International Workshop

CAUSALITY AND NON-LOCALITY IN PHYSICS (QUANTUM AND CLASSICAL)

12 and 13 November 2015

Aula 3, Centro Carlos Santamaría Zentroa
Universidad del País Vasco, UPV/EHU

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Proyecto de Investigación
"Causalidad, Localidad y
Libre Albedrío".

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PROGRAM

Thursday, 12th November

9:15– 9:30 :: Welcome and Introduction

9:30– 10:30 :: Huw Price (Cambridge University)
The Parisian Zigzag –Is Science Safe?

10:30– 11:30 :: Adrian Wüthrich (technical University of Berlin)
Local Acausality

11:30– 12:00 :: *coffee break*

12:00– 13:00 :: Gábor Hofer-Szabó (Research Center for the Humanities, Budapest)
On Einstein's Reality Criterion

13:00– 15:00 :: *lunch*

15:00– 16:00 :: Mathias Frisch (University of Maryland)
Retrocausation as a cure for non-locality in quantum mechanics?

16:00– 17:00 :: Iñaki San Pedro (University of the Basque Country)
Two sources of non-locality in Quantum Mechanics?

17:00– 17:30 :: *coffee break*

17:30– 18:30 :: Jon Pérez Laraudogoitia (University of the Basque Country)
Causality, Non-locality, Entanglement and Free Will in an Enlarged Formulation of Classical Mechanics

Friday, 13th November

9:30– 10:30 :: Mauricio Suárez (Complutense University of Madrid)
Interventions and Causality in Quantum Mechanics

10:30– 11:30 :: Henrik Zinkernagel (University of Granada)
Complementarity, causality and the limits of quantum mechanics

11:30– 12:00 :: *coffee break*

12:00– 13:00 :: Thomas Mormann (University of the Basque Country)
Causality in Cassirer's Neo-kantian Philosophy of Science

13:00– 15:00 :: *lunch*

15:00– 16:00 :: Michael Esfeld (University of Lausanne)
Dynamical structure: quantum and classical

16:00– 16:30 :: *coffee break*

16:30– 17:30 :: Miklós Rédei (London School of Economics)
Locality and causality in categorial quantum field theory

17:30 :: Closing

ABSTRACTS

Michael Esfeld (University of Lausanne)
"Dynamical structure: quantum and classical"

In this talk, I'll argue in the first place for a basic ontology of primitive objects in space-time that is the same in classical and quantum physics, namely permanent particles that are structurally individuated by the spatial relations in which they stand. The argument for this ontology is that it enables an elegant solution to the quantum measurement problem. The main part of the talk then is an argument for the following claim: given this ontology, the natural dynamical structure is one that is in the first place only defined for the particle configuration as a whole, as illustrated by the wave function in quantum physics and its development. On the basis of a dynamics that is local in configuration space one obtains an elegant explanation of quantum non-locality, i.e. one that preservers an ontology of objects in space-time and that is not subject to the mysteries associated with wave function collapse. I illustrate this claim by drawing on the de Broglie-Bohm-Bell quantum theory, arguing that, contrary to a widespread impression, this theory offers a serious explanation of the EPR experiment in terms of a non-local common cause.

Mathias Frisch (University of Maryland)
"Retrocausation as a cure for non-locality in quantum mechanics?"

In this paper I critically examine arguments by Huw Price for the conclusion that under certain plausible assumptions quantum mechanics gives rise to retro-causality. Against Price I argue that it is not the assumption of discreteness that leads to the appearance of retrocausality, but that, as in classical contexts, our causal verdicts track assumptions about initial vs. final independence.

Gábor Hofer-Szabó (Research Center for the Humanities, Budapest)
"On Einstein's Reality Criterion"

The talk has two main theses on Einstein's Reality Criterion. First, we argue that the Reality Criterion is that makes a difference between the EPR argument and Einstein's latter arguments devised against quantum mechanics. We will show that the EPR argument, making use of the Reality Criterion, is devised to show that certain interpretations of QM are incomplete, whereas Einstein's latter arguments, making no use of the Reality Criterion, are devised to show that the Copenhagen interpretation is unsound. Second, we claim that the Reality Criterion is a special case of Reichenbach's Common Cause Principle and also of Bell's Local Causality Principle.

Thomas Mormann (University of the Basque Country, UPV/EHU)
"Causality in Cassirer's Neo-kantian Philosophy of Science"

The aim of this paper is to argue that Cassirer's Neo-kantian philosophy of science may still have something to offer for contemporary discussions on the thorny issue of the concept of causality in science. In particular, it is argued that Cassirer gave an original answer to Russell's provocative thesis that the law of causality is a relic of a bygone age erroneously considered supposed to be no harm. Indeed, for Cassirer the principle of causality was not so much a law as rather a viewpoint in order that one can speak of laws. In other words, Cassirer may be considered with respect to causality as a „perspectivist" avant la lettre. The background of his Marburg neo-Kantianism, gave this causal perspectivism, however, an interesting special flavor.

