

Relazione finale sulle attività del / Final report of Visiting Professor Karl Svozil

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Abstract

In what follows a final report on the teaching and research activities of Professor Karl Svozil during his three months stay from May-July 2012 will be given.

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I. OVERVIEW

Visiting Professor Karl Svozil (K.S.) has visited the Dipartimento di Scienze Pedagogiche e Filosofiche, Università di Cagliari (UNICA) from May to July 2012, and has conducted scientific research as well as teaching. One of the main scientific topics discussed and pursued was the theory of quantum information and computation, as well as conceptional issues related to physical value (in-)definiteness, as it concerns concrete physical quantum random number generators.

K.S.'s main cooperation partners have been members of the group of Professor Roberto Giuntini.

K.S. has offered a course and seminars for UNICA students and post-docs; and contributed talks two conferences in Cagliari.

II. TEACHING AND LECTURING

As announced by Professor Marco Giunti, K.S. has offered a course on “*Physical aspects of classical and quantum information and computation*” with the following syllabus

- I. Foundations of Computer Science
 - A. What is an algorithm?
 - B. Uncomputability
 - C. Karp-Cook Thesis
- II. Physical foundations of computation
 - A. Reversible computation and statistical physics
 - B. Quantum Mechanics
 - C. Various theorems relating to hidden parameter models
- III. Fundamental Properties of Cbits and Qbits
 - A. Cbits and their state
 - B. Reversible Operations on Cbit
 - C. Qbits and their state
 - D. Reversible Operations on Qbit
 - E. The measurement of Qbit
- IV. Quantum Computation: General features and some simple examples
 - A. General computational process
 - B. No-cloning theorem
 - C. Deutsch's Problem and Parity
 - D. Bernstein-Vazirani problem
 - E. Factoring
- V. Quantum recursion theory
- VI. Counterfactual quantum computation
- VII. Quantum cryptography
 - A. Wiesner's conjugate coding
 - B. BB84 Protocol
 - C. Wright's generalized urn model and chocolate ball cryptography

Some of these topics were also covered by K.S.'s review presentations on related scientific articles at the weekly reading seminars of the group.

III. CONFERENCE PARTICIPATION

During his stay at UNICA, K.S. contributed to two conferences and gave talks there.

A. First Joint Cagliari-Olmouc Workshop on Algebraic Logic

UNICA Cagliari, 14-16 maggio 2012,

URL <http://www.unica.it/pub/7/show.jsp?id=18496>

Martedì 15 maggio 2012, aula 6

10.30–11.30 Karl Svozil (TU Wien e Università di Cagliari),

“Quantification of contextuality”

B. 11th Biennial IQSA Meeting Quantum Structures Cagliari 2012

UNICA Cagliari 23 - 27 July

URL <http://www.iqsa2012.org/>

July 23rd, Monday, aula 11

16:40–17:15 Karl Svozil (TU Wien e Università di Cagliari),

“The Present Situation in Quantum Mechanics and the Ontological Single Pure State Conjecture”

IV. SCIENTIFIC RESEARCH

During his time at UNICA, K.S. conducted research in quantum logic and quantum computation, as well as in the foundations of quantum mechanics; both alone and with members of the group of Professor Giuntini.

It was also very interesting for K.S. to communicate with Professor Michele Camerota about his article (together with Mario Helbing from the ETH Zürich) entitled *“Galileo and Pisan Aristotelianism: Galileo’s De Motu Antiquiora and the Quaestiones De Motu Elementorum of the Pisan Professors,”* which, in some for K.S. unexpected ways, characterizes a situation not dissimilar from today’s scientific disputes about some unresolved aspects of quantum mechanics.

As a result, the following two papers appeared as preprints.

A. arXiv:1206.6024

Quantum Physics: The present situation in quantum mechanics and the ontological single pure state conjecture

Submitted on 26 June 2012

Abstract: Despite its excessive success in predicting experimental frequencies and certain single outcomes, the "new quantum mechanics" is haunted by several conceptual and technical issues; among them (i) the (non-)existence of measurement and the cut between observer and object in an environment globally covered by a unitary (i.e. one-to-one Laplacian deterministic) evolution; related to the question of how many-to-one mappings could possibly "emerge" from one-to-one functions; and also where exactly "randomness resides;" (ii) what constitutes a pure quantum state; (iii) the epistemic or ontic (non-)existence of mixed states; related to the question of how non-pure states can be "produced" from pure ones; as well as (iv) the epistemic or ontic existence of pure but entangled and/or coherent states containing classically mutually exclusive states; an issue the late Schrödinger has called "quantum quagmire" or "jellification;" (v) the (non-)existence of quantum value indefiniteness and its purported "resolution" by quantum contextuality; and finally (vi) the claim that the best interpretation of the quantum formalism is its non-interpretation. All of these can be overcome by assuming that, at any given time, only a single pure state exists; and that the quantum evolution "permutes" this state in its Hilbert space.

URL: <http://arxiv.org/abs/1206.6024>

B. arXiv:1207.2029

Quantum Physics: Kochen-Specker Theorem Revisited and Strong Incomputability of Quantum Randomness

together with Alastair A. Abbott, Cristian S. Calude, Jonathan Conder

Submitted on 9 July 2012

Abstract: We present a stronger variant of the Kochen-Specker theorem in which some quantum observables are identified to be provably value indefinite. This result is utilised for the construction and certification of a dichotomic quantum random number generator operating in a three-dimensional Hilbert space.

URL: <http://arxiv.org/abs/1207.2029>

Further work on epistemic perceptions of quantum states will be jointly (by K.S. and the UNICA researchers) conducted in the future.

V. GENERAL REMARKS AND OBSERVATIONS

The time at UNICA has been very productive and insightful; K.S. would like to express his admiration for the achievements of the research group hosting him.

K.S. is deeply thankful for the opportunity this Visiting Professorship has offered to get into contact with students and fellow researchers at UNICA. Further academic joint activities are planned and will follow.
