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Imaging Spin Dynamics in Monolayer WS_2 by Time-Resolved Kerr Rotation Microscopy ELIZABETH BUSHONG, KELLY (YUNQIU) LUO, The Ohio State University, KATHLEEN MCCREARY, Naval Research Laboratories, MICHAEL NEWBURGER, SIMRANJEET SINGH, The Ohio State University, BEREND JONKER, Naval Research Laboratories, ROLAND KAWAKAMI, The Ohio State University — Monolayer transition metal dichalcogenides (TMDs) such as WS_2 offer a unique platform to probe spin and valley degrees of freedom in two-dimensional condensed matter systems. TMDs are of great interest because they have a direct band gap and optical selection rules that permit the excitation of both valley and spin-polarized electrons. Strong spin-orbit coupling leads to valley-dependent spin-splitting in both the conduction and valence bands, which may suppress spin relaxation and inhibit intervalley scattering, thereby increasing both the spin and valley lifetimes. To measure spin and valley dynamics of CVD grown WS_2, we developed time-resolved Kerr rotation microscopy with spatial resolution of ˜1 micron and temporal resolution of 150 fs. We observe a long spin lifetime of 5.1 ns in WS_2 at T = 6.5 K. We spatially map the spin populations at a given time delay, and observe a complex spatial dependence of the spin lifetimes with regions of spin lifetime less than 100 ps and regions of spin lifetime greater than 5 ns separated by only a few microns. To understand the origin of the long-lived spin states, we investigate the relationship between spin lifetime and the photoluminescence intensity. Application of in-plane magnetic fields shows an oscillatory and non-oscillatory component, indicating two spin populations that experience different effective fields.

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