## History of Mathematics
## Histoire des mathématiques
(Org: **Tom Archibald** (SFU))

**TOM ARCHIBALD**, Simon Fraser University

*Mittag-Leffler's Theorem: Genesis and Development of a Mathematical Fact*

Gösta Mittag-Leffler (1846–1927) remains well-known, in part for the theorem that bears his name. Roughly this states that one can define a function, meromorphic on a subset of the complex plane, such that the principal parts of the function's Laurent series at a given collection of poles are specified in advance. Mittag-Leffler's original work on the theorem was undertaken exactly in the pattern of his mentor Weierstrass, whose famous 1876 paper on single-valued analytic functions constitutes a kind of template for Mittag-Leffler's research and presentation. Between 1876, when the first version of the theorem was published in Swedish, and 1884, when a long paper on the subject appeared in Mittag-Leffler's new journal *Acta Mathematica*, Mittag-Leffler progressively worked on generalizing the theorem to apply to larger collections of poles and essential singularities. It was in this context that he came to view the work of Cantor on infinite point sets as important, a position which was shared by very few researchers of the time. Indeed, the development of Mittag-Leffler's research allows us to see how the currents of opinion and mathematical fashion shaped the focus of Mittag-Leffler's labours, and to some degree the nature of his results. Based on published and unpublished correspondence with Hermite, Weierstrass, Cantor, Poincaré and others, this paper will look at some highlights of the development and reception of Mittag-Leffler's theorem.

This paper describes joint work with Laura E. Turner (`laurat@sfu.ca`, Mathematics, Simon Fraser University).

**MARCUS BARNES**, Simon Fraser University, Department of Mathematics, 8888 University Drive, Burnaby, BC, V5A 1S6

*Some Aspects of the Mathematical Work of J. C. Fields*

Most mathematicians know of J. C. Fields (1863–1932) as the person for whom the Fields medal is named. Few mathematicians, however, know anything about Fields' actual mathematical work. After a biographical sketch and an outline of Fields' educational background, we will give a synopsis of Fields' mathematical work. If time allows, we will compare Fields' approach to algebraic function theory to that of other approaches that were followed during his lifetime.

**CRAIG FRASER**, University of Toronto

*Analysis and the Emergence of Analytic Mechanics in the Eighteenth Century*

By the middle of the eighteenth century the term analysis had largely lost its original meaning of "solution backwards". As is well known, during the early modern period analysis came to denote algebra and the use more generally of symbolic methods in the solution of problems. When one introduces a variable and derives an equation, one is assuming logically at the outset that the thing that is sought is at hand, even if one does know its value. Hence all methods in which the existence of the thing sought is first assumed as an unknown variable and its value is derived by means of some mathematical process is analytic. Analysis came to encompass algebraic symbolic methods that yielded equations and was contrasted with geometric modes of solution. It was seen not simply as a method but as a subject area in its own right employing processes that were linguistic or symbolic in character. Above all, analysis avoided geometric modes of representation. Synthesis denoted a geometrical conception of the mathematical object in which this object has a whole was taken as given and in which its known properties were used in the course of the investigation.

The elevation of analysis within mathematics was paralleled by the promotion of what was called the method of analysis in other areas of inquiry. In the writings of Isaac Barrow (1630–1677), Etienne Condillac (1714–1780) and Thomas Reid (1710–1796) analysis, understood as a very general process of investigation, was put forward as the way to truth in all branches of inquiry. The paper explores the meaning of analysis in eighteenth-century exact science for the case of analytical mechanics and considers mathematical analysis in reference to the larger intellectual context of Enlightenment thought.

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**ALEXANDER JONES**, Classics, University of Toronto, 97 St. George Street, Toronto, ON, M5S 2E8
*Some Properties of Arithmetical Functions in Ancient Astronomy*

Babylonian mathematical astronomy and its Greco-Roman continuation employed arithmetical functions to model aspects of phenomena. The most characteristic type was the linear zigzag function, according to which a quantity alternately increases and decreases by constant differences between a fixed minimum and maximum value. In modern discussions, zigzag functions are typically described as a sequence of equally-spaced discrete values of a continuous "ideal" function, in which the independent variable is time (not necessarily measured in units of constant duration). For the ancient astronomers, however, the tabulated values of a zigzag function were generated algorithmically, each value from its immediate predecessor.

