Experimental violation of the Leggett-Garg inequality under decoherence[1] JIN-SHI XU, CHUAN-FENG LI, XU-BO ZOU, GUANG-CAN GUO, University of Science and Technology of China — Despite the great success of quantum mechanics, questions regarding its application still exist and the boundary between quantum and classical mechanics remains unclear. Based on the philosophical assumptions of macrorealism and noninvasive measurability, Leggett and Garg devised a series of inequalities (LG inequalities) involving a single system with a set of measurements at different times. Introduced as the Bell inequalities in time, the violation of LG inequalities excludes the hidden-variable description based on the above two assumptions. Here, we experimentally investigate the single photon LG inequalities in a dephasing environment simulated by birefringent media. By implementing an optical Controlled-Not gate on a single photon, the LG inequalities are shown to be maximally violated in a coherent evolution process. This disproves its classical realistic description with the two assumptions of the LG inequalities. With the increase of birefringent media, the violation of LG inequalities becomes weaker and is shown to be not violated anymore at some time. The ability to violate the LG inequalities can be used to set the boundary of the classical realistic description.

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