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Trends and Development of Mathematics In The 20th Century

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Abstract:
A Mathematical survey is given of several aspect that have characterized mathematics in the 20th century. The impact of Mathematical-physics, Mathematical-Sociology, Mathematical-Ecology, soft set Topology etc. is also discussed, and some speculations are made about possible developments in the 21st century.

Keywords: Conservation, Modern Mathematics, Mathematical-Physics, Paradigm Shift.

Introduction: The development of mathematics is intimately interwoven with the progress of civilization, influencing the course of history through its application to science and technology. But mathematics has changed. Even the mathematics of the 1800s can seem quite strange now, so greatly has mathematics evolved in the past 100 years and so thoroughly has it been reworked in the post-modern approach. Despite its arcane appearance from the outside looking in, the present, abstract and highly specialized state of mathematics is the natural evolution of the subject, and there is much ahead that is exciting. It is impossible to cover everything, and in particular I will leave out significant parts of the story, partly because I am not an expert, partly because it is covered elsewhere. I will say nothing, for example, about the great events in the area between logic and computing associated with the names of people like Hilbert, Gödel and Turing. Nor will I say much about the applications of mathematics, except in fundamental physics, because they are so numerous and they need such special treatment. Each would require a lecture to itself, but perhaps you will hear more about those in some of the other lectures taking place during this meeting. Moreover, there is no point in trying to give just a list of theorems or even a list of famous mathematicians over the last hundred years. That would be rather a dull exercise, so instead I am going to try and pick out some themes that I think run across the board in many ways and underline what has happened. Let me first make a general remark. Centuries are crude numbers. We do not really believe that after a hundred years something suddenly stops and starts again. So when I describe the mathematics of the 20th century, I am going to be rather cavalier about dates. If something started in the 1890s and moved into the 1900s, I shall ignore such detail. I will behave like an astronomer and work in rather approximate numbers. In fact many things started in the 19th century and only came to fruition in the 20th century. One of the difficulties of this exercise is that it is very hard to put oneself back in the position of what it was like in 1900 to be a mathematician, because so much of the mathematics of the last century has been absorbed by our culture, by us. It is very hard to imagine a time when people did not think in those terms. In fact, if you make a really important discovery in mathematics, you will then get omitted altogether! You simply get absorbed into the background. So going back, you have to try to imagine what it was like in a different era when people did not think in the same way.

Some special areas and local to global performance: First theme is broadly what you might call the passage from the local to the global. In the classical period, people on the whole would have studied things on a small scale, in local coordinates and so on. In this century, the emphasis has shifted to try and understand the global, large-scale behavior. And because global behaviour is more difficult to understand, much of it is done qualitatively, and topological ideas become very important. It was Poincar´e who both made the pioneering steps in topology and who forecast that topology would be an important ingredient in 20th-century mathematics. Incidentally, Hilbert, who made his famous list of problems, did not. Topology hardly figured in his list of problems. But for Poincar´e it was quite clear it would be an important factor.

Few areas: Weierstrass function- In mathematics the Weierstrass function is an example of a real-valued functions that is continuous everywhere but differentiable nowhere. It is an example of a fractal curve. It is named after its discoverer Karl Weierstrass. For them, a function was a function of a complex variable, and for Weierstrass a function was a power series: something you could lay your hands on, write down, and describe explicitly; or a formula. Functions were formulae; they were explicit things. But then the work of Abel, Riemann and subsequent people, move us away, so that functions became defined not just by explicit formulae but more by their global properties: by where their singularities were, where their domains of definition were, where they took their values. These global properties were the distinguishing characteristic feature of the function. The local expansion was only one way of looking at it.

Increase in dimensions: Modern mathematics can be said to have been born in the 1800s, and characterized by grappling with the challenges from the Classical period, as well with addditional disturbances that had been found and continued to be found with the theory of mathematics as then understood: the basis of the integral and differential calculus, the impossibility of a solution by radicals of polynomials of degree five or higher (which explains why the classical geometric problems had no solution), paradoxes in logical foundations (Russell, Burale Forte, etc.), shocking results about higher orders of infinity and Cantor's theory of sets (the Continuum Hypothesis), the "monsters" of real analysis functions and measure theory (continuous but nowhere differentiable functions, etc.), and the shocking limitations of logic in Godel's Incompleteness Theorems. Linear algebra was always concerned with more variables, but there the increase in dimension was going to be more drastic. It went from finite dimensions to infinite dimensions, from linear space to

Hilbert space, with an infinite number of variables. There was of course analysis involved. After functions of many variables, you can have functions of functions, functionals. These are functions on the space of functions. They have all essentially infinitely many variables, and that is what we call the calculus of variations. A similar story was developing with general (non-linear) functions: an old subject, but really coming into prominence in the 20th century. So that is my second theme.

