The Sixth Conference on Information Theory and Complex Systems
TINKOS 2018

BOOK OF ABSTRACTS

Editors: Velimir Ilić and Miomir Stanković

Belgrade, Serbia, June 18-19, 2018
Mathematical Institute of the Serbian Academy of Sciences and Arts

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МИНИСТАРСТВО ПРОСВЕТЕ
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THEMATIC FIELDS

Information theory

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Decision making in complex systems

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Juncture between Complex Theory and History & Philosophy of Science

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Complexity; History and philosophy of science; Ptolemaic system; Scientific revolution; Complex light

Summary

Complexity research shows certain trends, that include: interdisciplinarity, unexpected fields and humanities [1]. At current stage of the theory of complex systems certain historically and philosophically recognizable situations and philosophic-scientifically re-examination which refers to the history of science, appear. As a presentation of that, we introduce two examples: the first concerns the interpretation of a well known situation from the history of science in the context of determining the origin of complexity, and the second reflects the current state in research of light and photonics.

Beside high dimensionality, network interactions, and nonlinearity which are commonly thought to be origins of complexity, in his search for additional roots for complexity Schuster points out more reasons for which a problem may appear complex: the lack of knowledge to comprehend the problem, deficiency of methods to interpret it adequately, and embedding of a simple system in a complex environment [2].

A situation from the history of astronomy that can be seen as the lack of knowledge which is the origin of complexity, is development of a system of the world [2]. The Pythagorean system of concentric harmonic spheres (6 BCE) didn't fit the astronomical data [2]. Contrary to that, Ptolemaic system (2 AD) represents a mathematical description of astronomical data from many centuries. The system was complex with a tendency to increase the number, inclination and function of constructs such as epicycle, deferent, equant and eccentric in order to keep celestial bodies moving on perfect cycles with uniform angular velocity [2]. Such a way of describing motions in astronomy can be compared to giving explanations by using complex systems [2]. Copernicus's heliocentric system (Mikołaj Kopernik, 1473-1543), Kepler's laws of planetary motions (Johannes Kepler, 1571-1630) and Newton's laws of mechanics (Sir Isaac Newton, 1643-1727) simplified the system of the world explanation and made a revolution in science [2]. The alternative idea and the discovery of universal laws led to a simple description of the planetary motions [2].

Our second example is taken from the domain of electromagnetic waves, whose discovery Popper (1902-1994) considers a revolution that is greater than Copernican [3]. It concerns the current state of the research of light and photonics. Since the discovery of electromagnetic waves and Maxwell's equations (James Clerk Maxwell, 1831-1879) which describe the classical electromagnetic field, the applied knowledge about electromagnetic waves has made a great impact on everyday life [4]. New ground-breaking advances and new stage in technological development are expected now from the highly active interdisciplinary field of complex light [4]. Complex light includes fundamental points some of which are beams with a structured wavefront, classical and quantum aspects of the spin and orbital angular momentum of light and novel propagation dynamics. Laguerre-Gauss, Hermite-Gauss, Bessel, Mathieu, Airy, helico-conical beams; imaging with structured light; quantum information processing and imaging with complex light; entanglement and hyper-entanglement with spatial modes are some of the included topics, too. In modern photonics paradigm shifts in magnetism at optical frequencies, backward waves, "engineering" of space and light have taken place [5]. New paradigm is an information-driven imaging [6]. In research of light and photonics complexity has become a method for solving puzzles but also for breakthroughs. According to modern optics, light can be a more complex phenomenon then it was previously considered [4].

Philosophical analysis at first appears with the question: Are the considered cases complex or complicated?

In claims that a new paradigm [5] or fundamental breakthrough [4] is emerging, we face ourselves with philosophy of science. In Kuhn`s theory (Thomas Kuhn, 1922-1996) the position in which light research and photonics are, could be a puzzle solving within normal science, or a crisis which takes place in the

expectation of scientific revolution [7]. For that reason factors which may lead to a new revolution, such as a different approach, are being investigated [8].

The emerging science of complexity “looks set to trigger the next great wave” [9] from which history and philosophy of science are inseparable.

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