MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

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History of Mathematics

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The meeting was organized by Kirsti Andersen (Aarhus, Denmark), Henk J.M.Bos (Utrecht, Netherlands), and Menso Folkerts (Munich, Germany).

It had 42 participants who were engaged in lively discussions on most talks.

The general theme was to assess the image of the history of mathematics in the informed mathematical public which has been created during the last four decades of historiographical research. For this reason a broad spectrum of topics had to be discussed. The main emphasis of the meeting lay upon:

- History of Stochastics up to mid-19th Century
- Mathematics in the Medieval Islamic World
- Mathematics in the European Medieval Period
- Interfaces between Mathematics and Social Practice 1850-1950
- Interfaces between Mathematics and Physics in the 19th Century
- Historical Studies on Ethnomathematics

All topics had a dialogical structure by virtue of a general presentation, followed by a prepared comment, and very extensive discussion.

A small number of talks on additional topics was given, mostly by younger scholars and new-comers to Oberwolfach.

A round-table on the state of the historiography of mathematics concluded the meeting.

The talks, in chronological order, were the following:

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The Development of Stochastics up to 1850 - a Comparison of Different Historiographical Approaches

Ivo Schneider

Currently stochastics is perhaps the one mathematical discipline which attracts more historical interest than any other. The changing images of stochastics within historiographic literature during the past 40 years can be exemplified by an analysis of the following three books:

F.N.David: Games, Gods, and Gambling (1962),

I. Hacking: The Emergence of Probability (1975),

L.Daston: Classical Probability in the Enlightenment (1988).

David is a continuation of Todhunter's classical book (1865), insofar as it projects current mathematical knowledge into the past. By way of contrast, the philosopher Hacking argues that prior to mid-17th century there was no serious conception of mathematical probability. Hacking holds that the present notion resulted from a radical mutation in various Renaissance concepts, including that of evidence. He introduced texts from law, medicine, theology, and logic to substantiate that claim. Daston, who understands herself as an intellectual historian, depicts classical probability as a more or less mathematically codified description of rational behaviour within the élite, which serves as a prescriptive model for the less enlightened. Daston replaces the idea of a progressive development of texts on probability by the notion of context-depending coherent periods which are separated from one another by periods of transition concerning the underlying concepts.

The different interpretations, by the three authors, of Huygens' "De ratiociniis in ludo aleae" serve as an example of the methodological shifts in historiography, as described above.

Comments on the Talk of Ivo Schneider

Sandy L. Zabell

Karl Pearson, who edited one of Todhunter's manuscripts after the latter's death, continued Todhunter's historical interests, lecturing on the subject in the 1920s. During the 1950s and 1960s historical papers appeared in Biometrica, the journal founded by Pearson. F.N.David's book, which is partly based on papers for Biometrica, thus represents the continuing of Todhunter's legacy. Hacking's 1975 book brought a sensitivity to the wider intellectual context largely absent in his English predecessors. Stigler's 1986 book must be regarded separately for it remains largely internalist, albeit informed by contacts with Hacking, Daston, Porter, and others of "externalist" bent.

Given its unique nexus with mathematics, applications, and philosophy, the field of stochastics requires insights from both internalists and externalists for a true picture of its evolution to emerge. The discovery of the normal limit theorem by De Moivre (for Bernoulli trials) illustrates this.

Hilbert - the Doubts behind Formalism. The Reception of Brouwer's Intuitionism, 1921-1935

Dennis Hesseling

The foundational debate between formalism and intuitionism in the 1920s and 1930s was, in general, one-sided. The questions of mathematical existence and of the validity of the principle of the exluded middle were the main themes discussed. However, formalism focused heavily on the critical side of intuitionism, almost completely neglecting its constructive part. As to Hilbert's reaction in his official publications, it was a bit puzzling. In some publications he describes intuitionism as a "Verbotsdiktatur", in others he takes over intuitionist views without even acknowledging so. The conjecture that Hilbert had serious doubts about the views he defended so vigorously in public is confirmed by some of the notes that can be found in the Hilbert archives in Göttingen.

