Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Loophole-free Quantum Steering[1] SVEN RAMELOW, BERNHARD WITTMANN, FABIAN STEINLECHNER, NATHAN K. LANGFORD, VCQ, Faculty of Physics, Univ. of Vienna and IQOQI Vienna, NICOLAS BRUNNER, Wills Physics Laboratory, Univ. of Bristol, HOWARD WISEMAN, Centre f. Quantum Computation and Communication Technology (ARC), Griffith University, RUPERT URSIN, ANTON ZEILINGER, VCQ, Faculty of Physics, Univ. of Vienna and IQOQI Vienna — Experiments testing quantum mechanics have provided increasing evidence against local realistic theories. However, a conclusive test that simultaneously closes all major loopholes (the locality, freedom-of-choice, and detection loopholes) remains an open challenge. An important class of local realistic theories can be tested with the concept of "steering." Schrödinger introduced this term for entanglement seemingly allowing to remotely steer the state of a distant system [1]. Einstein called this "spooky action at a distance." Steering was recently formalized by deriving steering inequalities allowing experimental tests. Here, we present the first loophole-free steering experiment [2]. We use entangled photons shared between two distant laboratories and close all loopholes by a large separation, ultra-fast switching and quantum random number generation, and high, overall detection efficiency. Beside its foundational importance loop-hole-free steering is relevant for is relevant for device-independent certification of quantum entanglement.

[1] E. Schrödinger, Proc. Camb. , Phil. Soc. 31, 553 (1935)
[2] B. Wittmann, S. Ramelow, F. Steinlechner, N. K. Langford, N. Brunner, H. Wiseman, R. Ursin, A. Zeilinger, arXiv:1111.0760, (2011)

[1]Funding by FWF (CoQuS and SFB FoQus) and ERC (QIT4QAD)

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Date submitted: 09 Dec 2011 Electronic form version 1.4