Mathematisches Forschungsinstitut Oberwolfach

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Mathematik im Kontext: Geschichte der mathematischen Wissenschaften in der frühen Neuzeit (16. - 18. Jahrhundert)

January 5th – January 11th, 2003

The meeting was organised by Kirsti Andersen (Århus), Enrico Giusti (Firenze), and Volker Remmert (Mainz). During the five days of the conference 17 talks were given and one panel discussion was organised.

The aim of the conference was to present and to focus on new research shedding light on the development of mathematics in early modern times and to connect recent tendencies of researches within the history of mathematics and the history of science. The contextualisation of the development of mathematics directs the attention to the question of the driving forces inside mathematics and the outward effect of mathematics. The conference was characterized by open discussions which, together with the talks and the panel discussion, shed more light on the new interpretations which consider the mathematics of early modern times from the perspective of the mathematics of the time rather than in the light of present mathematics, and the connection between research practice and the demands from 'outside'.

The organizers and participants thank the "Mathematisches Forschungsinstitut Oberwolfach" for making the conference possible in the usual comfortable and inspiring setting.
The abstracts follow in alphabetical order.

Abstracts

Descartes' program for geometry and the obstacles from its philosophical and mathematical context

Henk Bos

Descartes' program for geometry was to provide, once and for all, a canon for the solution of geometrical problems in an exact and genuinely geometrical way. A prerequisite for such a program was the interpretation of "exact, genuinely geometrical". Here Descartes sought answers in philosophical context; he undertook to transfer philosophical criteria for certain knowledge into requirements for the geometrical constructions to be accepted in genuine geometry. Another prerequisite was that a complete method should be elaborated to find acceptable solutions for all possible geometrical problems. Here Descartes took over much of the current practises in the geometry of his time, in particular the early modern tradition of geometrical problem solving. This tradition featured a rather restricted conception of what geometrical problems were, and a recent strong interest in the use of algebra as analytical method to find the solutions of these problems.

The two contexts of his endeavour, the philosophy of method and certainty, and the mathematics of geometrical problem solving, provided stimulation as well as obstacles to his program. I discussed these obstacles and the changes they induced in his visions of geometry and his canons for geometrical construction. I argued that, if judged with respect to Descartes' original intention, the results which constituted the Geométrie, although highly influential and fertile later, constituted in some respects a failure. I argued that in these respects we may see a tragic element in Descartes' geometrical achievements, mixed with the evident success of the techniques he presented.

Exchange of knowledge across the Mediterranean sea in the early modern period

Sonja Brentjes

The early modern period witnessed major efforts to acquire and distribute knowledge in several disciplines closely related to mathematics (astronomy/astrology; geography - cosmography - mapmaking; fortification/military theory) as well as in other fields (medicine, pharmacy, botany, zoology, alchemy, history, chronology, theology, philology) across the Mediterranean sea. The exchange took place in a variety of forms such as travel, purchase of manuscripts and other items, piracy, espionage, diplomatic networking and gift-giving, missionary expansion, trade, and correspondence. The results of the exchange were often fragmentary, irregular, and semi-public. As a result the phenomenon has escaped the attention of most historians of mathematics and science and was reduced to a history of philology and religion. Moreover, the relatively low number of published results of the exchange in the early modern period has induced historians of mathematics and science who took notice of t! he phenomenon to downplay its significance. I presented two examples both taken from cartography/geography/travel, one from the Ottoman Empire, the other from Italy + France, in order to substantiate the claims made above and showed what kind of specific cultural work of transformation took place before knowledge from the one culture was regarded as knowledge in the other culture.

