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Critical phenomena and femtosecond ordering dynamics associated with electronic and spin-ordered phases in YVO3 and GdVO3

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Abstract

We present a systematic study of the electronic- and spin-excitation dynamics associated with the sequence of spin- and orbital-ordering phase transformations in the complex vanadates YVO3 and GdVO3 with ultrafast optical pump-probe reflectance spectroscopy. Relaxation dynamics occurs on a different time scale for each of the ordering transitions, which enables us to unambiguously associate the critical behavior in the dynamics with the observed ordering phenomena. Spin-ordering dynamics is observed on two time scales: τr 2ps (rise time) and τs 300-3000ps (decay time), observed below TN in both compounds. In contrast, the relaxation dynamics associated with orbital ordering occurs in YVO3 on a time scale of τo 20-50ps. From the temperature dependence of the dynamics, we observe that in both the G-type and C-type orbitally ordered (OO) phases of YVO3 spin order develops in a second-order mean-field fashion with the Nèel temperature of the C-OO phase found from our data TNC =83±7K. In GdVO3 we identify the emergence of a new ordered phase within the phase-separated state below 60 K. A new response component with a lifetime of ~60ps is observed below 60 K together with other anomalies in the ΔR/R (Δt) data. This new phase is not resolved in x-ray diffraction and is not present in YVO3. © 2010 The American Physical Society.

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