Devil is in detectors: Towards classical field model of quantum phenomena

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We show that (opposite to rather common opinion) quantum theory can be considered as emergent from theory of "prequantum random fields" – classical random fields having spatial and temporal scales which are essentially finer than the corresponding scales of quantum mechanics. In our model, so called prequantum classical statistical field theory (PCSFT), quantum density operators appear as normalized (by the trace) covariance operators of the prequantum random fields; e.g., an electron in the state rho is nothing else as (spatially and temporally distributed) random (e.g., Gaussian) field which covariance operator B reproduces rho=B/Tr B. Quantum observables correspond to quadratic forms of the prequantum random fields. Averages and covariances of these quadratic forms coincide with quantum quantities, including even the EPR-Bohm correlations and hence violating Bell's inequality [1].

Recently PCSFT was completed by measurement theory based on usage of detectors of the threshold type (threshold detection theory, TSD). In this model a detector clicks when it "eats" energy from the prequantum field which exceeds the threshold. TSD gives quantum probabilities as probabilities of discrete events – clicks of detectors. In this way we model even the coincidence probabilities for the EPR-Bohm experiment [2,3].

[1] Andrei Khrennikov, Masanori Ohya, Naboru Watanabe, Classical Signal Model for Quantum Channels. Journal of Russian Laser Research, v. 31, N 5, 401-407, 2010; arxiv.org/abs/1008.3772.

[2] Andrei Khrennikov, Börje Nilsson, Sven Nordebo, Classical signal model reproducing quantum probabilities for single and coincidence detections. Journal of Physics: Conference Series, 361, art N 012030 (2012); arxiv.org/abs/1112.5591.

[3] Andrei Khrennikov, Quantum probabilities and violation of CHSH-inequality from classical random signals and threshold type properly calibrated detectors. arxiv.org/abs/1111.1907.