Mathematical science and craft practice in the Scientific Revolution: The reality behind the aspiration

Floris Cohen

Between mid-15th and the end of the 16th century certain craft practises (painting in perspective, fortress building, determination of place on Earth) were improved by mathematical means. Around 1600 this process appeared to receive a big boost from Galileos upcoming program of a mathematical science of the real world. This went much farther, in that it raised the expectation of a radical transformation of rule-of-thumb craftsmanship through mathematical science all across the board. We all know that eventually a science-based technology was to come from this. The leading question of my talk is to what extent such expectations were fulfilled already during the 17th century, at a time of Scientific Revolution, when the program was first tried out. To that end I have surveyed the literature on the ten practical problems for which, in course of the 17th century, mathematical scientists actively sought solutions. It appears that for those already in existence craft improvement either had meanwhile come to a standstill (perspective, fortification) or went somewhat ahead in the same direction as taken before (map making). It further appears that newly undertaken efforts to mathematize craft problems, whether felt to be pressing (musical temperament, windmills, water management, gunnery, geographical longitude) or not (strength of materials, machine efficacy) without exception overshot their mark by far in that, whether theoretically sound in principle or not, they proved of no appreciable use in actual practice. Why not? This appears on historical analysis to be due to underestimation of the world's messiness, to the increasingly apparent shortcomings of the Euclidean doctrine of proportions, to lack of mathematical expertise among craftsmen, and to social distance between craftsmen and mathematical scientists. It further appears that with the newly invented mathematical instruments, the pendulum clock and the telescope, the same pattern manifested itself in a somewhat mitigated form, leading indeed to something faintly resembling our modern, two-way chase between science and technology. The 18th century, between the Scientific and the Industrial Revolution, is really when the hurdles just listed began to be overcome, chiefly through the emergence of craftsmen of a new, scientifically informed kind.

About Viète's work and its impact on the mathematical culture through the 16th and 17th centuries

Paolo Freguglia

The aim of my contribution is an analysis of the work of Franois Viète (1540-1603) in connection with the successive works of the scholars (J. L. Vaulzard (1630), M. Ghetaldi (1630), A. Vasset (1630), J. Hume (1636)). Particularly, I present the fundamental ideas of "ars analytica", some crucial aspects of Viète's algebraic equations theory and some results of the reading by Viète of Diophantus's work (Arithmetica). Of course, my historiographical examination considers the cultural and mathematical context of the second half of the XVI century and the first half of the XVII century.

Analytical tools in d'Alembert's physics

Franois de Gandt

The reception of Newtonian science in France passed through a first stage of philosophical discussions in the 1730'ties. Then came the time of the "géometrie". Newton's Principia were not written in analytical style, but they were progressively reinterpreted in that style. A turning point is the commented edition given by Jacques (173941). The young d'Alembert started from there, and we have an autograph manuscript (circa 1740) commenting this commentary, with a clear preference for analytical methods and an interesting formula for central forces (Huygenian centrifugal force v^2/r plus radius of curvature). Another manuscript of d'Alembert (1741) is a long tentative to decide whether a Cartesian model for the refraction of light can give the usual law of sines. D'Alembert studies carefully the breaking and deviation of a disk entering a fluid, according to various hypotheses of resistance. Another manuscript of 1748 is the witness of a crisis in Newtonian theory (fi! nally solved by Clavius in 1749). D'Alembert tests various modifications of the Newtonian gravitation, to see if they could yield a correct notion for the moon's apogees (an additional fluid, an irregular shape of the moon, the addition of another force). All these texts may be described as experiment on paper, a strategy which is characteristic of a new style in science.

Some aspects of practical arithmetic and Euclidean tradition in Girolamo Cardano's mathematical works

Veronica Gavagna

Girolamo Cardano (1501-1576) was one the most important scientists of the Renaissance. His name is closely connected to the principles for solving cubic equations, but he wrote on a wide variety of topics: medicine, astronomy, astrology, philosophy and others. The purpose of my talk is to sketch how Cardano was, at the same time, one the most important heirs of the abacus mathematics (with Tartaglia and Pacioli) and a careful reader of the classical texts, in particular of Euclid's Elements. I am studying an unpublished manuscript, titled "Commentaria in Euclidis Elementa", which could shed more light on Cardano's early mathematical studies on Euclid. Cardano started writing this 'Euclidean' work in 1535, just a few years before the publication of the "Practica Arithmeticae". In my talk I will try to explore the connections and the differences between these two writings.

