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Quantum Information and the Foundations of Quantum Mechanics: a story of mutual benefit

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Fundamental tests, particularly of quantum nonlocality, in the 1970s were crucial for the development of the new field of quantum information science. The consequent development of new technologies has led to novel possibilities to do fundamental tests. A most simple and clear test of noncontextuality, i.e. the existence of joint probability distributions, is due to a proposal by Klyachko et al. [PRL 101, 020403 (2008)]. There, the experimental tests became possible because of technology developed for quantum communication. It turns out that a very simple and intuitive picture of the contradiction with realism can be given. In parallel, an experiment closing the freedom of choice loophole in quantum entanglement [T. Scheidl et al., Proc Natl Acad Sci USA (2010) 19709], together with earlier experiments testing the Leggett-type inequality and objectivity, i.e. the existence of observables without the context of observation, might be challenged. Current micro-optics technology and the exploitation of external states of light like Hermite-Gauss and Laguerre-Gauss allows to extend this kind of experiments into higher-dimensional Hilbert Spaces. There, interesting connections between entanglement and mutually unbiased bases have been found.