Is energy conserved when nobody looks?

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Conservation principles are essential to describe and quantify classical and quantum mechanical processes. Classically, the conservation holds objectively because of the description of reality can be considered independent of observation. In quantum mechanics, however, invasive observations change quantities drastically, even if they are expected to be conserved classically. One may hope to overcome this problem by considering weak, non-invasive quantum measurements. Interestingly, we find that the non-conservation of some quantity Q is manifest even in weakly measured correlations, if some of the observables don't commute with the conserved quantity. The non-conservation shows up in third-order correlation functions of the conserved observable Q with two observables non-commuting with Q, which then depends on the order of measurements. At finite temperatures, the non-conservation becomes negligible pointing out its intrinsic quantum origin. Beyond elementary examples like a harmonic oscillator or a two-level system, we suggest measuring an apparent violation of angular momentum in a free-space electron beam experiment, detecting transverse positions and angular momentum of the electron. On a fundamental level, the observed non-conservation of "conserved" quantities can be related to a violation of a Leggett-Garg-type inequality. Therefore, our finding casts some doubt on the compatibility of conservation laws and quantum objectivity.