Experimental number theory in 17th-century France

Catherine Goldstein

A lasting topos in the history of mathematics opposes empirical recipes and deductive theories. A lasting topos in the history of science opposes experimental and mathematical components of its development. However, mathematicians have repeatedly stressed the experimental aspects of their work and more recently a few philosophers have advocated a deeper analysis of experimentation in mathematics. The early modern period seems particularly interesting to consider in this respect because of the numerous attempts to redefine the structure of mathematical information and to clarify the heuristics of mathematical innovation. Here I shall concentrate mainly on one example, that of Bernard Frenicle de Bessy who wrote a treatise on an experimental method to solve arithmetical problems. Frenicle inherited from his contemporaries a concern for method and an emphasis on problems (as opposed to theorems) but, contrary to Descartes, for instance, he dismissed algebra as an inadequate universal methodological tool, in particular for number-theoretical questions. I shall show how close his proposals are to Baconian foundational suggestions in the Novum Organum (in particular in the systematic use of tables and the treatment of counter-evidence) and how Frenicles work in number theory embodies both the constraints of his immediate mathematical environment, and an alternative logic, proper to mathematical invention, based on a specific notion of mathematical truth and experience.

Intersections between history of mathematics and history of philosophy: the case of Isaac Newton

Niccolò Guicciardini

As a philosopher of mathematics Newton does not compare with Descartes or Leibniz. However he held – and he did so very strongly – certain ideas concerning the nature and object of mathematics. Newton devoted many manuscript pages to the relationships between analysis and synthesis, to the relative merits of symbolic algebra and geometry, to the dependence of geometry upon mechanics. These ideas influenced both the way in which he practised mathematics and the way in which he publicized it. Thus, awareness of Newton's philosophy of mathematics helps our understanding of his mathematical work considerably. In this talk I tried to indicate how Newton's philosophy of mathematics is embedded into more general theoretical concerns which are generally studied by historians of philosophy.

The relationship between the Brouillon Project of Desargues and the Conics of Apollonius

Jan P. Hogendijk

Desargues' Brouillon Project (1639) was motivated by the Conics of Apollonius in various ways. I will begin with a summary of Apollonius' complicated theory of diameters and ordinates of conic sections. Then I will try to explain how Desargues was able to achieve a drastic simplification of this theory by means of his points and lines at infinity. Most of my talk will be based on my article "Desargues' Brouillon Project and the Conics of Apollonius" which appeared in Centaurus in 1991. Copies of this article will be available for all participants of the conference.

From Jesuit textbooks to imperial scholarship: the reconstruction of mathematics in early Qing China (1690-1723)

Catherine Jami

The transmission of mathematical knowledge from Europe to China in the seventeenth century is best understood against a double background: that of education in Jesuit colleges on the one hand, and that of the reconstruction of mathematics as a scholarly discipline in China on the other hand. In the last decades of the Ming dynasty (1368-1644), scholars and higher officials interested in "Western learning" (xixue) advocated its study both as a tool for statecraft and as body of certain, verifiable knowledge.

After the advent of the Qing dynasty in 1644, and especially under the Kangxi Emperor (r. 1662-1722), an all-embracing reconstruction of learning was undertaken under imperial patronage. As part of this enterprise, an Office of Mathematics (Suanxueguan) was created in 1713: it was commissioned to compile compendia in mathematics, calendrical astronomy, and musical harmony. In the talk I focused on the mathematical compendium, Shuli jingyun ("Essential Principles of Mathematics", 1723), and discussed its structure and composition.

