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Probing the timescale of the exchange interaction in a ferromagnetic alloy EMRAH TURGUT, CHAN LA-O-VORAKIAT, MARK E. SIEMENS, MARGARET M. MURNANE, HENRY C. KAPTEYN, JILA, University of Colorado, Boulder, STEFAN MATHIAS, PATRICK GRANITZKA, STEFFEN EICH, MARTIN AESCHLIMANN, University of Kaiserslautern and Research Center OPTIMAS, Germany, PATRIK GRYCHTOL, ROMAN ADAM, CLAUS M. SCHNEIDER, Peter Grünberg Institute, Research Center Jülich, Germany, JUSTIN M. SHAW, HANS T. NEMBACH, THOMAS J. SILVA, National Institute of Standards and Technology, Boulder — The underlying physics of all ferromagnetic behavior is the cooperative interaction between individual atomic magnetic moments that results in a macroscopic magnetization. In this work, we use extreme ultraviolet pulses from high-harmonic generation as an element-specific probe of ultrafast, optically driven, demagnetization in a ferromagnetic Fe-Ni alloy (Permalloy). We show that for times shorter than the characteristic timescale for exchange coupling, the magnetization of Fe quenches more strongly than that of Ni. Then, as the Fe moments start to randomize, the strong ferromagnetic exchange interaction induces further demagnetization in Ni, with a characteristic delay determined by the strength of the exchange interaction. We can further enhance this delay by lowering the exchange energy by diluting the Permalloy with Cu. This measurement probes how the fundamental quantum mechanical exchange coupling between Fe and Ni in magnetic materials influences magnetic switching dynamics in ferromagnetic materials relevant to next-generation data storage technologies.

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