The History of Mathematical Analysis

14th May 2022, Birkbeck

Thank you for participating in this conference on the History of Mathematical Analysis. It has been organised by the British Society for the History of Mathematics (BSHM), with support from the Department of Economics, Mathematics and Statistics at Birkbeck College, University of London. We have an exciting programme for the day with eight excellent speakers covering a range of topics. We hope you enjoy it. If you are not already a member of the BSHM, we encourage you to consider joining. You can go to the website www.bshm.ac.uk for more information.

The conference will be in the Clore building (building number 2 on the map on page 4), opposite the main Birkbeck building. Registration and tea/coffee breaks through the day will be in the basement foyer with lectures in the adjacent lecture theatre; on entering the Clore building just turn right and head down the stairs; there is lift access if required. Please let us know of any other access requirements. For everyone's safety, we recommend face coverings be worn during the day.
To keep registration fees to a minimum, lunch is **not** provided. There are numerous cafes and shops nearby; a few suggestions are given on page 4.

Programme

9:45 Registration

10.00 Opening remarks by BSHM President Sarah Hart

10:05 Niccolò Guicciardini: *The birth and reception of the Newtonian and the Leibnizian calculi*

10:50 Tea/Coffee

11:15 Jeremy Gray: *Differential Equations – the real (and complex) reasons for Analysis*

12:00 Clare Moriarty: *Ructions over Fluxions: Maclaurin's Draft Response to Berkeley's Analyst*

12:25 Gavin Hitchcock: *Surprises in the history of analysis*

12:50 Lunch

14:10 Brigitte Stenhouse: *Mary Somerville's abandoned manuscripts and the promotion of analytical mathematics in 1830s Britain*

14:55 Steve Russ: *On Limits and Values: their Concepts and Expressions*

15:20 Alessio Rocci: *On Gibbs-Heaviside "interaction at a distance": the curl of a tensor and the generalization of Divergence and Stokes theorems*

15:45 Tea/Coffee

4:15 Kenneth Falconer: *Fractal Geometry through the 20th Century*

5:00 Close

Abstracts

(listed in alphabetical order of speaker)

Kenneth Falconer: *Fractal Geometry through the 20th Century*

The highly irregular objects, now known as fractals, originated as a few one-off constructions, such as the middle-third Cantor set and the Sierpínski triangle, designed to demonstrate specific mathematical features. During the 20th century the common features of these and many other such sets came together into a wide-ranging theory, which has now become an area of mathematics in its own right known as "Fractal Geometry". The talk will reflect on aspects of this development.

Jeremy Gray: *Differential Equations – the real (and complex) reasons for Analysis*

Most histories of mathematical analysis in the 19th century concentrate on the rise of rigour, and that is indeed important. But that can give the impression that rigour was the sole or prime concern of mathematicians throughout the century. This talk will concentrate on a few examples to show how central differential equations of various kinds were in driving mathematics forward, and how increased rigour was part of an ongoing process of discovery.

Niccolò Guicciardini: *The birth and reception of the Newtonian and the Leibnizian calculi*

Most histories of mathematical analysis describe the 18th century as a transition period in between two phases of radical innovation: the 17th century with the advent of the 'common' and the 'new' analyses, namely analytic geometry and calculus, and the 19th century with the development of real and complex analysis, abstract algebra, and the non-Euclidean geometries. Contrary to this view, the 18th century was an extremely creative period in which new concepts and methods were developed. In the first part of my talk, I will present the Newtonian and the Leibnizian versions of the calculus. Most notably, I will ask a question concerning the Newtonian calculus that deserves our attention. In the second part, I will give a general outline of the reception and profound transformation of these two mathematical heritages in the 18th century. I will propose another question concerning the development of calculus during the Enlightenment.

Gavin Hitchcock: *Surprises in the history of analysis*

This talk will survey some of the most 'surprising' episodes in the story of analysis, as experienced by my undergraduate students and myself, in many years of teaching analysis with the help of its history. I would expect most of my selections to be similarly surprising for any teacher or student of a standard university analysis course today who knows little of the history. Many episodes retain the element of surprise even when pains are taken to think contextually and not in terms of hindsight and heritage. Some may be interesting and even remain puzzling to historians, pointing to anomalies demanding explanation or to connections inadequately understood. Episodes may include: the 'fundamental theorem of calculus', Leibniz' 'Interchangeability Theorem', origins of bivariate calculus, improper integrals, analytic treatment of elementary functions, Lagrange and foundations, oppositions and synergies of French formalism and English conceptualism, contrasting Cauchy and Babbage in 1821, Bolzano's insights, Abel's inconsistencies, the curious historical relationship between theoretical abstraction and physical problems, exceptions & counterexamples & changing standards of 'proof', and the question: who 'discovered' uniform convergence and uniform continuity.