Recent research (by Han Qi and myself) has shown that this work was in great part based on the lecture notes written by Antoine Thomas (1644-1709) who was one of Emperor's tutor in mathematics in the 1690. Three of his treatises (on calculation, algebra, and the "Elements of calculatis" respectively) are discussed im my presentation.

Benedetto Castelli's science of waters

Domenico Bertoloni Meli

This talk presents a few observations on the origins, development, and reception of Benedetto Castelli's science of water in the period from Galileo to Newton. The talk is largely based on the analysis of subsequent editions of his book "On the measurement of running waters", his key work on the subject. The book was first published in 1628 and went through two subsequent editions in 1639 and (posthumously) in 1660. In 1661 it was translated into English and in 1664 into French. The talk focuses on the link between theory and experiment, experiments and model construction, and the role of geometric diagrams.

Magnetism and mathematical navigation: contexts of development for practical mathematics in early modern England

Katherine Neal

The paper focuses on exploring the relationships between the development of William Gilbert's magnetic philosophy and practical mathematics, leading to the famous 1600 publication of De Magnete, the seminal work in this period on magnetic and electrical phenomena. Emphasising the impact of Gilbert's natural philosophy on later mathematical practitioners, the intersections between magnetism, mathematical navigation, and the development of practical mathematics will be examined.

One of the reasons Gilbert's magnetic philosophy attracted the attentions of other, competing natural philosophy innovators was the fact that it so obviously and persuasively drew upon and fed back into the practical mathematics tradition. This paper explores some of these interactions: Magnetic philosophy was extremely persuasive partially because of its close association with terrestrial magnetism, and its promise of utility in navigation, mainly through its supposed bearing on determining longitude at sea. Mathematicians such as Edward Wright, Henry Briggs, and Thomas Blundeville had been quite willing to work with Gilbert, supplying him with tables and navigational information because of this association. The work of practitioners such as Robert Norman, who were clearly in the navigational tradition, was also utilised by Gilbert, philosophically as well as rhetorically aiding the claims to utility. In turn, Gilbert's philosophy provided an experimental framework for late! r practitioners such as Edmund Gunter and Henry Gellibrand that resulted in the discovery of secular changes in magnetic variation.

In sum, at the most general level, the paper aims to elucidate some of the interconnections between the development of practical mathematics, particularly logarithms, with magnetic philosophy, and mathematical navigation.

Perspective as a mixed science

Jeanne Peiffer

Since the 1990's, disciplinary maps and its alterations are on the agenda of history of science. The emphasis being on the actor's categories, those of subordinate, middle or mixed sciences, and their development in the early modern period, were studied by colleagues as Jean-Marie Mandosco, Anna de Pace and Peter Dear. In a short first part, I rely on my reading of these secondary sources to brush a rough picture of this category, between physics and mathematics. In a second part of this lecture, I will turn to perspective, a geometrical device invented by the painters somewhere between the end of the 13th century (Giolto in Assisi and Padua) and the quattrocento Florence (Brunelleschi). This invention has slowly given raise to a new discipline, mathematical perspective (and later, with Desargues, projective geometry). How will "perspective" fit into the existing schemes? My focus was on some perspective texts of the second half of the 16th century, when more foundational! or mathematical questions were asked by personalities like Barbaro or Danti. How do these writers, with a theoretical background, take the mixed character of the ancient perspectiva (or optics) into account? What disciplinary space do they attribute to the perspective of painters, the perspectiva artificialis? These are some of the questions I have adressed in this lecture.

Johann Bernoulli's lectures to the Marquis de l'Hôpital

Patricia Radelet

At the end of 1691, the young Johann Bernoulli, 24 years old, arrived in Paris where he met Malebranche and l'Hpital. Rapidly they convinced him to give some lectures about the new differential and integral Calculus. He did so until the summer of 1692. During the summer, he went to Ouques with l'Hôpital, where he gave him some private lectures. After his return to Basel, he kept writing and answering the questions l'Hôpital asked him by letter. In fact, a kind of contract linked the two men. Looking through Johann Bernoulli's autobiographies, the correspondence between, Johann Bernoulli, L'Hôpital and Varignon, and a letter Johann wrote to Montmort on May the 21st 1718, we'll try to better understand the relations between Johann Bernoulli and l'Hôpital as well as the scientific part Johann took in l'Hôpital's publication "L'analyse des infiniment petits" which was published in 1696.

