Seminarium: **Okolice podstaw mechaniki kwantowej**

Godzina **14-16,** Wydział Matematyki i Informatyki UJ, **sala 1146**

Organizatorzy: Paweł Błasiak, Jarosław Duda

Data	Temat spotkania
2018-11-09	***Born rules, Bell violation and Anderson localization from statistical path ensembles*, Jarosław Duda (UJ)** Trying to decompose electric conductance into local currents down to atomic level, we are asking for diffusion model for electrons – this natural looking question has turned out problematic: predicting nearly uniform probability density for defected lattice – for example wrongly predicting that semiconductor is a conductor. It turns out that these standard diffusion models only approximate the crucial in statistical physics: (Jaynes) maximal entropy principle. Repairing this approximation, Maximal Entropy Random Walk (MERW) turns out to lead to the same stationary probability distribution as quantum ground state – with Anderson localization, for example preventing electron conductance in semiconductor. MERW equivalently is uniform (or Boltzmann) distribution among possible paths – getting mathematical agreement with quantum predictions thanks to resemblance to Euclidean path ensembles. Such idealized path ensembles also lead to Born rule and consequent violation of Bell inequalities – offering a simple explanation of quantum nonlocality. Slides
2018-06-22	***Review of book "The universe in helium droplet" by G. Volovik,* Krzysztof Pomorski (AGH)** There are fundamental relations between three vast areas of physics: particle physics, cosmology, and condensed matter physics. The fundamental links between the first two areas — in other words, between micro- and macro-worlds — have been well established. There is a unified system of laws governing the scales from subatomic particles to the cosmos and this principle is widely exploited in the description of the physics of the early universe. This book aims to establish and define the connection of these two fields with condensed matter physics. According to the modern view, elementary particles (electrons, neutrinos, quarks, etc.) are excitations of a more fundamental medium called the quantum vacuum. This is the new 'aether' of the 21st century. Electromagnetism, gravity, and the fields transferring weak and strong interactions all represent different types of the collective motion of the quantum vacuum. Among the existing condensed matter systems, a quantum liquid called superfluid 3He-A most closely represents the quantum vacuum. Its quasiparticles are very similar to the elementary particles, while the collective modes are analogues of photons and gravitons. The fundamental laws of physics, such as the laws of relativity (Lorentz invariance) and gauge invariance, arise when the temperature of the quantum liquid decreases. Slides
2018-06-21	***Monopoles as topological solitons*, Manfried Faber (TU Wien)** We define a Lagrangian for a scalar SO(3)-field in Minkowski space and derive the equations of motion. We determine the topological excitations of these fields. The three degrees of freedom of the SO(3)-field are sufficient to get long-range Coulomb forces, mass as field energy, spin as a topological quantum number and 4-Pi rotations as characteristic of fermions. Due to a spontaneous breaking of symmetry two massless degrees of freedom appear which can be compared with the two polarisations of electromagnetic waves. A U(1) gauge symmetry is emerging.
2018-06-06	***Is single-particle interference the mystery?,* Paweł Błasiak (IFJ)** A great deal of effort in quantum foundations research goes into identification of distinctive features which make the theory unique and effective at the same time. So, was Feynman right describing single-particle interference as *"a phenomenon which is impossible, absolutely impossible to explain in any classical way, and which has in it the heart of quantum mechanics. In reality, it contains the only mystery."* ? And does it have anything to do with contextuality, or non-locality of the collapse of the wave function? Despite a host of paradoxical effects appearing in a single-particle regime, an honest answer to these questions should be NO. In this talk, I will give explicit counterexample demonstrating that

