Closing the gap between the fields of nuclear quantum dynamics and condensed matter nuclear science

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Key parameters of nuclear reactions such as the half-lives of alpha emitters or the rates of fusion reactions have traditionally been considered to be unaffected by their environment. However, as has been noted since at least the 1960s[1], this assumption only holds in the absence of quantum-coherent effects. Quantum coherence can amplify initially weak couplings between nuclei and thereby lead to modified energy transfer and conversion pathways in strongly coupled systems, analogous to how such effects occur – and have been widely studied – at the atomic scale. Modified energy pathways, in turn, can mean the acceleration of fusion reactions as well as the modification of reaction products. A recent series of papers[2,3,4,5] published in journals of the Nature and Science families experimentally demonstrate changes in nuclear state transitions as a result of stimulating samples with coherent photons. Here I lay out how such findings – which are rooted in the established field of quantum dynamics – are highly relevant for the field of condensed matter nuclear science (CMNS), representing basic mechanisms for the manipulation of nuclear states. I show the connection between this recent line of work and the work of CMNS theorists such as Hagelstein[6] and Schwinger[7] and lay out what connecting pieces – in terms of conceptually simple experiments – are still needed to close the gap between the burgeoning field of nuclear quantum dynamics and CMNS. I expect that closing this gap will enable the systematic investigation of a large number of nuclear anomalies reported in recent decades, and will also be accompanied by a major influx of resources as well as renewed interest in such anomalies.

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