The Doctoral Thesis of Grete Hermann (1901-1984): between Constructive and Abstract Ideal Theory

Silke Slembek

Hermann's thesis is entitled "Über die Frage der endlich vielen Schritte in der Theorie der Polynomideale. Unter Benutzung nachgelassener Sätze von K.Hentzelt." It was supervised by Emmy Noether and published in the Mathematische Annalen 1926.
Hermann emphasizes the necessity of constructive methods. The paper culminates in the construction of a primary decomposition of polynomial ideals. There are some errors in the paper; their appearance is explained and commented. Nowadays the focus has shifted from the errors to the utility of the given constructions and Hermann is referred to as the pioneer who showed that certain ideal theoretic operations can be computed.
The talks ends by telling the story of Hermann's life. As a collaborator of L.Nelson's, she later went into the philosophy of physics. She had to leave Germany in 1936, married in Great Britain and returned to Bremen after the war.

Pictures of the Past: the Case of Arabic Mathematics

Jan P. Hogendijk

By "Arabic" mathematics I mean mathematics in Islamic civilization in the period 700 - 1500 A.D. (the word Arabic refers to language). I assumed that the informed mathematical public obtains the information from general histories of mathematics. So I checked 7 "ancient" histories which were popular 40 years ago (Bell, Bourbaki, Cajori, Hofmann, Sarton, Smith, Struik) and 7 histories which are widespread today (Anglin, Boyer, Burton, Dahan-Dalmedico & Peiffer, Gericke, V.Katz, M.Kline). These histories contain different answers to the question, whether the Arabic mathematicians were only transmitters of mathematical knowledge or whether they did original contributions as well? Many of these histories lack awareness of the results of recent and not so recent historical research on Arabic mathematics. V.Katz, A History of Mathematics, an Introduction (New York, 1993), is a positive exception, among others.

I then discussed six examples of research from the last 50 years which are cited in some of the recent histories of mathematics (research by P.Luckey, A.S.Saidan, S.Ahmad, R.Rashed and others). Much of that research has the potential to influence the general picture, at least to some extent. However, the specialists in Arabic mathematics, a rather esoteric subject, should work harder to inform the general historians of mathematics and mathematicians with real interest.

Comments on the Talk of J.P.Hogendijk

Ahmed Djebbar

A quick comparison of the "image" of Arabic mathematics given by the 7 "ancient" histories with the one presented in M.Chasles' history of geometry in the last century shows that the latter is better and richer. This leads to the conclusion that the development of research from the 19th to the 20th centuries was not sufficient to change the "image" of Arabic mathematics.

It would be interesting to relate the image of Arabic medieval mathematics in Western histories to the "positive" image constructed by contemporaneous Arabic vulgarizations of those sources. Likewise, the "negative" image produced by certain orientalists (e.g.Arnaldez/Massignon in 1957) deserves investigation. The "amelioration" of the image of Arabic mathematics since the 1980s in the francophone region is due to two factors: the publication in French of A.P.Youshkevich's "Les mathématiques arabes" and the appearance of the history by Dahan & Peiffer.

Errors and Approximations in Medieval Indian and Islamic Spherical Trigonometry

Kim Plofker

A fourteenth-century Sanskrit astrolabe text, the Yautraraja of Mahendra Suri, provides the first definite evidence for the incorporation of Islamic spherical trigonometry (from unspecified sources) into Indian astronomy. The Sanskrit renderings of some of these formulas, however, show marked differences from their Arabic counterparts in an earlier Islamic source. The nature of these differences indicates that they may have been introduced as errors due to misunderstanding of the foreign source(s), and transformed into approximations by empirical adjustment in a manner typical of much Indian mathematics.

Development of Mathematics in Western Europe between 1100 and 1500

H.L.L.Busard

The 12th century meant a turning point for medieval mathematics in Europe since translations from Arabic manuscripts brought suddenly a wealth of new knowledge. Until recently there was known only one fragmentary translation of the Arithmetic of al-Hwarizmi. M.Folkerts found a second manuscript which gives the full text. Arabic arithmetic and algebra were diffused via Italian abacus-schools. In the second half of the 15th century the first signs of the birth of a modern algebraic notation appeared in books by German mathematicians (Regiomontanus, Widmann). In geometry three translations of Arabic versions of Euclids Elements were made in the 12th century. These and later revisions shaped the image of the early 16th century of Euclid's Elements. The most important translations from the Greek were done in the 13th century by William Moerbeke. He translated almost all works by Archimedes, and the Eutocius-commentary.