	these features are present in classical stochastic models too. I will show that all single-particle phenomena in the interferometric circuits can be simulated/explained as epistemic effects in a local hidden variable model. This observation sets the bar higher for quantum discussions based on an ostensible weirdness of single-particle effects. In particular, it shows that claiming non-locality in the single-particle regime is unwarranted, and thereby the real mystery is pushed to the genuine multi-particle behavior. Slides
2018-05-22	***Dyskusja – kauzalność w eksperymencie Wheelera, z opóźnionym wyborem, algorytmie Shora?*** Zostanie przedstawione i poddane dyskusji kilka eksperymentów naiwnie sugerujących wpływ późniejszych zdarzeń na wcześniejsze: eksperyment Wheelera szczególnie w realizacji grupy Aspecta, eksperyment z pracy grupy Vaidmana "Asking photons where they have been", delayed choice quantum erasure w realizacji grupy Walborna oraz grupy Zeilingera, oraz algorytm Shora. Link do slajdów.
2018-05-08	***Nie ma świata klasycznego, czyli interpretacja Everetta mechaniki kwantowej – część II: dekohrencja i prawdopodobieństwo,*** **Paweł Jochym (IFJ)**
2018-04-24	***Nie ma świata klasycznego, czyli interpretacja Everetta mechaniki kwantowej,*** **Paweł Jochym (IFJ)** Przedstawię podstawowe założenia interpretacji Everetta, oraz ich konsekwencje dla obrazu świata. Interpretacja ta, zwana często interpretacją “wielu światów” jest często posądzana o brak ekonomii, czy łamanie zasady Ockhama. Często nazywa się ją też nieortodoksyją czy skrajną. Postaram się pokazać, że w istocie jest to jedna z najbardziej konserwatywnych interpretacji mechaniki kwantowej. Przedstawię także najważniejsze trudności jakie napotyka jej zastosowanie.
2018-04-06	***Równanie Abrahama-Lorentza, czyli o paradoksach klasycznej teorii cząstek naładowanych*****, Marcin Markiewicz (UJ)** Słynne równanie Abrahama-Lorentza to równanie ruchu dla punktowej cząstki naładowanej poddanej działaniu sił zewnętrznych. Ponieważ występuje w nim jawnie trzecia pochodna położenia cząstki (drugie przyspieszenie), równanie to ma paradoksalne własności, takie jak sygnalizowanie z przyszłości. W krótkim wystąpieniu omówię to słynne równanie, jego konsekwencje, oraz sposoby aby uniknąć jego paradoksalnych konsekwencji.
2018-03-30	***Topological charge as electric charge – particles as topological solitons,*** **Jarosław Duda (UJ)** Maxwell's equations have two weaknesses: field of electric charge has infinite energy, and lack of charge quantization: Gauss law allows for charge being any real number. In contrast, Gauss-Bonnet theorem allows to conclude that integrating field's curvature over a closed surface, we get topological charge inside - which has to be integer. Hence defining electric field as curvature of some more fundamental field leads to topological solitons with long-range Coulomb-like interaction, and magnetism resulting from Lorentz invariance. Such simple model of electron (by Manfried Faber) also regularizes charge to finite energy thanks to Higgs-like potential: allowing to leave the topologically nontrivial minimum in the center of charge. I will also briefly discuss its extensions to obtain further particles as topological excitations of a single field. Slides.
2018-03-16	***On classical electrodynamics with distribution-valued sources. In particular, the problem of point charge will be discussed*****, Edward Kapuścik (IFJ)**
2018-03-02	***Kwantowa nielokalność bez nierówności*****, Paweł Błasiak (IFJ)** Zacznę od krótkiego przypomnienia sporu o kompletność mechaniki kwantowej jaki toczyli Einstein i Bohr (1935) oraz fundamentalnego wkładu Johna Bella (1964) w dyskusję lokalnego realizmu teorii. Oryginalne rozumowanie Bella oparte o łamanie statystycznych nierówności na korelacje wyników pomiarów w teoriach lokalnych można obecnie zastąpić silniejszym argumentem prowadzącym do logicznej sprzeczności. Podczas seminarium opowiem o trzech różnych dowodach na nielokalność mechaniki kwantowej: oryginalnych nierównościach Bella-CHSH (1969) oraz dwóch paradoksach logicznych Hardy’ego (1992) i GHZ (1990). Link do slajdów.
2018-02-14	***Hydrodynamical analogues of a few quantum phenomena,*** **Jarosław Duda (UJ)** There are recently popular experiments started by Couder’s group with classical objects: “walking droplets” having wave-particle duality. In the best journals there are shown for them: interference patterns in double-slit statistics, tunneling, orbit quantization in a few ways: including Zeeman

	effect and double quantization (of separately radius and angular momentum), and recreating wavefunction with path statistics. I will also mention about hydrodynamical analogues of Casimir and Aharonov-Bohm effects, and some connections with quantum mechanics. Slides.
2018-01-31	Spotkanie organizacyjne