Dr Jonathan Reynolds

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Employment

Aut 2011 - Present. Tutor at the University of East Anglia. Visited Athanasios Pheidas and Nikos Tzanakis at the University of Crete and gave two lectures on my research.

2009 - July 2011 **Marie Curie Intra-European Fellowship** held at Utrecht University.

This is an independent research grant based around a project on elliptic divisibility sequences which I wrote and gained funding for after completing my PhD (PIEF-GA-2009-235210). I also taught at Utrecht. During my fellowship I visited the University of British Columbia.

Degrees

2008 **PhD** "Extending Siegel's theorem for elliptic curves",
University of East Anglia (United Kingdom),
Supervisors: Prof. Graham Everest & Prof. Shaun Stevens.

2004 Master of Mathematics with First Class Honours,
University of East Anglia,
(awarded prize for most distinguished work).

Teaching and Organizational Experience

Taught a third year course, Utrecht University. I designed and taught a course about rational points on elliptic curves via Diophantine equations. I was responsible for lecturing and giving exercise classes. The course was popular and I was able to pass on some of my own expertise in number theory to the students of Utrecht; 15 students took the course and 12 scored 7 or above (out of 10).

Teaching / Marker, University of East Anglia. Assisted with a variety of basic and advanced undergraduate courses. These included basic mathematics for scientists, first/second year algebra and analysis along with third year pure courses. I was responsible for marking hundreds of scripts as well as giving exercise classes.

Organizer, University of East Anglia MTH Postgraduate Seminar.

In the spring of 2007 I spent a week visiting North Walsham High School, Norfolk, UK. As well as observing, I gave a couple of presentations and helped students with their work. I also gave a talk about my research to A-level students at Paston College and my visit to the college appeared in a local paper.

List of Publications

[1] $\mathbb{Q}$-curves and elliptic divisibility sequences, with Sander Dahmen, (in preparation).

[2] Matrix divisibility sequences, with Gunther Cornelissen, *Acta Arithmetica* (accepted).

[3] Perfect powers in elliptic divisibility sequences, *J. Number Theory* **132** 998–1015, 2012.

[4] Perfect powers generated by the twisted Fermat cubic, *Funct. Approx. Comment. Math.* **46**(1) 133-145, 2012.

[5] On the pre-image of a point under an isogeny and Siegel's theorem, *New York J. Math.* **17** 163–172, 2011.

[6] Extending Siegel's theorem for elliptic curves, PhD Thesis, University of East Anglia, 2008.

[7] On the denominators of rational points on elliptic curves, with G. Everest and S. Stevens, *Bull. London Math. Soc.* **39**(5) 762–770, 2007.

Research Interests

My main research area is Number Theory. In particular, I study interactions between the arithmetic of divisibility sequences and the solvability of Diophantine equations. Also, I'm starting to study connections with Dynamical Systems.

Workshops, Conferences and Courses

Spr 2011 **Ergodic Theory and Applications in Number Theory**, Utrecht. An advanced level course taught by Prof. Tom Ward as a rapid introduction to ergodic theory.

05/2010 **Rational Points - Theory & Experiment**, ETH Zürich. The workshop covered a wide spectrum of problems about rational points on curves and higher-dimensional algebraic varieties. Here, I met Szabolcs Tengely and our discussions helped with the solution of a Diophantine equation related to my Marie Curie project.

12/2009 **The Diverse Faces of Arithmetic**, University of East Anglia. On the occasion of Graham Everest's retirement, the conference covered the remarkable interactions of Number Theory with Logic, Dynamical Systems and Mathematical Physics.

04/2009 **Counting Points on Varieties**, Leiden University, The Netherlands.

05/2007 **Solvability of Diophantine Equations**, Leiden University, The Netherlands. Here, Prof. Michael Bennett and Prof. Samir Siksek gave lectures on how modular methods introduced by Wiles are being developed and combined with other techniques to solve an increasing number of Diophantine equations. After the conference I was able to establish a relation between perfect powers in certain elliptic divisibility sequences and Diophantine equations to which the modular approach is applicable.