All zigzag functions used in ancient astronomy had parameters that can be expressed by terminating sexagesimal fractions, and the sequence of generated values repeats exactly after an integral number of steps. Neugebauer demonstrated in the 1940s that such sequences have certain properties that are not obvious from consideration of the ideal function; for example, the mean rate of increase of the running totals of a zigzag function may not be equal to the mean of the ideal maximum and minimum. The present paper will consider whether evidence exists that ancient astronomers were aware of these properties and developed mathematical methods for handling them.

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**DEBORAH KENT**, Simon Fraser University, Department of Mathematics, 8888 University Drive, Burnaby, BC, V5A 1S6
*Analytic Mechanics, Astronomy, and Linear Associative Algebra?: Context and Motivation for B. Peirce's Anomalous Paper*

Throughout the nineteenth century, the mathematical work of Harvard professor Benjamin Peirce primarily involved analysis and astronomy. Nonetheless, Peirce's most well-known work today is *Linear Associative Algebra*, which appeared in the *American Journal of Mathematics* in 1881. This paper contains results foundational to the structure theory of algebras. Considered in context, it comes into focus as the culmination of a lifetime of thought and mathematical work, rather than a departure from earlier research interests.

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**TOKE LINDEGAARD KNUDSEN**, Brown University
*Jñānarāja and mathematical astronomy in early 16th century India*

One of the important astronomers and mathematicians in Indian history was Jñānarāja (fl. 1503) from what is now the state of Maharashtra. His two surviving works, often cited by later Indian writers, are a treatise on astronomy and a treatise on mathematics, none of which has been published.

Based on my research on Jñānarāja's astronomical work, the talk will focus on the mathematical astronomy of Jñānarāja and its place in the history of astronomy and mathematics in India.

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**SHAWNEE MCMURRAN**, US Military Academy, Department of Mathematical Sciences, West Point, NY 10996
*The Impact of Ballistics on Mathematics*

In 1742 Benjamin Robins published *New Principles of Gunnery*, the first book to deal extensively with external ballistics. Subsequently, Frederick the Great asked Euler for a translation of the best manuscript on gunnery. Euler chose Robins' book and, being true to form, tripled the length of the work with annotations. The annotated text was translated back into English, which, two and a half centuries later, brings us to the theme of this lecture.

This work was done in collaboration with V. Frederick Rickey and Maj. Patrick Sullivan (United States Military Academy).

**DUNCAN MELVILLE**, St. Lawrence University
*Reflections on Sargonic Arithmetic*

The mathematical corpus from the Sargonic period of Mesopotamia (ca. 2350–2200 BC) is modest and limited, comprising some dozen problem texts involving sides and areas of rectangular fields. However, this period is situated between the earlier phases of metrological computation and the development of the abstract sexagesimal system in the subsequent Ur III period, and is thus of great interest to historians of mathematics attempting to trace the development of abstraction in arithmetic. Recently, two contrasting theories of Sargonic mathematics have been proposed. We review these theories and analyze the remaining difficulties in interpreting these texts.

**V. FREDERICK RICKEY**, United States Military Academy
*Some History of the Calculus of the Trigonometric Functions*

Can you evaluate the integral of the sine using Riemann sums? Do you think Archimedes could? Is it intuitively clear to you that the derivative of the sine is the cosine? If not, why not? What did Newton and Leibniz know about sines and cosines? When did sines become the sine function? Who is the most important individual in the history of trigonometry? Answers will be provided.

**DIRK SCHLIMM**, McGill University, Dept. of Philosophy
*On the importance of asking the right research questions: Could Jordan have proved the Jordan–Hölder Theorem?*

In 1870 Jordan proved that the composition factors of two composition series of a group are the same. Almost 20 years later Hölder (1889) was able to extend this result by showing that the factor groups, which are quotient groups corresponding to the composition factors, are isomorphic. This result, nowadays called the Jordan–Hölder Theorem, is one of the fundamental theorems in the theory of groups.

The fact that Jordan, who was working in the framework of substitution groups, was able to prove only a part of the Jordan–Hölder Theorem is often used to emphasize the importance and even the necessity of the abstract conception of groups, which was employed by Hölder.

However, as a little-known paper from 1873 reveals, Jordan had all the necessary ingredients to prove the Jordan–Hölder Theorem at his disposal (namely, composition series, quotient groups, and isomorphisms), despite the fact that he was considering only substitution groups and that he did not have an abstract conception of groups. Thus, I argue that the answer to the question posed in the title is "Yes".