Mathematics in the European Medieval Period

Laura Toti Rigatelli

Following the work of the historian Boncompagni, there was a long interruption in research on medieval mathematics. That research was resumed by Gino Arrighi in 1958. He published many transcripts of complete manuscripts from the 14th and 15th centuries and analyzed even more manuscripts.
In Siena there is a historiographical research group Centro Studi della Matematica Medioevale which is dealing mainly with algebra from Fibonacci to Cardano. There are worldwide only 12 manuscripts which deal exclusively with algebra. However, many abacus-texts

have a chapter on algebra. In the manuscripts we have found four traditions which can be related to four persons:

Maestro Dardi of Pisa (14th cent.) - abacus teacher
Nicolas Chuquet of Paris (15th c.) - physician
Antonio de Mazzinghi (14th c.) - abacus teacher
Piero della Francesca (15th c.) - painter

The tradition of Antonio de Mazzinghi, who is the author of the book "Fioretti", is the one of the school of Florence.

The Changing Historiography of Medieval Mathematics since 1953, and the Resulting Image

Jens Høyrup

About 1950 the history of medieval European mathematics had been considered a dead subject since about 1915. The situation began to change in 1953, when Clagett split the "Adelard Euclid" into "Adelard I", "II", and "III". Since then 5 Euclid versions have been translated which changed our image of a periodization of medieval European mathematics considerably. It is now roughly as follows:

550-780: dominated by Isidor's understanding
780-1050: Carolingian to Ottonian Renaissance
1050-1200: culmination of the Latin tradition
1200-1300: rise of universities, spread of algorism
1300-1400: Bradwardine, Oresme, Albert of Saxony, maturation of abaco tradition
1400-1500: low point of university mathematics, but specialization of roles, allowing new developments in astronomy (Peurbach,Regiomontanus etc.)

Perspectives on Mathematics and the Mathematical in Modernity

Herbert Mehrtens

The talk addressed the question of a "big picture" of mathematics in modernity from the situation of "postmodernity" (or late modernity, disoriented modernity...). The image of mathematics is changing. The hierarchy of "pure", "applied", "elementary" was the self-constructed partly realistic, partly mythical (or ideological) image of 19th/20th century mathematics. Purity was connected with mathematical modernism (sets, axiomatics, structures). The value of purity and the modernist orientation are historical phenomena to be analyzed. Historiography of mathematics has produced and reproduced this image, therefore metahistorical reflection is needed. Blinded out were to some extent applied and application-oriented fields, but more so the "improper" mathematics of formal-symbolic practices with a mathematical aspect to it, like accounting, statistics, standardization, etc. The spread of such practices is of extreme importance in modern, industrialized societies and thus should be in the focus of history of mathematics. Here history of mathematics can connect to various other fields of historiography.

Comments on Paper by Herbert Mehrtens

Donald MacKenzie

Mehrten's work has been amongst the most important in recent history of mathematics. My commentary selected out certain central themes in his talk, such as the distinction between the "high" culture of pure and applied mathematics, and the "low" culture of mathematicized social practices, and posed several questions, for example:

- Is "modernity" too broad a brush. Is it a descriptive or explanatory term?

- Is there a "postmodern" mathematics?
- What is to be gained from the history of mathematicized social practices as distinct from separate histories of statistics, accountancy, etc.?

I conclude with an examination of the relationship between computing and mathematics, noting that computing makes formal proof a practical possibility, rather than just an object of proof theory. Will computerization complete the (incomplete) modernization of mathematics by formalizing the practice of proof?

Changing Views of Mathematics in the Empire

June Barrow-Green

The talk is related to the construction of a data-base built in support of the study of the 19th/20th century British mathematical community. Four main topics to be studied are:

1) Setting up of mathematical departments in new colonial surroundings
2) Mathematical training within Britain
3) The promotion and diffusion of scientific education in the Empire
4) The establishment of specific scientific projects in colonial outposts.

A detailed comparison in this respect is made between the first colonial mathematics department (Sydney 1892) and the high ranking mathematics in Cambridge.

