best environment I could hope for to carry out my mathematical research. Moreover, with the easing of travel restrictions, in-person conferences and workshops have now resumed and I have been fortunate to be able to travel again for this purpose on numerous occasions.

Ongoing research projects

1. Classification problem for Higgs bundles: Building on the work completed during my DPhil, I have continued my study of Higgs bundles (mathematical objects arising from theoretical physics) and their classification. I submitted at the beginning of this academic year an article titled *Three instability stratifications of the stack of Higgs bundles on a smooth projective curve* for publication. This paper is the basis for two additional papers which I am currently working on: *Moduli spaces for Higgs sheaves of length two Harder-Narasimhan type*, and *Moduli spaces for twisted Higgs bundles of rank two on the projective line* (the latter in collaboration with Associate Professor Steven Rayan).

2. Generalising Non-Reductive Geometric Invariant Theory: Another project I am involved in is in collaboration with Dr Joshua Jackson and Associate Professor Victoria Hoskins. We are generalising a recently developed theory called Non-Reductive Geometric Invariant Theory (NRGIT), itself a generalisation of GIT, a classical and powerful theory for solving classification problems. Our aim is to develop a theory that is applicable to an even wider range of classification problems. In December 2022 I spent a week at the University of Nijmegen with my two collaborators to work intensively on this project, and we intend to submit our results for publication in the next few months.

3. Non-Reductive Geometric Invariant Theory and Statistics; In 2021 I began a project exploring links between NRGIT and Maximum Likelihood Estimation (MLE) in statistics, in collaboration with a previous collaborator of mine, Associate Professor Gergely Bérczi, and three researchers in algebraic statistics (Dr Visu Makam, Dr Anna Siegal, and Philipp Reichenbach). Results obtained so far shed new light on MLE non-identifiability, an important problem in statistics.

Invited talks

1. University of Georgia (seminar), Nov 2021
2. University of Cambridge (seminar), Nov 2021
3. University College London (workshop), Nov 2021
4. University of Edinburgh (workshop), Dec 2021
5. University of Essex (workshop), April 2022
6. University of Chicago (conference), June 2022
7. University of Toulouse (seminar), June 2022
8. University of Pisa (conference), July 2022
9. University of Warwick (conference), July 2022
10. American Institute of Mathematics (workshop), Feb 2023
11. Upcoming: University of Washington (seminar), May 2023
12. Upcoming: University of Oxford (workshop), June 2023
13. Upcoming: University of Birmingham (seminar), Sep 2023.

College activities

1. In Michaelmas 2021 I conducted admission interviews for Newnham in Mathematics and Natural Sciences.
2. In Michaelmas 2021 I reviewed a JRF application.
3. In Michaelmas 2022 I conducted admission interviews for Newnham in Mathematics.
4. Since Michaelmas 2021 I have been a member of the Environmental Committee.
5. Since Michaelmas 2022 I have been a member of the Valuable Possessions Committee.
6. Since Michaelmas 2022 I have been an Assistant Tutor.