MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

T a g u n g s b e r i c h t 18/1994

Geschichte der Mathematik: Innovation und Transmission, Rezeption und Transformation

21. - 30. April 1994

Die Tagung fand unter Leitung von K. Chemla (Paris), E. Knobloch (Berlin) und J. Peiffer (Paris) statt. An ihr nahmen 43 Mathematikhistoriker aus 13 Ländern teil. Zu Beginn der Tagung wurde der zehn Mathematikhistoriker gedacht, die seit der 31. Oberwolfacher Tagung zur Geschichte der Mathematik (April 1992) starben: Jean Dieudonné, Juy Hirsch, Morris Kline, Si Jimin, Fëdor Andreevich Medvedev, Herbert Oettel, Aydin Sayili, Shimodaira Kazuo, Peter Wallis, Adolf Pavlovich Yushkevich. In den insgesamt 32 Vorträgen wurden die verschiedensten Fallbeispiele aus der Geschichte der Mathematik von der Antike bis in unser Jahrhundert behandelt. Es wurde demonstriert, auf welchen verschiedenen Wegen mathematisches Wissen überliefert, rezipiert und dabei verändert und weiterentwickelt wurde.

Im Mittelpunkt des Interesses standen die allmählichen Transformationen, denen das mathematische Wissen ausgesetzt ist, wenn es zwischen Personen, Schulen, Institutionen, Kulturen, Sprachen und Disziplinen weitergeben wird und nicht die großen revolutionären Umbrüche, von denen die Wissenschaften im 16. und 17. Jahrhunderts geprägt wurden. Das Studium der - oft übersehenen und häufig unterschätzten - lokalen Veränderungen wurde als eine hilfreiche Methode betrachtet, die dazu dienen kann, die historische Entwicklung der Mathematik besser zu verstehen. In ihren Vorträgen konzentrierten sich die Referenten darauf herauszustellen, wie mathematische Innovationen entstanden sind, auf welche Weise Wissen transformiert wurde und wie sich neue Konzeptionen, Methoden und Disziplinen innerhalb der mathematischen Gemeinschaft durchsetzen und etablieren konnten. Als mögliche Zugänge, die der Historiker nutzen kann, um die Transmissionsprozesse zu analysieren und zu beschreiben, wurden - in den Diskussionen und dem abschließenden Rundtischgespräch - u. a. folgende erarbeitet:

-die Analyse des sozialen Kontextes, in dem das mathematische Wissen verhandelt wurde, indem z. B. Korrespondenzen und gegenseitige Referenzverweise ausgewertet werden, um über die sozialen Netzwerke Aussagen treffen zu können;
-die historische Analyse des inhaltlichen Kontextes, in dem der Transmissionsprozeß als eine Selektion und Interpretation von Wissen abläuft; diese Sichtweise ermöglicht, das konkrete Bedingungsgefüge zu untersuchen, in welchem sich dem Mathematiker die Probleme stellen und er seine individuellen Lösungsentscheidungen fällt.

Vortragsauszüge

S. BRENTJES:

The Arabic translations of Euclid's "Elements" and their transmission

According to Medieval sources and their contemporary interpretations two major traditions shaped the Arabic transmission of Euclid's "Elements": two versions prepared by al-Ḥajjāj b. Yūsuf b. Maṭar (fl 850) and the translation made by Isḥāq b. Ḥunain (d 911) and its edition by Thābit b. Qurra (d 901). Based on earlier studies The speaker formulated expectations about what characterizes a text belonging to one or the other of the two traditions. Then she presented some descriptions of the preserved Arabic manuscripts, their relation to my expectations and certain similarities and differences between them, the Greek edition of the "Elements", three Arabo-Latin translations of the 12th century and three commentaries on the "Elements".

C. SCRIBA:

The Chinese Remainder Problem - some remarks and queries about innovation and transformation during the process of transmission and reception

The Chinese remainder problem was solved in antiquity and the middle ages by at least three different methods, developed in China, India, and Byzantium. It is closely related to Euclid's algorithm ever since the Renaissance mathematicians described, improved and transformed the methods of solution. But in addition they also presented the statement itself in various formulations. Even if one does not pay attention to the changes in symbolism, the variations in the point of view, and hence in the interpretations, are obvious. For the historian this raises the question whether the analysis of such modifications can improve our understanding of the development of mathematics as a component of culture, or even as a cultural clue.