Interfaces between Mathematics and Physics in the 19th Century

Jeremy Gray

In this talk I analyzed pictures of mathematics and physics by considering pairs of relations between Pictures, Authors, B others and X, the subject of the picture (as it might be: mathematics, physics, the growth of a profession). I suggested that the institutional base of authors, A, (in mathematics or humanities faculties in the English speaking world) and their preferred audiences, B, have a marked effect on their attitude to mathematics and, often, the technical contents of science, X. The difficulty of mathematics, X, and its seemingly cumulative nature further conditions for historical accounts given in histories of science or mathematics. The re-presentation of science by T.S.Kuhn (Structures of Scientific Revolution) has allowed more radically historical presentations of science; no comparable revision of mathematics exists. I then turned to specific problems: X = the split between (pure) mathematics and physics, the rise of applied mathematics, and P, accounts of this history. I concluded that seeing mathematics and physics as intimately linked at a conceptual level across the disciplinary divides (19th/20th cent.) and the importance of mathematisation affords a fruitful area of research (one broached by several authors) and calling for a philosophical sensitivity.

Comments on Gray

Moritz Epple

Commenting on the previous talk, I emphasized the need for realistic, causally coherent narratives on the interface between mathematics and physics during the 19th century. Historical realism, though, is no easily achieved goal. The historiographical distinction between the chronicle and the narration of a historical account was introduced, and I argued that both an extension of the chronicle of the history of 19th-century maths and a corresponding modification of the narrative is necessary for a coherent history of the causal weave relating mathematics and physics in the period considered. After hinting at some examples (analysis, group theory, differential geometry) where recent studies have in fact changed the historical picture, the issue of mathematization was discussed. For the 19th century a mathematization of the "Baconian" sciences (like electricity and magnetism) is characteristic which continues processes of mathematization started in the 18th century and is in turn continued by further mathematizations in the 20th century. Addressing this issue could provide a means to link some history of mathematics to general history.

The Disciplinary Split between Mathematics and Physics in the 19th Century: Some Consequences for Mathematics

Thomas Archibald

Historians of physics, notably C.Jungnickel & R.McCormmach, have established the conditions of the disciplinary split between mathematics and physics in the 19th century. Here I discussed with examples from potential theory, some aspects of this split, notably the changes in proof technique connected with the banishment of physical entities from the proof; the shifting of research specialties from a mixed to a pure mathematical situation; and corresponding impacts on physics. Institutional and cultural aspects of this split - such as competition for positions with physicists - were also discussed.

Betti's Contribution to mathematical physics - Dirichlet Principle and Green Function

Rossana Tazzioli

Betti's contribution to mathematical physics - in particular to potential theory, heat theory and the theory of elasticity - were connected with the history of the Dirichlet principle. In potential theory, instead of the Dirichlet principle, another method can be used. Indeed, it is sufficient to find an appropriate Green function in order to solve the given Dirichlet problem. Unfortunately, even this procedure is very difficult. Many mathematicians, such as Lipschitz, Carl and Franz Neumann, and Betti himself, tried to find functions similar to the Green function in order to solve problems in heat theory, magnetism and electrodynamics. As for the theory of elasticity, from his reciprocal theorem Betti deduced some functions, similar to the Green function, which allowed him to express the rotation and dilatation of an elastic and isotropic body in equilibrium by means of the forces acting on the body. Later on Somigliana proved a formula, similar to Green's formula; it describes the displacements of a body by means of the given forces and the displacements of the surface points.

The Theory of Dirichlet Series until 1915

Kurt Ramskov

The paper gave a survey of Dirichlet series until the first book, devoted exlusively to that topic: Hardy and Riesz "The General Theory of Dirichlet's Series", 1915. A general Dirichlet series is an infinite series of the form $\sum a_n e^{-\lambda_n s}$, $\lambda_1, \lambda_2, \ldots \lambda_n \ldots$ The presentation dealt with three topics: 1) Roots of D.S. in number theory: D.S. emerged as tools in number theory in the works of

Euler and, especially, of Dirichlet, who used them systematically. Dedekind, in his edition of Dirichlet's "Vorlesungen", introduced the name "Dirichlet series" for the first time. 2) The classical theory: Cahen's dissertation from 1894 gave the first systematic theory of D.S. as complex functions. That dissertation contained wrong results. In the first decade of the 20th century, the work of E.Landau, who corrected several of Cahen's mistakes, was still motivated by number theory and stimulated the general interest in D.S. 3) Summability theory of divergent series was another stimulus for the theory of D.S.. H.Bohr and M.Riesz were the first to consider summability theory of D.S. in 1909. This branch developed quickly and, in part, in separation from the classical theory, because it is of no use in number theory. The perspective of Hardy's & Riesz's book of 1915 is that of summability theory. However, the classical theory of D.S. continued to be useful in number theory.

