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By: Gabriel Gache, Science News Editor

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How Elementary Particles Lose Their Quantum Properties

Understanding quantum mechanics

We live in a highly dynamic universe, no surprise here because, if it wasn't, we probably wouldn't be here at all. However, what is weird is that while at large scale things appear pretty natural to us, at a quantum level interactions between particles look more like stories taken out of a science fiction book. Particles can exist in two extremely different states at the same time, they can even be in two places at the same time or even pop in and out of existence randomly. Our brain is wired in such a way that this kind of interactions appear impossible to us in the real world, the macroscopic level, albeit they take place and are part of our daily lives even though we can't observe them with the naked eye. What is most important to us is how elementary particles interact and lose their quantum mechanical properties. California NanoSystems Institute at the University of California and US Department of Energy Ames Laboratory researchers believe they can answer these questions, or at least a part of them. According to the researchers, the key lies into understanding how the classical world, as we know it, emerges from the quantum level of matter. Unraveling the quantum dynamics of a single particle spin coupled to a collection of particles with random spins may unlock the way to understanding why some materials around us behave the way they do, such as the quantum tunneling process or magnetic resonance. "We were stunned by these unexpected experimental results, and extremely excited by the ability to control and monitor single quantum states, especially at room temperature," said author of the study David Awschalom from the University of California. Quantum mechanical properties loss is now more important than ever into the field of quantum information, due to the overwhelming advantages opposed to classical computation techniques. Most of the work is focused on high fidelity coherent control of a single spin, such as that of the experiment conducted by physicists in Awschalom who investigated the electron spin in a diamond, studying spin-bath interactions and decoherence dynamics. The diamond has unique features which enable scientists to investigate coherent dynamics and precise optical control of a single spin that can only be viewed in diamonds. The team observed multiple extraordinary phenomenons, amongst which time-dependent disappearance and reappearance or quantum oscillations inside the diamond lattice. "To our surprise, when looking at longer times, the oscillations disappeared and then re-appeared," said co-author Ronald Hanson. The first time the phenomenon appeared, the team believed it to be a random artifact, but upon reseting the experiment a couple of time, the measurements convinced them that the oscillation pattern was genuine. According to Hanson, electronic and atomic spins are some of the prime candidates for the future quantum information processors and spintronic devices. Additionally, theoretical models proved that diamond spins serve as nearly ideal, adjustable model of central spin. Because the experimental and theoretical models all point towards the same direction, they complement each other to create a more detailed picture of what really happens in diamond spin centers. Diamond spin quantum dynamics is the preferred topic by most researching teams around the world and could also have relevance in carbon-based electronic devices involving carbon nanotubes and graphene.