H.-J. WASCHKIES:

<u>Die wissenschaftstheoretische Deutung der Geometrie der Antike und deren Rezeption durch Kant</u>

Aristoteles vertrat die Ansicht, daß der Geometer beim Konstruieren Strukturen, die zuvor nur latent vorlagen, in die Wirklichkeit überführt. Kant, der eine Variante von Proklos aus Chr. Wolffs Schriften kannte, benutzte sie in seiner vorkritischen Periode als Prämisse für seinen physiokratischen Gottesbeweis (1763). Während der vorkritische Kant noch meinte, daß der Mensch im absolut gedachten Raum nur Figuren entdecken kann, die Gott zuvor geschaffen hat, sieht der kritische Kant in ihnen Schöpfungen des menschlichen Verstandes, der die bloße Form der Anschauung dabei spontan näher bestimmt. In beiden Fällen folgt für Kant, der sich dabei an der Wissenschaftstheorie von Descartes orientiert, daß die Sätze der Mathematiker mit apodiktischer Gewißheit gelten, weil man sie primär durch unvermitteltes und damit im Prinzip gegen jede Täuschung gefeites Betrachten vom Objekt gewinnt.

S. UNGURU:

<u>Apollonius and Descartes</u>

The <u>Conica</u> are a geometric treatise. Its formal structure, overall conception, argumentative structure, approach to the sections and to their <u>géométrie</u>, and on the other hand, its generous use of algebra to solve geometrical problems, make it an entirely different kind of book. In it "elements" became "method", finding a fourth proportional became multiplication and division, the geometrical construction of a curve became the setting up of an equation, finding a normal to a curve became the construction of a equation of a certain type (form), etc. Descartes sometimes thinks that he has merely recovered the hidden sources of Greek mathematics. This is not an accurate belief. It seems rather to be the case that Descartes' algebraic approach represents a veritable revolutionary reinterpretation of the ancient Greek mathematical texts.

H. BOS:

On Descartes' role in the development of the number concept

There is a remarkable difference in the assessment of Descartes' role in the development of the number concept between historians of philosophy on the one hand and historians of mathematics on the other hand. The latter tend to place and evaluate Descartes' achievement within a line of development leading to the modern definition (Dedekind, Cantor) of real numbers **R**, based on the natural numbers **N**, to structures related to **R** and to later variant conceptions of the continuum. Among historians of philosophy we find another view, which emphasises the successive stages of abstraction of the concept of number and which disregards the Cantorian continuum, or any reduction of real numbers to natural ones. It appears that the difference of viewpoints cannot be simply dismissed as an unfortunate misunderstanding on the part of one of the scholarly groups involved. Rather, it suggests some interesting problems concerning the historical study of mathematics and the problems caused by the "fluidity" of most concepts in past mathematics.

H. BREGER:

Fermat's letter to Brulart de St. Martin

Since its publication in 1919, Fermat's letter to Brulart has always been considered to be very important, although the interpretations of the letter differ. Fermat tries to argue that his method of extreme values is generally valid, admitting that he is giving an incomplete version of his argumentation. Some historians claim that Fermat's argumentation is wrong. Our difficulties in understanding Fermat are to a large extent due to a process of translation and reception. Fermat is thinking of neither index notation nor functional notation, but explains his ideas with reference to a particular example. The change in the level of abstraction seems to be a characteristic feature of mathematical progress.

M. PANZA:

Different Interpretations of Taylor's Theorem in the XVIIth and XVIIIth centuries

In our modern sense Taylor's Theorem does not appear in mathematical texts of the XVIIth and XVIII centuries. Nevertheless the mathematicians of the period derived two propositions which - taken together - are close to such a theorem with respect to real functions. The propositions are:

1. If y=y(x) is a function, then the series:

$$\sum_{0}^{\infty} k \frac{d^k f(a)}{dx^k} (x-a)^k$$

coincides with the expansions obtained from f(x) by exclusively algebraic methods.

2. A power series $\sum_{0}^{\infty} k A_k (x-a)^k$ converges to y(x) on an interval $(a-\delta, a+\delta)$ with $\delta \neq 0$, $\delta \neq dx$

The speaker have discussed different interpretations and formulations of such propositions in Newton, Taylor, Stirling and Euler comparing them with results obtained in the Leibnizian tradition.