Clare Moriarty: *Ructions over Fluxions: Maclaurin's Draft Response to Berkeley's Analyst*

Following the publication of *The Analyst* (1734), numerous mathematicians responded to Berkeley's allegations of rigour violations and a culture of mathematics-laced heresy. Maclaurin's *Treatise on*

Fluxions (1742) addressed itself to Berkeley and shaped the reception of his mathematical views. The published *Treatise* focused on securing Newton's fluxions against Berkeley's claims that they were unrigorous. However, an earlier draft had a different, ideological focus. This text sheds new light on Maclaurin and Berkeley, and points to an interesting cultural dimension that animated early debates about the respectability of analysis. I argue that Maclaurin was concerned with much more than rigour. His initial response helps us to properly contextualise Berkeley's hostilities to mathematics in issues of mathematical reputation and questions about the morality of mathematicians in an emerging culture of mathematical authority.

Alessio Rocci: *On Gibbs-Heaviside "interaction at a distance": the curl of a tensor and the generalization of Divergence and Stokes theorems*

In June 1888, Oliver Heaviside received an officially unpublished pamphlet, written and printed by Josiah Willard Gibbs. Heaviside studied it very carefully and wrote some annotations in the margins of the booklet, which is preserved in the Dibner Library in Washington DC. The two authors developed independently the modern system of vector and tensor calculus and this document is explicit evidence of their "interaction at a distance". After a brief presentation of the pamphlet, we shall present some of Heaviside's annotations related to the history of vector analysis, i.e. Heaviside's generalizations of Divergence and Stokes theorems and the concept known nowadays as the curl of a tensor.

Steve Russ and Elías Fuentes Guillén: *On Limits and Values: their Concepts and Expressions*

At least since Hilbert's celebrated lecture 'Mathematische Probleme' (1900), in which he named Bolzano among those who provided "the arithmetical formulation of the concept of the continuum", it has been common-place to credit the latter with taking the first steps in the nineteenth century 'arithmetisation of analysis'. We shall assess such a claim with reference to his *Rein analytischer Beweis* (1817) and its historical context by giving a sample answer to the question (in traditional examination form): Compare and contrast the concept of limit, and its expression, in the work of both pairs of mathematicians:

(i) Archimedes and Bolzano (ii) Bolzano and Weierstrass.

Brigitte Stenhouse: *Mary Somerville's abandoned manuscripts and the promotion of analytical mathematics in 1830s Britain*

In her 1831 book, Mechanism of the Heavens, Mary Somerville (1780-1872) actively promoted the adoption of analytical methods both to mathematicians and to those natural philosophers who were not mathematically literate. She argued that a true understanding of physical astronomy - the motions and shapes of the planets, moons, and comets - could only be reached by those who understood mathematical analysis. However, although she continued to publish articles and books on the physical sciences, none of Somerville's subsequent works spoke directly to mathematicians nor did they prioritise mathematical questions. This is somewhat surprising considering that Somerville had explicitly depicted analytical mathematics as a fertile ground waiting to be farmed. In this talk I will give an overview of two book-length manuscripts first written by Somerville in the 1830s - one a volume on the form and rotation of planets, the other an analytical work on curves and surfaces. Somerville evidently spent large amounts of time on these technical manuscripts, which include hundreds of hand-drawn diagrams, but in 1834 they were left by the wayside and she instead brought a survey of recent scientific advancements to press in which all the mathematical formulae had been removed. By considering the market for mathematical books at the time, alongside Somerville's place in the scientific community as a self-educated woman, I will demonstrate why these manuscripts remained unfinished and unpublished.

Places to Eat near Birkbeck

- We have **an hour and twenty minutes** for lunch.
- Within Birkbeck (building 1 on the map), on the ground floor by the foyer, there is a **Costa Coffee** open from 9am which has a range of hot and cold sandwiches and snacks.
- Externally there are several shops where you can buy sandwiches and snacks - you can bring these back and have them in the room where we have tea and coffee if you wish. The nearest are the Life Goddess Deli and the Co-op Local on **Store Street**, (South-West of Birkbeck on the map below) or the Pret-a-Manger and Tesco Metro opposite Russell Square Tube.
- The **Marlborough Arms** (36 Torrington Place – west from Birkbeck, passing Waterstones on your left) is the nearest pub, serving standard pub food. The **College Arms** on Store Street is an alternative. It's also where we will likely go for a post-conference drink.
- **Planet Organic** on Torrington Place (turn left out of the main building, then head left along Torrington Place, passing Waterstones and the Marlborough Arms on your left, and crossing Gower Street) sells vegetarian and vegan food to eat in or take away.