Jon Pérez Laraudogoitia (University of the Basque Country, UPV/EHU)
"Causality, Non-locality, Entanglement and Free Will in an Enlarged Formulation of Classical Mechanics"

In this talk I shall offer a purely classical formulation of some conceptual problems which are usually linked to quantum mechanics and its interpretation. This will be done with the help of a toy model which highlights such issues in a particularly simple way. My starting point will be the case of one-dimension point-like interactions (i.e. collisions) in classical mechanics. In this scenario the theory can be provided with a richer structure by implementing conservation laws so that their usual interpretation —purely in causal terms— blurs out in the light of new non-local phenomena, which involve space separated entangled particle colliding systems, while Galilean invariance is still in place. Just like in the standard quantum case, entanglement is related here to the existence of non-causal correlations that arise in the context of specific indeterministic system evolutions. Finally, the toy model presented here allows for a precise (non-trivial) characterisation of an external agent's free actions when interacting with such a particle system, depending on whether a compatibilist or an incompatibilist view of free will is adopted.

Huw Price (Cambridge University)

"The Parisian Zigzag –Is Science Safe?"

Responding to the EPR argument, O. Costa de Beauregard (1953) proposed that the quantum world might allow spacelike causal influence, without action at a distance, so long as the influence takes a zigzag path, via the intersecting past lightcones of the events in question. This suggestion is related to what has come to be called the retrocausal loophole in Bell's Theorem, but – like that loophole – it receives little attention, and remains poorly understood. In this talk I present a new argument for Costa de Beauregard's zigzag, discuss its relation to the motivation stemming from EPR and Bell, and respond to the suggestion that it would require abandoning assumptions essential to science.

Miklós Rédei (London School of Economics)

"Locality and causality in categorial quantum field theory"

In the talk relativistic locality of a probabilistic physical theory is interpreted as an interconnected web of properties which express compatibility of the theory with the underlying causal structure of spacetime. Four components of this web are distinguished: spatiotemporal locality, causal locality-Independence, causal locality-Dependence, and causal locality-Dynamic. These four conditions will be specified in terms of concepts from the categorical approach to quantum field theory and results are recalled indicating the extent to which an algebraic quantum field theory satisfying the Haag–Kastler axioms is causally local.

Iñaki San Pedro (University of the Basque Country, UPV/EHU)

"Two sources of non-locality in Quantum Mechanics?"

I explore some of the implications of the violation of the "measurement independence" condition —also known as "no-conspiracy" or "λ-independence"—, a commonplace requirement in (hidden variable) common cause explanations of EPR correlations, and their connection with non-locality. I shall argue that, in a well defined specific causal context and space- time arrangement, "measurement independence" may be taken as a locality condition. Moreover, I shall discuss whether or not the notion of locality (non-locality) encapsulated by "measurement independence" is fundamentally different to that usually assumed in the derivation of the Bell inequalities, most commonly expressed by conditions such as "parameter independence" or the like.

Mauricio Suárez (Complutense University of Madrid)

"Interventions and Causality in Quantum Mechanics"

I argue that the Causal Markov Condition (CMC) is in principle applicable to the Einstein–Podolsky–Rosen (EPR) correlations. This is in line with my defence in the past of the applicability of the Principle of Common Cause to quantum mechanics. I first review a contrary claim by Dan Hausman and Jim Woodward, who endeavour to preserve the CMC against a possible counterexample by asserting that the conditions for the application of the CMC are not met in the EPR experiment. In their view the CMC is inapplicable to the EPR correlations —i.e. it neither obtains nor fails. The view is grounded upon the non-separability of the quantum state, and the consequent unavailability of interventions. I urge that whether interventions are available in EPR —and why— is a complex and contextual question that does not have a unique or uniform answer. Instead, I argue that different combinations of causal hypotheses under test and interpretations of quantum mechanics yield different answers to the question.

Adrian Wüthrich (Technical University Berlin)

"Local Acausality"

A fair amount of recent scholarship has been concerned with correcting a supposedly wrong, but widespread, assessment of the consequences of the empirical falsification of Bell-type inequalities.
In particular, it has been claimed that Bell-type inequalities follow from "locality tout court" without additional assumptions such as "realism" or "hidden variables". However, this line of reasoning conflates restrictions on the spatio-temporal relation between causes and their effects ("locality") and the assumption of a cause for every event ("causality"). It thus fails to recognize a substantial restriction of the class of theories that is falsified through Bell-type inequalities.

(Talk based on DOI 10.1007/s10701-014-9796-y)

Henrik Zinkernagel (University of Granada)

"Complementarity, causality and the limits of quantum mechanics"

In this talk, I outline some basic characteristics of Bohr's interpretation of quantum mechanics and discuss how it both presupposes and limits the classical notion of causality. Furthermore, I discuss how Bohr' insistence on the necessity of classical concepts in quantum mechanics leads to a rejection of what may be called quantum fundamentalism; the view that everything in the universe (if not the universe as a whole) is fundamentally of a quantum nature and ultimately describable in quantum-mechanical terms. My point of departure will be some general considerations regarding the scope of physical theories and the prospects of reductionism. This will provide a context for relating Bohr's views and the question of quantum fundamentalism to other possible limitations of quantum mechanics, e.g. the extent to which biological systems like Schrödinger's cat can be described in quantum mechanical terms.