F. DE GANDT:

Reception of Newton's Principia on the continent

As a starting point the speaker presented two contrasting formulas for the evaluation of central forces of Newton (1687) and of D'Alembert (1739, 1743). The first is geometrical and involves only the center of forces. The second is more convenient for analytical treatment and involves 2 centers: the center of curvature C and the center of force. D'Alembert considers the second formula as a combination of two elements from Huygens' work: the formula for centrifugal forces and the determination of curvature via evolutes.
This historical picture is false, but has some truth in it: the development of the theory of central forces on the continent was enriched by the cartesian "schools", by the use of leibnizian calculus.

N. GUICCIARDINI:

British Newtonians and the treatment of central force motion

J. Bernoulli, J. Hermann and P. Varignon devoted general papers to the solution of the problems that Newton had faced in the Principia. Their efforts to translate Newton's geometrical dynamics into the analytical language of the differential and integral calculus led to the foundations of analytical dynamics. It is less known that also British mathematicians had a program concerning the Principia that implied a rewording of Newton's masterpiece in terms of the fluxional calculus. The result of the efforts of Newton, David Gregory and A. de Moivre was a paper, signed by Keill and published in 1708. Here the inverse problem of central forces was handled with the help of fluxional equations. The speaker compared Keill's analytical dynamics with a theory proposed by Varignon, Hermann and J. Bernoulli.

M. GALUZZI:

Lagrange's paper "Recherches sur la manière de former des tables des planétes d'après les seules observations" (1772)

This paper of Lagrange is a remarkable achievement in the history of trigonometric interpolation, even if it is difficult to consider it as a real tool to make practical astronomical tables. Anyhow, the paper contains much more than formulas to interpolate (generalized) trigonometric polynomials. Just to name a few things, it contains a fine algorithm to obtain " Padé approximants" from given series, and it suggests a use of a class of polynomials, very similar to Chebyshev ones, in number theory.

H.PIEPER:

Eulersche und Jacobische Reihe-Produkt-Identitäten

Der Euler-Legendresche Pentagonalzahlensatz (Eulersche Identität), die Jacobische Tripelprodukt-Identität, der analytisch eingekleidete Fundamentalsatz der elementaren Zahlentheorie und andere Reihe-Produkt-Identitäten sind Beispiele aus der Geschichte der Zahlentheorie, die zeigen, wie mathematische Sätze bei ihrer Weitergabe an jüngere Generationen bzw. bei ihrer Übertragung in andere mathematische Disziplinen transformiert worden sind und dadurch Neues hervorgebracht haben.

CH. HOUZEL:

Gauss and the Transformation of Analysis at the beginning of the 19th century

The process of Transformation of Analysis in the 19th century is a complex one, with two separate steps: one at the beginning of the century, the other after Riemann. The first step itself is not homogeneous, coming from different authors with different points of view. The transformation of analysis is linked with precise problems rather than with an abstract lack of rigour. This is illustrated by the case of Gauss and three of his papers: the 1799 thesis on the fundamental theorem of algebra (existence problem); the 1813 paper on hypergeometric functions and the 1811 letter to Bessel (definition of new transcendental functions). The new conception of rigour comes out of a new way to do Analysis.

R. TAZZIOLI:

The Riemann Mapping Theorem - Its Reception and Reinterpretation by Schwarz

In his Inaugural dissertation Riemann proved - by using Dirichlet's principle - that every simply-connected region having at least two boundary points can be mapped one-to-one onto a circular disc by means of an analytic function. As in the late 1860s Dirichlet's principle began to be questioned, Schwarz proved Riemann's mapping theorem for particular simply-connected regions without using it. Schwarz criticized Riemann's proof but did not reject his mapping theorem. He did not formulate a rigorous proof of Dirichlet's principle, but tried to put Riemann's mapping theorem on a solid basis with a new proof.

U. BOTTAZZINI:

Geometry and "Metaphysics of space" in Gauss and Riemann

Which is the "true" geometry of space? This is the crucial question which dominated Gauss' research on the principles of geometry and the axiom of parallels. Even his paper "Disquisitiones generales circa superficies curvas" was, in his words, "deeply entwined" with "the metaphysics of space". Further references to this can be found in various papers by Gauss (1831, 1846): In this connection one can also understand his allusions to multi-dimensional manifolds. Inspired by Gauss's ideas, in his 1854 lecture Riemann tried to answer the same question and related questions concerning the laws of the propagation of natural phenomena.

