LMS Prospects in Mathematics 2020, Bath

GEOMETRY

Hamid Ahmadinezhad

Loughborough University

Geometry: Study of "Shapes"

Topology continuous properties of shapes (connectedness, compactness,...)

Differential Geometry approximating smooth shapes with Euclidean coordinates
Applications: Einstein's relativity, economics,...

Complex Geometry differential geometry over complex coordinates
Applications: String theory,...

Chow's theorem

Algebraic Geometry shapes defined by algebraic equations (polynomials) over

$$\ldots, \mathbb{C}, \ldots, \mathbb{R}, \ldots, \mathbb{Q}, \ldots, \mathbb{Z}$$

Applications: String theory, statistics, biology, combinatorics, number theory,...

Arithmetic Geometry algebraic geometry over non-closed fields (excluding $\mathbb{R}$), e.g. number fields, finite fields, p-adic fields,... Applications: cryptography,...

Discrete Geometry relative position of points, lines, circles in the plane (combinatorics)

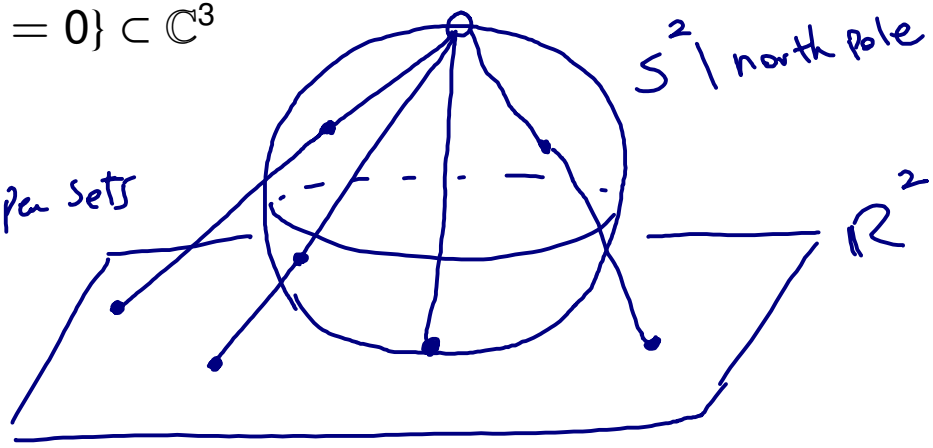
Geometric Group Theory geometric techniques in the study of finitely generated groups. Highlight: Perelman's proof of Poincaré conjecture

Algebraic Geometry

Within algebraic geometry, most of my work fall within *Birational Geometry*. For example, Let $S: \{x^2 + y^2 + z^2 - 1 = 0\} \subset \mathbb{C}^3$

S^2 Bir'l $\mathbb{R}^2$

- they have two iso (Zariski) open sets
- there is a rat'l map $S^2 \dashrightarrow \mathbb{R}^2$ with a rational inverse



Question: Let X be the space of solutions to a (random) degree 3 polynomial in 5 variables (i.e., a 4-dimensional subset of $\mathbb{C}^5$). Is X birational to $\mathbb{C}^4$?

Claire Voisin (Paris)

She offers a method that can tackle such problems (rationality problem) extensively. However we still don't have a solution to this particular question.

Birational Geometry

Any given algebraic variety of dimension at least two is birational to infinitely many other varieties. The aim is to find a geometrically simple representative in each birational class.

The two dimensional case is classical, and the three dimensional birational geometry was mainly developed in the 80s. Higher dimensional case is very advanced but with many open questions remaining.

Shigefumi Mori
Fields medal 1990

3types:

- Fano fibrations
- Calabi-Yau
- General type

There are finitely many families of Fano varieties in each dimensions.

Caucher Birkar
Fields medal 2018

Most of my work concerns the study of birational geometry of Fano varieties, their rationality, birational classification, K-stability,...

My PhD students

Current Students:

Laura Mallinson 
PhD: October 2017 – Summer 2021
Project: Construction of flips in dimensions 3 and 4

Tiago Guerreiro 
PhD: October 2017 – Summer 2021
Project: Birational models of Fano varieties with higher index

My PhD students

Past and Future Students:

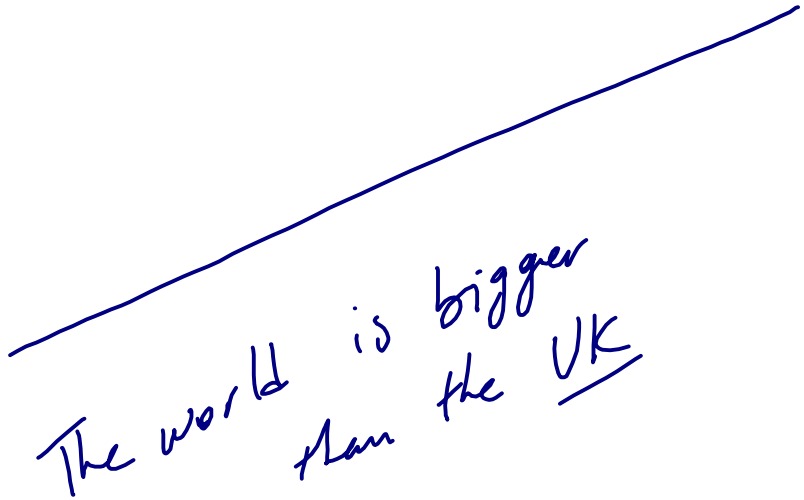
Erik Paemurru 
PhD: October 2016 – July 2020
Project: Birational models of singular Fano varieties
Now: 4 months LMS fellowship at Imperial College London, then moving as a postdoc to Basel (Switzerland)

Erroxe Etxabarri 
PhD: October 2020 – Summer 2024
Project: who knows? :)

Algebraic Geometry in the UK

Bath
Birmingham
Cambridge
Cardiff
Edinburgh
Glasgow
Kent
Liverpool
London (Imperial College, UCL,...)
Loughborough
Manchester
Nottingham
Oxford
Sheffield
Warwick

+ Essex + more ...



THANKS
FOR
LISTENING