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Real time imaging of magnetic excitations in the spin ice $Ho_2Ti_2O_7$

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Theoretically, a special form of spin frustration in classical spin ices results in emergence of excitations that are directly mapped to magnetic monopoles. Experimentally, many aspects of the energetics of the magnetic excitations in spin ices are still not well understood, in part, because of scarcity of experimental tools that can explicitly and directly test for monopole dynamics. Using scanning Superconducting QUantum Interference Device (SQUID) microscopy we obtain real time images of spontaneous magnetic field fluctuations in the spin ice $Ho_2Ti_2O_7$. We determine a distribution of activation energies of spontaneous magnetic excitations from the temperature and frequency dependence of the observed field fluctuations. We discuss an agreement of the extracted energy distributions with the expected ones for monopoles excitations. This study opens new horizons for studies of real space and real time magnetic fluctuations and their relations to emergent phenomena in a variety of frustrated magnets.