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Preface to the 2014 Publication

This publication of mathematical speculations and writings made during the 1970:s and early 1980:s contains the general principles of a proposed deductive approach to theoretical physics and an outline of a mathematical theory. A rigorous and self-contained exposition of the three most basic concepts of the theory, containing the definitions and theorems quoted in Part II, is given in *Successive Confidence Estimates on Solutions to the Many-Particle Schrödinger Equation. Basic Concepts* which is included in this book as Part III. The reference lists are incomplete in the sense that I have not been in a position to do ordinary studies of and make ordinary references to other existing works related to the present work.

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I wish to thank Peje Löfgren for many years of profound mathematical discussions. Many of these have bearing on my own work. Let me just give one example. A central concept in the present theory is that of finite approximations. I owe much to Peje's own work on this subject.

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Preface

The principal object of the following theory is to treat and develop theoretical physics as a deductive science.

Common theoretical physics, although deductive in certain parts or steps, generally displays an apparent lack of deductiveness. There are excellent examples of completely deductive theories such as e.g. Newtonian point mechanics, but they appear as small isolated and widely separated islands when considered in relation to our complete physical knowledge. Practically every theoretical discussion frequently introduces extra, often implicit, assumptions depending on the specific problem under concern, without deriving the validity of these extra assumptions from basic postulates. In some cases these extra assumptions are more or less obvious or natural (although they might be difficult to prove). In some cases they are rather doubtful. However, it is a remarkable fact that derivations of such extra assumptions are often missing in the literature even in cases where it would be a straightforward task to work out a rigorous proof. For example, we will not take for granted, but derive rigorously, the fact that light propagates along straight lines and with the "velocity of light" c. A rigorous and complete formulation and proof of this statement needs a thorough consideration of confidence estimates on wave packets. Although quite nontrivial, it is obtained by a rather elementary exercise in Fourier transform theory. It ought to be found in any thorough theoretical discussion on light.

A similar situation appears when one theory is a special case of another more general theory. There are seldom any attempts to derive in a more definite way the validity of the basic principles of the special theory from the more general theory. The task of working out such derivations, connecting different theories, is of a central interest in the following theory. Let us note that such a derivation is not only a matter of formality. It is in fact intimately related to the problem of finding the exact conditions under which the special theory is applicable and such conditions have an immediate physical significance. Often the special theory appears as an approximation of the more general theory and one also wants to know the degree of accuracy of this approximation, which also has an obvious physical significance. The lack of derivations discussed means that important physical questions are left outside the theoretical treatment.

A consequence of this general lack of deductiveness is also that it makes it practically impossible to apply the mathematical method effectively. The central position of proofs in the mathematical method is intimately connected to the function of mathematics as an "art of computation". Computations are in fact examples of the deductive method. There is no principal difference between a proof, which in a deductive way leads to a qualitative prediction and a computation, which in a deductive way leads to a quantitative prediction. Thus, we see again that deductiveness is not only a question of formality but has a practical importance. It is only when we have complete deductiveness that we can fully exploit the power of the theoretical method.

Parallel to the lack of rigorous proofs there is in common theoretical physics a pervading lack of precise definitions of important concepts used in the theories.

This indicates that the apparent lack of deductiveness is connected to general conceptual problems of theoretical physics. In order to develop a general deductive theoretical physics we have to solve the following two problems:

1) Establish a general conceptual basis for deductive theoretical physics.

2) Establish a formulation of quantum mechanics with general and unproblematic applicability to physical problems.

These two problems are closely connected since the solution of one of them presupposes a solution of the other. Classical theoretical physics is composed of a set of disconnected theories, mechanics, the electromagnetic theory, thermodynamics, etc., and the only theory which offers the possibility of a general theory, encompassing these classical theories, is quantum mechanics. On the other hand we claim that a solution of the controversial conceptual problems of quantum mechanics presupposes a general conceptual deductive framework. Our proposal for solving these two problems is the embedding of the Schrödinger equation formalism in a general "physico-logical" structure which we shall call "stochastic event structure". This structure provides basic concepts for direct descriptions both of classical and quantum phenomena in a unified and objectivistic way. The Schrödinger equation then complements this descriptive structure with a general dynamics generalizing and encompassing the classical theories.

The theory proposed in part II below is at the same time a mathematical theory and a physical theory. As a physical theory it has of course a phenomenological character. Thus, the mathematical theory below is suggested by speculations on quantum mechanics, which in turn has its origin in the physical phenomenology, and the purpose of the theory is to describe the physical reality. As any physical theory it then ultimately stands or falls depending on its further success in describing, analyzing and predicting physical phenomena. We can thus distinguish three different steps in the development of a physical theory.

1) Axiomatize the theory. This means that we establish the basic mathematical concepts which are to describe the basic physical concepts of the theory and establish in a mathematical form the basic laws connecting these concepts. The axiomatization thus results in a specific mathematical theory.

2) Develop this mathematical theory.

3) Compare results obtained in the mathematical theory with the physical reality.

It is important for the deductiveness of the theory that we are in a position where steps 1 and 3 present no problems and we can deal mathematically with step 2 in a free way, undisturbed by unformalized physical questions. We claim that the theory proposed below meets this demand.

The purpose of the following exposition is to give the general principles of the theory i.e. establish step 1) above. For the mathematical development of the theory, step 2) above, we refer to the self-contained, purely mathematical exposition given in Part III.