Semiotics and the History of Mathematics. 3 Studies

Alain Herreman

The aim of this talk was to present very briefly three studies on the history of mathematics dealing with semiotics. These are: Rotman B.: Signifying Nothing: The Semiotics of Zero, London MacMillan, 1987; Netz R.: The shaping of deduction in Greek mathematics, Dissertation, Cambridge, 1995 (to appear at CUP); Herreman A. :Eléments d'histoire sémiotique de l'homologie, Thèse, 1996, (to appear at Rank Xerox Editions).

The use of semiotics by Rotman offers him the possibility to compare mathematics, painting and economy, stating for example "that Zero is neither more nor less abstract than the vanishing point in a painting or imaginary money".

Netz proposes an analysis of the interdependences of the diagrams and the text. His concern with semiotics is mainly in the distinction introduced by Peirce between icon, symbol, and index. In this respect, he states that letters in Greek diagrams may be seen as indices, rather than symbols.

A part of the work of Herreman's concerns an analysis of the remarks that mathematicians sometimes make in their texts about their own signs. An example is taken from an article of Alexander. Taking the notion of the "frontière" in the works of Poincaré on Analysis situs, Herreman shows that a set theoretical interpretation of it is not correct.

All these works are analysing mathematical signs in a different way than the one suggested by realism, formalism and they pay special attention to the consequences of the written dimension of mathematics.

The Contribution of Ethnomathematics to Our Picture of Mathematics' Past

Marcia Ascher

The basic tenet of ethnomathematics is that the expression of mathematical ideas is intimately related to culture; that ideas arise within cultural contexts and which ideas are emphasized and how they are expressed vary depending on the culture.

The need to clarify what is meant by mathematical ideas and to enlarge our view of context are particularly important when dealing with cultures that do not set mathematics apart as an explicit category. Because there are about 5000 distinct cultures (based on linguistic criteria), recognizing the mathematical ideas of cultures previously ignored introduces considerable diversity and geographic breadth. Ethnomathematics is helping to change a prevalent picture of traditional peoples which was largely based on the late 19th century theory of classical evolution. The notion of a linear universal path that mathematical ideas must follow is being replaced by a more complex and textured mosaic including expressions of different peoples at different times and in different places.

Three examples (Marshall Islands stick charts, logical-numerical recording system of Incas, and Malagasy divination) are used to give substance to the introductory general statements. The examples are chosen to differ in time, place, mathematical ideas, cultural contexts, and individual significance for mathematics' history; all, however, share being substantial systems that are specially learned and carefully passed on.

Ethnomathematics, as a field of inquiry, began in about 1970 although the term itself did not come into use until about 10 years later. Some of the progress since then is cited. Most important is that ethnomathematics is contributing to a more global perspective in the history of mathematics.

General Histories of Mathematics

Ivor Grattan-Guinness

This lecture dealt with the reactions which general histories have made and might make to the mass of specialised work which has been carried out in the last 40 years. An appraisal of some of the better works of this time shows a more sophisticated and informed treatment in many respects, but significant changes of balance and filling of lacunae would make such books much more general than they currently are. The following five topics or aspects were noted (among others):

1) Less uneven a balance between periods so that this and the last centuries have a better airing. It is not necessarily the case that more recent mathematics is harder to understand, especially as it will be closer to mathematics that is regularly taught.

2) A review of Arabic mathematics and its transmission to Europe and use there. Time for a new general history on this topic itself.
3) Proper recognition of applied mathematics, the main driving force into the 19th century. Mechanics and mathematical physics were by far the central part; two more general histories, please.
4) Probability and statistics, often now completely omitted.
5) Education and institutions, especially following the great expansion in the 19th century. The bearing of the education (not) available upon the training of the future research mathematicians should be stressed; and the status of the textbook as a source of research could be examined.

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