H. SINACEUR:

Transformation eines Satzes über die Zahl der reellen Wurzeln eines Polynomes von Fourier zu Sylvester

Der algebraische Satz von Sturm liefert eine algebraische Methode, mit der die Werte der reellen Wurzeln eines Polynoms bestimmt werden können. Die erste Rezeption des Satzes, sein Beweis mit Hilfe eines ähnlichen Satzes von Fourier und seine erste Transformation durch Sylvester, Cayley, Hermite und Borchardt lassen folgende Schlüsse zu:

1. Mitunter besteht ein Zusammenhang zwischen der inneren Bedeutung eines Resultates und seinem glänzenden und sofortigen Erfolg.
2. Oft treten Transformationen und Transmissionen gleichzeitig auf. Umformungen können so umfassend erfolgt sein, daß die Übereinstimmung zwischen dem ursprünglichen Satz und dem davon abgeleiteten nur noch schwer zu erkennen ist.
3. Innovationen entstehen oft dann, wenn verschiedene Kontexte zusammenwirken, deren Beziehungen untereinander oft nicht auf den ersten Blick hin sichtbar werden.

J. DHOMBRES:

<u>Reception and Transformation: the History of Logarithms from Bürgi and Napier to Newton</u>

A challenging fact in the history of mathematics is the length of time it took for logarithms to be included whithin mathematical knowledge: a large diffusion in the early twenties of the seventeenth century, a period of silence considering the theoretical point of view, a long period of oblivion and, suddenly in the sixties the unquestionable presence of logarithms in papers, books, i. e. in the mathematical consumer. The paper tries to raise a certain number of issues by focusing on the specialized point around the formula $\log n = \int \frac{dx}{x}$. How was it obtained in the middle of the 17th century (before integral calculus as such was created)? How was it received and what was the status of such a result?

A. MALET:

<u>The Remaking of Indivisibles in Seventeenth-Century Mathematics</u>

As is well known, the notion of indivisibles changed markedly during the 17th century. This paper aims to provide some tentative answers to the questions of why and how the change of both notions, indivisibles and infinitesimals, provided by Barrow and Wallis, occurred in the 1660's and 1670's. It is argued that concerns with rigour and the conceptual formulations of the method of indivisibles led these mathematicians to substitute infinitesimals for indivisibles.

V. JULLIEN:

The Indivisibles of Roberval - Transmission of a doctrine of a "petite différence"

About his own indivisibles, Roberval writes that there is a "petite différence" in comparison with those of Cavaleri. What about this "petite différence" which seems to be, in fact, a big move in the infinitesimal method? Roberval refuses to compare "hétérogènes" and tries to build a doctrine - as he says - with homogeneous indivisibles. The speaker showed by three examples from "The Traité des Invisibles" what kind of indivisibles Robervall actually used for demonstrations.

C. S. ROERO:

The reception of the Leibnizian calculus in Italy (1700-1720)

The Leibnizian calculus appeared in Italy at the beginning of the 18th century, when some mathematicians, interested in the new methods, began to read by themselves the Acta Eruditorum and the *Analyse* by L'Hôpital. To see how the reception took place we can divide the first twenty years into three parts: 1. 1700-1707: The principal center of study of the calculus was Bologna. Two books on differential and integral calculus were published (Grandi 1703, Manfredi 1707), but they exerted little influence on Italian mathematics. 2. 1708-1713: Hermann taught at the University of Padua. His main purpose was the diffusion of the Leibnizian calculus in Italy and he attained it through his public and private lessons, his articles published in the Giornale de'Letterati (GLI) and his relationships with Italian mathematicians and scientists. 3. 1714-1720: Many writings in the GLI and some books show the use of the Leibnizian calculus by Italian mathematicians (Manfredi, Riccati, Checozzi, Fagnano, Poleni, Zendrini, Michelotti) to solve problems of geometry, physics, hydrodynamics, mechanics and medicine.

J.VAN MAANEN:

History in mathematics education: the ultimate case of transmission and reception

These years an active movement is going on in Europe and the USA which tries to improve mathematics teaching by introducing elements from the history of mathematics. In the talk the speaker discussed this movement along the following lines: 1. aims and activities within this movement; 2. some recent work done in the Netherlands; 3. two examples taken from his own teaching; 4. work to be done: educational research on the question whether history in mathematics education improves the qualitity of mathematics teaching and work to be done by historians of mathematics in supplying material to teachers and their students. This is a large and important "market".