Mathematical-Physics: Mathematical physics refers to the development of mathematical methods for application to problems in physics. The *Journal of Mathematical Physics* defines the field as "the application of mathematics to problems in physics and the development of mathematical methods suitable for such applications and for the formulation of physical theories".[1] An alternative definition would also include those mathematics that are inspired by physics (also known as physical mathematics). Some special branches of Mathematical Physics.

1) Classical Mechanics
2) Partial Differential Equations
3) Quantum Theory
4) Statistical Mechanics
5) Relativity and quantum relativistic theorem.

Mathematical Ecology: Mathematical techniques have a long and rich history in ecology, often serving as a virtual laboratory to test hypotheses, generate novel predictions, and investigate underlying ecological mechanisms. Recently, novel simulation techniques, advances in computing power, and numerical methods for implementing statistical models have significantly advanced our ability to integrate empirical and theoretical ecology. However, a divide still remains between mathematical and empirical studies, their readership, and integration into the broader literature. Because insights from mathematical ecology are far more general than the techniques employed, limitations in communicating mathematical advances to a broad spectrum of ecologists have arguably hindered ecology's progress, particularly in confronting theoretical predictions with empirical experiments and data. Here, we present a guide for both authors and readers of mathematical ecology, with the aim of increasing the accessibility of mathematical ecology for a broad group of ecologists.

Mathematical Sociology: Mathematical sociology or the sociology of mathematics is an interdisciplinary field of research concerned both with the use of mathematics within sociological research as well as research into the relationships that exist between maths and society.

Because of this, mathematical sociology can have a diverse meaning depending on the authors in question and the kind of research being carried out. This creates contestation over whether mathematical sociology is a derivative of sociology, an intersection of the two disciplines, or a discipline in its own right. This is a dynamic, ongoing academic development that leaves mathematical sociology sometimes blurred and lacking in uniformity, presenting grey areas and need for further research into developing its academic merit

History of Mathematical Sociology: Starting in the early 1940s, Nicolas Rashevsky, and subsequently in the late 1940s, Anatol Rapoport and others, developed a relational and probabilistic approach to the characterization of large social networks.in which the nodes are persons and the links are acquaintanceship. During the late 1940s, formulas were derived that connected local parameters such as closure of contacts – if A is linked to both B and C, then there is a greater than chance probability that B and C are linked to each other – to the global network property of connectivity.

Focusing on mathematics within sociology research, mathematical sociology uses mathematics to construct social theories. Mathematical sociology aims to take sociological theory and to express it in mathematical terms. The benefits of this approach include increased clarity and the ability to use mathematics to derive implications of a theory that cannot be arrived at intuitively. In mathematical sociology, the preferred style is encapsulated in the phrase "constructing a mathematical model." This means making specified assumptions about some social phenomenon, expressing them in formal mathematics, and providing an empirical interpretation for the ideas. It also means deducing properties of the model and comparing these with relevant empirical data. Social network analysis is the best-known contribution of this subfield to sociology as a whole and to the scientific community at large. The models typically used in mathematical sociology allow sociologists to understand how predictable local interactions are and they are often able to elicit global patterns of social structure.

Soft set Topology: Soft set theory is a generalization of fuzzy set theory, that was proposed by Molodtsov in 1999 to deal with uncertainty in a parametric manner. A soft set is a parameterised family of sets - intuitively, this is "soft" because the boundary of the set depends on the parameters. Formally, a soft set, over a universal set X and set of parameters E is a pair (f, A) where A is a subset of E, and f is a function from A to the power set of X. For each e in A, the set $f(e)$ is called the value set of e in (f, A).

One of the most important steps for the new theory of soft sets was to define mappings on soft sets, which was achieved in 2009 by the mathematicians Athar Kharal and Bashir Ahmad, with the results published in 2011 .Soft sets have also been applied to the problem of medical diagnosis for use in medical expert systems. Fuzzy soft sets have also been introduced. Mappings on fuzzy soft sets were defined and studied by Kharal and Ahmad.

Mathematics in Modern concept: The Galois theory, that resolved as impossible the unsolved problems from classical geometry and also the unsolved problems from classical algebra and theory of equations;

1) the careful definition of the concept of limit, the treatment of infinite series as a limit of partial sums, and the foundation of analysis on arithmetical terms, i.e. the

construction of the real number system as equivalence classes of Cauchy sequences, thus effectively completing the number system and including the irrational numbers;

2) the investigation of algebraic structure of integers, polynomials, number theory, of matrices, quaternions, and vectors, modern algebraic structures, and algebraic mathematics applied to geometry and the continuum;
3) the resolution of the parallel postulate unsolved problem by the demonstration of logically valid non-Euclidean geometries;
4) the establishment of a set theory able to handle the infinite and higherorders of infinity;

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