08/2006 **LMS-EPSRC Short Course**: Topics in Arithmetic Geometry (Modular Forms, Galois Representations and Iwasawa Theory), King's College London.

03/2005 **Extensions of Hilbert's Tenth Problem**, American Institute of Mathematics, Palo Alto, California. Here, I learnt how Cornelissen (Utrecht) and Zahidi (Ghent) have shown that a certain quantifier elimination problem, first studied by Julia Robinson, can be settled by the existence of a special elliptic divisibility sequence.

Selected Talks

11/2011 "Divisibility Sequences and Diophantine Equations",
University of Crete.

03/2011 "Perfect powers generated by the twisted Fermat cubic",
Utrecht Number Theory Seminar.

02/2011 "Modular methods for perfect powers in elliptic divisibility sequences",
Intercity Number Theory Seminar, Utrecht.

04/2008 "Power-integral points on elliptic curves",
University of Warwick Number Theory Seminar.

04/2008 "Power-integral points on elliptic curves",
University of East Anglia Pure Mathematics Seminar.

Future Research Directions

In addition to continuing work on the project mentioned above, aiming for uniform results and extensions to function fields, in my remaining time at Utrecht I attended a course given by Tom Ward on 'Ergodic theory and applications in number theory'. I hope to grasp some the powerful connections which can be made in this area. There are many strong links with number theory and dynamical systems. In particular, Siegel's theorem and Silverman's primitive divisor result for elliptic divisibility sequences have dynamical analogues. In order to pursue these ideas it is possible for me to visit Silverman.

In a recent paper with Gunther Cornelissen we argue that behind each of the usual divisibility sequences lies hidden a naturally defined divisibility sequence of matrices, where the usual sequence is obtained by taking determinants. The main motivation behind this new definition is for smoother applications to decidability, but these implications require further work.

Teaching Statement

Whenever possible, I let my students combine theoretical work with hands-on experiments on computers and use of the Internet. This gives students a feeling for independent discovery and research. At Utrecht I was able to show students how to download and install PARI/GP (for free) on their laptops in order to check work that they had previously done by hand. In order to emphasize the importance of being able to compute the rank of an elliptic curve, I mentioned some of the current world records and showed them, on the Clay institute website, that a proof of the Birch and Swinnerton-Dyer Conjecture is worth $1 million.

I encourage "learning by doing". One student commented on his course evaluation that he found it frustrating not to immediately be given a full solution when he asked for help but realized in the end that this was best for him. Lecture notes are made readily available on my website and students appreciate this.

Giving tutorials for service courses and high school activities have given me insight into the problems people have rearranging and manipulating algebraic equations. These operations, fundamental to mathematics, are taken for granted at higher levels. Often the difficulties were resolved by them taking more time, not being afraid write down more steps and not trying to bend the rules.

Many first year students find themselves expected to produce proofs which are much longer than before and require explanation as well as algebraic manipulation. I find this often leaves them unsure of how to ask for help since there may no longer be an "answer" to check and they are not used to breaking solutions into steps. To tackle this, it is required to approach the students who seem to be struggling and show them how to break the problem down.

With a much larger tool kit available, in later years students find that there can be more than one (long) solution to a problem and this also presents more challenges for the tutor/marker. Mistakes can be subtle and, as when working on a research problem, it can sometimes be difficult to find the error. To make things easier, I find it helpful to get the student to explain their solution and take the time in classes to get to know how they work. This is more practical at this level and also makes it easier to give good feedback.

Overall, I encourage students of all abilities to ask (the right) questions and to be hands-on.

Referees (Others available on request)

Prof. Shaun Stevens
School of Mathematics,
University of East Anglia,
Norwich, NR4 7TJ

Prof. Gunther Cornelissen
Mathematics Institute,
Utrecht University,
3508 TA Utrecht

Prof. Samir Siksek
Mathematics Institute,
University of Warwick,
Coventry, CV4 7AL

Prof. Mike Bennett
Department of Mathematics, UBC,
1984 Mathematics Road,
Vancouver, BC V6T 1Z2