# Terahertz driven ionic Kerr effect and dynamical multiferroicity in $SrTiO_3$

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The Kerr effect measures the birefringence induced in an otherwise isotropic material by a DC or AC applied electric field. Its ultrafast implementation with AC optical pulses has been widely used to investigate the nonlinear optical properties of many different systems. More recently, its THz counterpart has shown the ability to induce a largely enhanced response due to the resonant excitation of Raman-like processes involving lattice vibrations[1] or broken-symmetry electronic and magnetic collective modes[2,3]. In a recent work[4], we have provided experimental evidence that in insulating $SrTiO_3$ also infrared-active lattice vibrations can give rise to a sizeable terahertz Kerr effect, named ionic Kerr effect, thanks to a non-linear excitation of multiple phonon modes[5]. Such a signal can be disentangled from the off-resonant electronic excitations responsible for the conventional electronic Kerr effect by moving out the light-phonon resonance condition with temperature. Its identification is made possible thanks to a quantitative theoretical modelling[6] linking the measured birefringence signal to the microscopic processes responsible for the time and polarization dependence of both the ionic and electronic contribution. When circularly polarized pulses are applied, an additional contribution besides the Kerr effect has been observed[7]. We have shown that this component can be related with a quasi-static macroscopic magnetization induced by the circular motion of the ions, in agreement with the theory of dynamical multiferroicity[8].

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