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MATHEMATICAL MODELLING IN THEORETICAL PHYSICS

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ABSTRACT

Modelling is an activity in which we think about and make models to describe how devices or objects of interest behave. Mathematical modelling is of great importance in the natural sciences, especially in physics. Physics theories are invariably explained using mathematical modelling. The application of mathematics to any given problem in physics and the development of mathematical methods are necessary for the application and formulation of theoretical physics.

In the nineteenth century use of abstract mathematical structures permitted a rigorous description of theoretical physics. There was a flow between mathematicians and physicists which led to new and deeper connections. Presumably one of the fundamental laws of motion is the law of gravitation which according to Newton is represented by simple equation, but according to Einstein it needs the development of elaborate analysis before its equation can be written down. The theory of relativity is very much accepted, inspite of it going against simplicity is its great mathematical beauty. Theoretical Physics requires a vast domain of pure or applied mathematics which is connected to non-communicative multiplication. Originally scientists proposed that a single Higgs Boson could explain the energy range, but new theories such as super symmetry and extra hidden dimensions suggest multiple Higgs Bosons. No matter which of these theories, one thing is clear, that it would unlock a new world of physics for scientists to explore.

The new approach of mathematics resulted in a more developed mathematical language, new powerful mathematical tools and inspired new application areas that have resulted in tremendous discoveries in other applied sciences including computer science and technology. This enabled physicists to use modern mathematical tool to solve deep classical problems left by previous generation.

Key words: Modelling, Theoretical physics, relativity, Higgs Boson.

INTRODUCTION

Modelling is an activity in which we think about and make models to describe how devices or objects of interest behave. Mathematical models are of great importance in the natural sciences, particularly in physics. Physical theories are almost invariably expressed using mathematical models. Throughout history, more and more accurate mathematical models have been developed. Newton's laws accurately describe many everyday phenomena, but at certain like relative theory and quantum mechanics must be used; even these do not apply to all situations and need further refinement. It is common to use idealized models in physics to simplify things. Mass less ropes, point particles, ideal gases and the particle in a box are among the many simplified models used in physics. The laws of physics are represented with simple equations such as Newton's laws, Maxwell's equation and the Schrödinger equation. These laws are such as a basis for making mathematical models of real

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situations. Molecules can be modelled by molecular orbital models that are approximate solutions to the Schrödinger equation. In engineering, physics models are often made by mathematical methods such as finite element analysis.

In the 18th and 19th century mathematical language was vague and did not allow much interaction among mathematicians of different field. In 1950's and 1970's mathematicians concentrated more on problems related to topology, algebraic geometry and complex analysis, and they developed new methods and concepts. Mathematics in the 20th century started harmonizing and unifying diverse fields. The traditional area of Application of mathematics in physics was in theoretical physics where Einstein's general theory of relativity was based in classical differential geometry of Riemannian spaces, the Hilbert spaces, the theory of linear operators and special theory .The new approach of mathematics resulted in a more developed mathematical language, new powerful mathematical tools and inspired new application areas that have resulted in tremendous discoveries in other applied sciences including computer science and technology. The physicist is thus provided with a principle of simplicity, which he can use as an instrument of research.

Modelling in theoretical physics: The discovery of the theory of relativity made it necessary to modify the principle of simplicity. Presumably one of the fundamental laws of motion is the law of gravitation which, according to Newton, is represented by a very simple equation, but, according to Einstein, needs the development of an elaborate technique before its equation can even be written Theoretical Physics requires a vast domain of pure or applied mathematics which is connected to non communicative multiplication. Originally scientists proposed that a single Higgs Boson could explain the energy range, but new theories such as super symmetry and extra hidden dimensions suggest multiple Higgs Bosons. No matter which of these theories, one thing is clear, that it would unlock a new world of physics for scientists to explore. The theory of relativity so acceptable to physicists in spite of its going against the principle of simplicity is its great mathematical beauty. This is a quality which cannot be defined, any more than beauty in art can be defined, but people who study mathematics usually have no difficulty in appreciating. The theory of relativity introduced mathematical beauty to an unprecedented extent into the description of Nature. The restricted theory changed our ideas of space and time in a way that may be summarised by stating that the group of transformations to which the space-time continuum is subject must be changed from the Galilean group to the Lorentz group. Quantum mechanics requires the introduction into physical theory of a vast new domain of pure mathematics - the whole domain connected with non-commutative multiplication. This, coming on top of the introduction of new geometries by the theory of relativity, indicates a trend which we may expect to continue.

Mathematics and physics are becoming ever more closely connected, though their methods remain different. One may describe the situation by saying that the mathematician plays a game in which he himself invents the rules while the physicist plays a game in which the rules are provided by Nature, but as time goes on it becomes increasingly evident that the rules which the mathematician finds interesting are the same as those which Nature has chosen. It is difficult to predict what the result of all this will be. Possibly, the two subjects will ultimately unify, every branch of pure mathematics then having its physical application, its importance in physics being proportional to its interest in mathematics. According to the mechanically determined scheme of physics or to its relativistic

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modification, one needs for the complete description of the universe not merely a complete system of equations of motion, but also a complete set of initial conditions, and it is only to the former of these that mathematical theories apply.

Conclusion

The knowledge theoretical physicist need regarding mathematics, certainly depends on what they're trying to do. But there does seem to be a well-defined list of what mathematics goes into our current most fundamental physical theories, and anyone who hopes to work on extending these should start by learning these subjects, which include (besides the classical mathematical physics of partial differential equations, Fourier analysis, complex analysis etc). There is yet no theory that covers all scenarios, however a search for such a model (sometimes called a unified field theory) continues with the assumption that one must be found very soon. Further modelling needs to be done in order to handle solvability and complexity.

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