Non-reversible Photoinduced Phase Transition in the RbMnFe Prussian Blue Analogue Studied by Streaming Crystallography

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Modern ultrafast laser technologies have opened new perspectives in controlling bistable magnetic materials, where light can be used to switch between different phases and thus different properties down to ultrashort timescales [1]. Among the available bistable materials, Prussian Blue Analogues (PBAs) are cyano-bridged bimetallic compounds with a phase transition based on a charge transfer between two stable states of different spin [2]. Moreover, the electronic charge transfer is coupled to symmetry breaking and large volume change, leading to a wide bistability hysteresis [3].

In this work, we followed the multiscale dynamics of the photoinduced phase transition within the thermal hysteresis of RbMnFe PBA micro-crystals (Figure 1) [4,5]. This was made possible by developing a new streaming crystallography method for time-resolved X-ray diffraction studies of non-reversible phenomena. Our results reveal that, above threshold excitation, complete photo-transformation from tetragonal to cubic phases can be achieved down to ultrashort timescales, leading to a permanent photo-induced phase. The out-of-equilibrium and multiscale dynamical behavior results from the coupling of volume strain driven by photoinduced charge transfer and symmetry change [5,6]. More generally, these results open a broad field of dynamical studies for photo-switching in bistable materials through ultrafast crystallography.

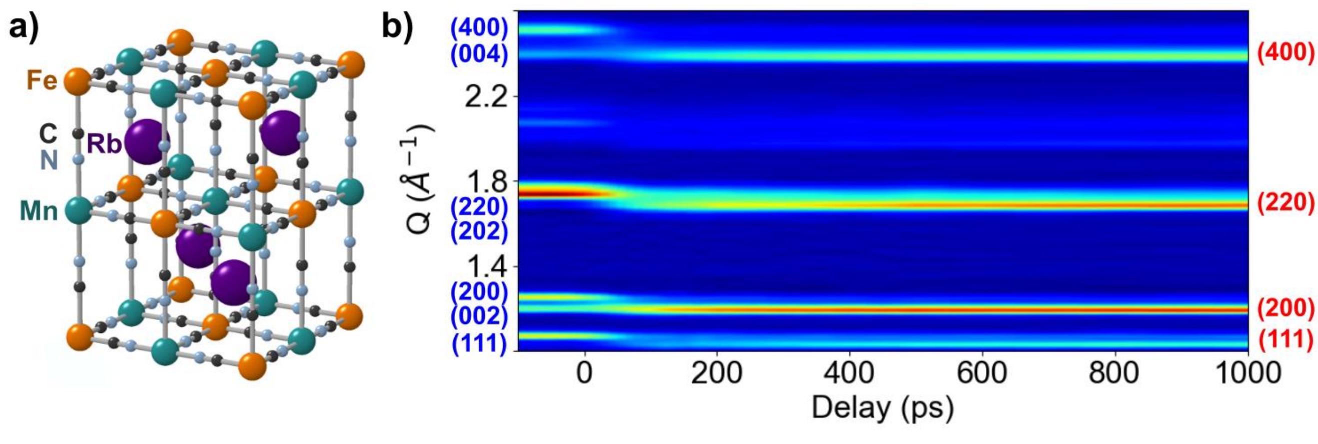

Figure 1. a) Structure of the RbMnFe PBA; b) Time-resolved X-ray diffraction pattern of RbMnFe, with (hkl) indices for the initial, tetragonal (left, in blue) and final, cubic (right, in red) phases.

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