Quantum 1/f Noise --a Decoherence Phenomenon

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Abstract

The Quantum Theory of 1/f Noise is a new aspect of quantum mechanics, introduced¹ in 1975 as an infrared divergence phenomenon. It is also a decoherence phenomenon. Indeed, in the 1980’s, the Quantum Theory of 1/f Noise was misunderstood by some for many reasons, but *finally for only one reason:* In general, the bremsstrahlung energy loss components emerging from any scattering, or from other processes, are known not to interfere with the main wave function. They are orthogonal, with phases differing by 90 degrees in a certain representation. Therefore, some said that my theory, based on such interference, is not valid. But the experiment always verified our Quantum 1/f (Q1/f) formulas in all domains, universally. Their mistake was ignoring the universal phenomenon of decoherence. Indeed, soon after the superposition state with 90 degrees phase differences is created, decoherence scrambles the phases, randomizing them, as we always assumed in our theory of the conventional and coherent quantum 1/f effects, which we introduced. This is also why the Schrödinger cat is never found half dead and half alive, and why we don’t have good quantum computers yet! This was now finally understood by the scientific community, particularly after a 2013 paper², and there are no other objections left to our theory and to its simple, practical, universal engineering formulas. They are applicable to all high-tech applications, for materials, devices and systems, existing in any domain in time and space, including also sensors or high stability resonators, oscillators and clocks. It’s as basic as time and space, as it also happens with gravitons as infraquanta, instead of photons. It shapes all existence in time and space. It is caused, in final analysis, by the interaction of our system with the rest of the world. As pointed out by us³ since 1982, the phases of the bremsstrahlung energy loss components of the outgoing wave function in a scattering process are randomized, as implied by the density matrix formalism used in that paper.

In this paper we introduce the degree D of quantum 1/f decoherence and focus on the determination of the decoherence time scales. We determine D from comparison of the calculated and measured 1/f noise or phase noise levels close to carrier. These D values are determined in a wider class of materials, devices and systems, at various temperatures, in order to use the D values for a new, independent method of investigating special materials, devices and systems, e.g., materials with lower dimensionality, for their transport properties, and reliability, including the study of low-temperature behavior of D. A main focus of this paper is the application of these results to the improvement of quantum computers.

Decoherence, however, happens only to 10% in beta radioactive decay⁴. The paper also shows how partial decoherence can reduce the observed Q1/f noise in devices.