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**Round-table in commemoration of Niels Bohr Centenary**

Niels Bohr - A survey of some of his contributions  
to science and international co-operation

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**NIELS BOHR AND GENETICS**

by

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(The views expressed by the author do not necessarily  
reflect the standpoint of Unesco.)

Niels Bohr and Genetics. (A short summary.)  
H.B.G.Casimir.

The object of my short presentation will be to encourage a discussion on the questions briefly outlined in this abstract and perhaps my title is not well-chosen.

Bohr himself was convinced that quantummechanics provides an adequate description of the atomic world, when interpreted according to his ideas on "complementarity". He also believed that the lessons learnt from physics could have a bearing on many other subjects. That idea he put forward in many private conversations, and also in several lectures. Of course the remarks of a wise and generous man like Niels Bohr were always worth listening to, but can we really speak of an application of the idea of complementarity to other fields? Here we have to distinguish between a parable and a true application. If we draw a parallel between the dependence of simultaneity on the choice of space-time coordinatesystem (an essential notion of the theory of relativity) and the dependence of ethical norms on the structure of a society, then we are dealing with a parable, an instructive parable perhaps, but not with an application of the theory of relativity. We must try to decide whether Bohr's ideas on a variety of subjects were parables.

#### Complementarity in Physics.

##### A. Non-classical features of atomic physics

a. Statistical character of the elementary processes. Example: radioactive decay. There is a probability that a nucleus disintegrates in a given time interval. This probability does not depend on the age of the nucleus, nor on outside influences. This type of probability is exactly described by quantummechanics.

b. In some experiments the electron appears clearly as a particle. But there exist interference experiments that can only be accounted for by electron waves. For lightquanta the situation is analogous.

c. It is impossible to know both the place and the velocity of a particle simultaneously.

B. Objective reality. Bohr does not deny the objective existence of phenomena, but one can only know something about a system that includes measuring gear that can provide us with macroscopic data.

C. Complementarity. It is impossible to design an experiment that reveals both the wave character and the particle character of an electron or a light quantum. It is also impossible to design an experiment that measures both position and velocity. We can design complementary experiments. Together they provide all the information we can ever hope to get about nature. Einstein: the quantum mechanical description is consistent, is useful, but is incomplete. Bohr: it is as complete as it can possibly be, given the existence of the quantum and given our human nature.

Cautionary remarks. Bohr points out that quantum mechanics has taught us to be extremely careful when we apply existing notions to new fields. A thorough examination of definitions and assumptions is called for. I do not think anyone could take exception to that statement.

Some topics discussed by Bohr.

A. Living organisms. Here Bohr originally thought that applying the methods of physics to living organisms would destroy life and that this would limit the applicability of physics. The work on molecular biology and the genetic code made him to a certain extent revise this attitude.

B. Psychology; perception. Bohr liked to mention the following example of complementarity. If we find our way in the dark using a stick we transfer so to say our perception to the point of this stick. We cannot use the stick for orienting ourselves and at the same time perceive the form of the handle.

C. Psychology; consciousness. It is clear that observation either by self or by an outsider has an influence on the subject observed.

D. Human culture. Bohr points out that there are two memory systems at work. The one deals with what is stored in the genetic code. The other is read in during life and contains the wisdom and experience of innumerable generations. Perhaps the chief character of human culture is the prevalence of this second memory system, which has language as its main tool. Is this a case of complementarity?

E. Heridity; "racial " characteristics. Since according to Bohr the most important part of our mental make-up is read in and not genetically determined there existed for him no reason whatever for assuming that a certain pattern of culture should be necessarily associated with a definite human race. That was a healthy - and in the Germany of those days not at all welcome - reaction against the mad racism that was rampant in Hitler's Germany. But Bohr was inclined to exclude all genetic influence on the ability to learn, which is certainly an exaggeration, although recent work does stress the importance of early childhood and the damaging influence of malnutrition, even of malnutrition in utero. Niels and Harald Bohr grew up under very similar conditions. Both were highly intelligent, but they were in many ways quite different. I find it hard to believe that there were no genetic factors at work!