Novel theory how the classical world emerges from quantum mechanics

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The descriptions of the quantum realm and the macroscopic classical world differ significantly not only in their mathematical formulations but also in their foundational concepts and philosophical consequences. When and how physical systems stop to behave quantumly and begin to behave classically is still heavily debated in the physics community and subject to theoretical and experimental research. Conceptually different from already existing models, we have now developed a novel theoretical approach to understand this quantum-to-classical transition. It neither needs to refer to the environment of a system (decoherence) nor to change the quantum laws itself (collapse models) but puts the stress on the limits of observability of quantum phenomena due to our measurement apparatuses. First, we demonstrated that for unrestricted measurement accuracy a system's time evolution cannot be described classically, not even if it is arbitrarily large and macroscopic. Under realistic conditions in every-day life, however, we are only able to perform coarse-grained measurements and do not resolve individual quantum levels of the macroscopic system. As we could show, it is this mere restriction to fuzzy measurements which is sufficient to see the natural emergence of the classical Newtonian laws out of the full quantum laws: the system's time evolution governed by the Schrödinger equation and the state projection induced by measurements. This resolves the apparent impossibility of how classical realism and deterministic laws can emerge out of fundamentally random quantum events.

Under the magnifying glass of sharp measurements Albert Einstein sees a strange and colorful quantum picture of the face next to him. Its abstractness is symbolized by Pablo Picasso's "Head of a Reading Woman". Under an every-day coarse-grained view the classical appearance of Charlie Chaplin emerges.