Colloquium: FROM CLASSICAL TO QUANTUM PHYSICS

on occasion of Domenico Giulini's 60th birthday

ZARM, University of Bremen

28 - 29 October 2019

Quantum theory is widely believed to be universal in the sense that, at a fundamental level, all kinds of matter and fields require a quantum description and that classical (non-quantum) physics can only be viewed as an approximation (which is, of course, often very good). The standard formalism of quantum theory, which may be derived from a few postulates, has proven very successful and is, until now, in agreement with all experiments. However, there are several open questions. Firstly, it seems fair to say that the measuring process, often described in terms of "the collapse of the wave function", is not yet fully understood. This problem is also related to the interpretation of the wave function. Secondly, the transition from quantum mechanics to classical mechanics is still a matter of debate. Whereas it is clear that, roughly speaking, a classical description is possible whenever the action is big in comparison to Planck's constant, it is not yet clear at which length scale quantum effects have to be taken into account. Experiments with molecules consisting of hundreds of atoms still show interference and, thus, quantum behaviour. No fundamental length (or mass or energy) scale appears on the experimental side. These two questions are related since the measurement process also induces an element of classicality into the quantum formalism. An even more important problem arises when one wants to combine general relativity with quantum theory. No satisfactory formalism has been developed so far. Also experimentally it is very difficult to explore this true quantum-gravity regime. This would require exploring the gravitational field created by quantum states. There are also proposals that this problem is related to the measuring problem described above. The purpose of this colloquium is to address these problems and related ones. We dedicate this colloquium to Domenico Giulini on occasion of his60th birthday. His scientific work is deeply related to these questions.

Monday, October 28

17:00 - 17:15 Volker Perlick + Claus Lämmerzahl: Welcome
17:15 - 18:00 Norbert Straumann (U Zurich): Lemaîtres inhomogeneous cosmological model from 1933, its recent revival and confrontation with observational data
18:00 - 18:45 Claus Kiefer (U Cologne): Canonical gravity, decoherence, and all that

19:00 Dinner

Tuesday, October 29

09:00 - 09:45 Gary Gibbons (U Cambridge): Some Applications of Carrollian and Bargmann Structures
09:45 - 10:30 Felix Finster (U Regensburg): Total Mass, Area and Matter Flux in the Theory of Causal Fermion Systems
10:30 - 11:00 Steffen Aksteiner (AEI Potsdam): All local gauge invariants for black hole perturbation theory
11:00 - 11:30 Coffee
11:30 - 12:15 Norbert Dragon (LU Hannover): Surprises in Relativistic Quantum Physics
12:15 - 13:00 Heinz-Peter Breuer (ALU Freiburg): Non-Markovian Quantum Dynamics of Open Systems

1300 - 14:00 Lunch

14:00 - 14:30 André Grossardt (FSU Jena): Classically gravitating quantum systems and causality
14:30 - 15:15 Friedrich W. Hehl (U Cologne): If spin is present, the energy-momentum tensor is asymmetric
15:15 - 15:45 Domenico Giulini (U Bremen and LU Hannover): Final remarks

16:00 End of Colloquium