On bridging the gap: reflections on internal versus external approaches to early modern mathematics

David Rowe

Early modern science and mathematics were linked in numerous ways, and yet relatively few studies have managed to illuminate these manifold interrelations. Internal studies continue to dominate the literature on the history of mathematics, but these may in some cases serve as springboards for more general studies. Henk Bos's recent book on Descartes' Geométrie is an excellent case in point, particularly since he illuminates the intellectual context, that preceded Descartes so successfully. For the classical background one can refer to Wilbur Knorr's study on the ancient tradition of geometrical problems, though Knorr mainly concentrates on special aspects and technical issues. Bos gives a masterful description of the early modern counterpart, in particular the complex chain of research activity in connection with Commandini's 1588 edition of Pappus' Collection. This work contributed to a major preoccupation of the era: methods of discovery and proof. These methodological concerns inside mathematics went hand in hand with innovations in natural philosophy and epistemology. Descartes, Newton, and Leibnitz all reflected on such matters. I will sketch a line of development from the reception of Pappos to Newton's Principia and the Newton-Leibniz "debate". In doing so, I will attempt to show how the changing terms of conflicts over analysis and synthesis (old and new) informed the larger debates familiar from classic studies in the history of science (Koyré et al).

Harriot, Viète and Descartes: "The greate invention of Algebra"

Jackie Stedall

Thomas Harriot (1560-1621) left behind hundreds of manuscript sheets on astronomy, optics, geometry and algebra, most of which have never been published. Some of the algebra was published posthumously in the 'Artis analyticae praxis' in 1631, but was badly edited and often bears little resemblance to the original. I have reassembled, reordered and translated 140 sheets of Harriot's algebra, and the result is a coherent and self-contained treatment of polynomial equations, which I have called the "Treatise on equations". I will discuss the contents of this treatise and show how Harriot's algebra derives from Viète's; I will also discuss the possible influence of Harriot on Descartes.

Willebrord Snellius (1581-1626): A humanist mathematician

Liesbeth de Wreede

In this paper, I will present Willebrord Snellius as a humanist mathematician. This means that I will not focus on his technical innovations, but on his mathematical style. I suggest that he should be considered an innovator in style and that this perspective is important for evaluating Snellius' part in the mathematics of his time.

This style was 'humanist mathematics': studying mathematics within the framework of humanist learning. This means that the problems and techniques of antique mathematics were Snellius' main point of reference, that he wrote in an eloquent Latin style and included large historiographical paragraphs in his texts, referring to classical authors to found his arguments. Other scholars also combined humanism and mathematics, yet none of them seems to have explored this combination so profoundly as Snellius did. One of the advocates of mathematics as part of the humanist curriculum was Petrus Ramus, the controversial French philosopher, who influenced Snellius. Ramus was no mathematical specialist, however, which meant that he influenced part of Snellius's motivation for studying mathematics, but not the content of his books.

One of the reasons why Snellius explored this style may have been his wish to acquire an appointment in Leiden university, which had a tradition of humanist scholarship. He indeed became a professor of mathematics in 1613. Leiden university, the fame of which was rapidly increasing and where – in contrast to most early modern universities – research played an important part, was a very fertile soil for Snellius' 'programme'. This consisted of dealing with all mathematical sciences in a humanist way in order to show that mathematics was a worthy topic, whose importance stretched far beyond the propaedeutical programme in the 'artes'.

Edited by Tinne Hoff Kjeldsen and Annette Imhausen

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