P. ENGELFRIET:

"Chinese reconstructions". Interpretations of Euclidean constructions in 17th and 18th century China

In 1607 Euclidean geometry was introduced into China in the form of a translation of the first six books of Clavius' Latin version of Euclid's Elements (1574 first edition). Euclidean geometry brought several new concepts to China. This paper concentrated on the notion of geometrical constructions. Constructions were used by Chinese mathematicians to reinterpret traditional mathematics, while on the other hand traditional techniques were used to rewrite Euclidean constructions. First some peculiarities of the edition of Clavius were discussed. Then examples were taken from Chinese works that took over Euclidean material or methods, to show some problems in the dealing with constructions. The speaker tried to analyse the nature of these problems, offering some possible causes. Also, relevant aspects of the general cultural and historical context were discussed.

I. GRATTAN-GUINNESS:

Non-transmission: a non- und a late arrival

One is tempted to think that progress is inevitable, with opportunities always seized. However, this is far from being the case, as the speaker illustrated with two examples. First we have the part/whole theory. The traditional way of handling collections in philosophy is to be distinguished from set theory. It has *never* entered mathematics properly, even though it was a staple part of algebraic logic. Secondly, we have the late arrival of linear programming. It took off like a rocket after 1947: but its pre-history runs back 170 years, not only in partial traces but with the basic realization of the full theory on at least two occasions. Yet the progress was so slight that these anticipations played no role in the launch of the theory. Why was this so?

D. E. ROWE:

Examples of innovation and change in French & German Projective Geometry

The standard accounts of early 19th century projective geometry (Chasles, Coolidge etc.) have stressed a tradition of synthetic methods that were dominant in the French school (Monge, Gergonne, Poncelet) and the emergence of analytic methods in Germany, beginning with Plücker and Möbius. A closer examination of the techniques and ideas central in the work of Poncelet and Chasles reveals that algebraic concepts guided many of their key results. Plücker's work, on the other hand, made explicit use of algebraic formalism but it was largely employed to illuminate geometric relationships rather than as a tool to calculate or prove new results. Thus, the standard dichotomy between the French synthetic tradition and the German analytic approach during this period obscures important similarities and links between the work of the leading figures involved.

J. W. DAUBEN:

Abraham Robinson and the History of Mathematics: The Creation, Transmission, Transformation and Reception of Nonstandard Analysis

Abraham Robinson himself pinpointed the moment at which the idea for nonstandard analysis flashed across his mind -- as he was walking into Fine Hall where he was teaching in the Department of Mathematics at Princeton University in the Fall of 1960. That sudden, creative inspiration, however, was the result of Robinson's decade and more of research devoted to pioneering studies of model theory and a recent interest in Skolem's contributions to nonstandard arithmetic. The creation of nonstandard analysis was communicated almost immediately by Arend Heyting to the Dutch Academy of Science in April and soon thereafter was published in the Academy's Proceedings.

M. EPPLE:

Branch points of algebraic functions and the beginnings of modern knot theory

Many of the key ideas which formed modern topology grew out of normal research in one of the mainstreams of 19th century mathematical thinking - the theory of algebraic functions - and were finally separated from this context. One example of this process were discussed. Modern knot theory was formed after a shift in the mathematical perspective on the problems investigated by the Austrian mathematician Wirtinger which resulted in an elimination of the context of algebraic functions. This shift, clearly visible in M. Dehn's pioneering work on knot theory, was related to the deep change in the normative horizon of mathematical practice which brought about mathematical modernity.

R. SIEGMUND-SCHULTZE:

<u>The transfer of European, esp. German mathematics to the USA - outline of a project</u>

The talk outlined some social and intellectual levels of investigation for a deeper understanding of the shift of world-leadership in mathematics from Europe to the USA between the two World Wars. The different attitudes of two leading American mathematicians, George David Birkhoff and Oswald Veblen, towards the German tradition are mentioned. In some detail the German-American collaboration in the "annus mirabilis" 1931 in ergodic theory is examined. Birkhoff's contribution to European-American mathematical communication, especially as an envoy to Europe of the International Education Board (Rockefeller) in 1926 is discussed. The talk ends with some tentative discussion of the reasons for the "late arrival of applied mathematics in the USA".

A. DAHAN-DALMEDICO:

<u>Transformation and transmission in dynamical systems in the XXth century</u>

The lecture presented how some methods and results in Poincaré's works, concerning qualitative theory of differential equations and hamiltonian systems, have been transmitted and received: in the Soviet-Union during the first half of the XXth century and in the USA after World War II. In the first case, a brilliant schools in physics and non-linear mechanics (in particular Andronov at Gorki, Krylov and Bogolyubov at Kiev) used them in a completely different frame work of dissipative systems, for the needs of sciences of engineers and physics. In the second case, the speaker insisted on the role of Solomon Lefschetz and his school at Princeton who was at the origin of the renew at of the domain - mathematicians rediscovered these results, often through the Soviet school, and only after reading again Poincaré's works.

