THE OSKAR KLEIN --- MEMORIAL LECTURES

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Vol. 1: Lectures by C. N. Yang and S. Weinberg
with translated reprints by O. Klein

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Vol. 2: Lectures by Hans A. Bethe and Alan H. Guth
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PREFACE

The Oskar Klein Memorial Lecture and Seminar in 1990 were given by Hans A. Bethe, professor at Cornell University, Ithaca, USA, and Nobel Prize winner in Physics in 1967. The 1991 speaker was Alan H. Guth, professor at Massachusetts Institute of Technology, Cambridge, USA.

Bethe's lecture in the series of Oskar Klein Memorial Lectures at Stockholm University was given on October 9, 1990, and Guth's lecture on June 4, 1991. These two lectures, intended for both students and staff, are presented in this volume. The invited speakers also gave scientific seminars of a somewhat more advanced nature. These are also included here. Two of Oskar Klein's papers are presented in English translation for the first time.

Neutrinos are at the heart of Hans A. Bethe's contributions. In the lecture he deals with the problems to theoretically account for the observations of neutrinos from the sun. He concludes that the solar model cannot be blamed for the discrepancies between the observed flux of neutrinos and the predictions of the standard solar model. His preferred explanation is one based on neutrino oscillations between neutrinos of different flavours.

The theme of Bethe's scientific seminar was the theory of supernovae, and for anyone interested in gaining an understanding of the processes going on in the collapse and explosion of a large star this lecture is to be recommended. The main problem for the theory has been to reproduce the outgoing shock wave and the ejection of matter. According to Bethe we now qualitatively understand that "the supernova is powered by the absorption of neutrinos".

The invited speaker for 1991 was Alan H. Guth, originator of the inflation scenario for the big bang. His lecture and scientific seminar dealt with various aspects of the origin of the universe. In the written version of his lecture, "The Big Bang and Cosmic Inflation", he has included the latest observations from the COBE satellite and their theoretical interpretation. The lecture is a goldmine for anyone willing to grasp the essentials of these ideas despite not being an expert. "Inflation allows the entire universe to develop from almost nothing"

would be hard to understand without Guth's expert guidance. Towards the end he elegantly points out that the driving force behind the big bang expansion — something Oskar Klein devoted most of his late efforts to finding — is coming directly from the Klein–Gordon equation. The seminar dealt with the eventual possibility of creating a new universe in the laboratory. A quote from the seminar reads: "... the false vacuum bubble appears from the outside to be a black hole. From the inside, however, it appears to be an inflation region of false vacuum with new space being created as the region expands. The region completely disconnects from the original spacetime, forming a new, isolated closed universe."

In this volume, two papers by Klein are included in English translation from the original German. Both papers have to do with early applications of Dirac's theory for the electron. The modern reader will be surprised to see how Klein and Nishina in 1928 derived their famous formula for Compton scattering. They treated the electromagnetic field as a classical wave and the electron as a Dirac field. No particles, only waves, appeared in this so-called semiclassical treatment. They got the kinematics right and they got the angular distribution right for the scattered radiation. The theory with light as particles, first advocated in 1928 by Compton himself, up to 1928 never succeeded in getting the differential cross section right; only the kinematical relations came out in agreement with measurements.

In the historically oriented paper "The Klein–Nishina Formula", an account is given of the collaboration between a Swedish theoretician and a Japanese experimentalist. New studies of the Nobel archives shed light upon the prevailing view on the struggle between a corpuscular theory for light and the wave theory. In those days physicists were predisposed either to accept light as waves, rejecting light as particles, or to accept the reverse. One new unexpected finding is that Compton was not awarded the 1927 Nobel Prize in Physics for his discovery of the particle nature of light.

The second paper by Klein deals with the surprising results obtained when he calculated the reflection of Dirac electrons at a steep potential wall. The paper contains the "Klein paradox", namely that under certain conditions more electrons are reflected than are impinging upon the wall. The negative energy states, which Klein avoided by his method to solve the Compton scattering problem, but which were important for the reflection problem, were in those days considered unphysical. Klein's paper on wall reflection of electrons was considered a severe blow to the Dirac theory. Today there is no more any paradox. The reason for the phenomenon is the creation of electron–positron pairs in the strong electric field at the wall surface.

Some autobiographic material, which has been translated from the Swedish and included here, goes beyond what was contained in *The Oskar Klein Memorial Lectures*, Vol. 1 (ed. Gösta Ekspong, World Scientific, Singapore, 1991). One may here get acquainted with Klein's interest in cosmology and his attempts to find the driving force behind the expanding system of galaxies — the meta-galaxy in his terminology. The idea that there may be several isolated expanding meta-galaxies was not foreign to him. The reader of Guth's contributions will find similarities.

Stockholm, Sweden; March 1993

Gösta Ekspong