S. S. DEMIDOV:

The birth of the Soviet mathematical school

At the end of the nineteen twenties and the beginning of the nineteen thirties the "Soviet mathematical school" was founded. This was, first of all, the result of a synthesis of the Moscow school founded by D. F. Egorov and N. N. Luzin, the Petersburg school founded by P. L. Chebyshev and also some provincial mathematical schools. Its appearance was provoked by factors external to mathematics, mainly the extreme centralization of political and economic life in the USSR, a natural consequence of the centralization of scientific and cultural life. The state dictated scientific, educational, and personal policy in mathematics in all areas of the country. The best mathematicians accumulated in Moscov because of the transfer of the Academy of Sciences and the Steklov Institute from Petersburg to Moscow. Although mathematical life was important in other parts of the country - in Ukraine for example - the centralization of the system was a very dominant feature.

G. FRAISER:

The Calculus of Variations 1875-1900: A study in conceptual Change in the History of Analysis

The paper investigated the transformation that took place at the end of the 19th century in the calculus of variatious. It did so by comparing two American textbooks, Lewis Buffett Carll's "A Treatise on the Calculus of Variations" of 1885, and Oskar Bolza's "Lectures on the Calculus of Variations" of 1901. The older conception contained in Buffetts's treatise was contrasted with the new understanding presented by Bolza and based on Bolza familiarity with Weierstrass lectures. Special emphasis was placed on the emergence of the concepts and methods that defined the new approach.

R. THIELE:

On the influence of the calculus of variations on analysis

The lecture dealt with some of the developments in analysis against the background of Hilbert's mathematical problems (1900) concerning the calculus of variations. 1. From a historical I say a few words on the problem of calculus of variations followed by some remarks on the role of the calculus of variations during the 19th century. 2. In view of his topic the speaker described roughly the situation of analysis at the turn of the century, above all the relations between variational problems and the corresponding boundary value problem (f. e. Dirichlet's principle). 3. The proof of Dirichlet's principle led Hilbert to the questions arising in the 19th and 20th problems of his famous Paris address in 1900: existence in a generalized sense and the regularity of the solutions of elliptic partial differential equations. By this new concept Hilbert pointed out two very important issues in the modern theory of elliptic partial differential equations. The transformation of mathematical and physical concepts was briefly discussed.

J. GRAY:

Poincaré among the physicists

For most of his working life Poincaré occupied himself with mathematical physics, yet his reputation today has little to do with his accomplishments in the field. 1. Electromagnetism: Poincaré's work was contrasted with that of Lorentz: Poincaré emphasized mathematical principles, Lorentz physical models; Poincaré preferred Newton's law to experimental results while hoping for a resolution of a contradiction in Lorentz' experiments. Connections to Poincaré's conventionalism were raised. New physics (Poincaré stressed) obtained from mathematical priorities; 2. Applied mathematics: Poincaré proposed novel physical solutions, and also a theory of quadratic forms in infinite dimensions. 3. Several complex variables: Poincaré extended the theory of harmonic functions and obtained new results about meromorphic functions. 4. Modernism: Poincaré's work turned out to illustrate the utility of modernism as an historians' category: he observed disciplinary divides at a social level, had a sophisticated ontology of physics, and operated in different ways in physics, applied and pure mathematics.

E. SCHOLZ:

The Transformation of Bravais' Concept of Crystal Symmetry by C. Jordan

The shift of the concept of symmetry from Bravais' crystal theory to Jordan's "Mémoire sur les groupes de mouvements" (1869) was presented and discussed. Bravais combined discrete translational symmetries inherent in his point lattices in space with finite point symmetries in such a way that only symmetry reduction could occur. That was a result of the imbedding of his symmetry studies in the context of his version of crystal structure theory. As is well known Jordan extracted the symmetry ideas of Bravais from the crystallographic context and transferred them to a semantical field which combined elements from the kinematics of helical motions with symbolical elements from permutation group theory. Thus a new semantical field was created: that of geometrical (transformation) group theory. The speaker discussed the material from the point of view of character and role of concepts as central organizing structures of semantic fields which are always linked to cultural communities. Moreover he defended the feasibility of the research for implicit stages of concept formations, emerging concepts, explicit concepts, transformation of concepts etc.

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