THz control of Nickelate's devices

Nickelate compounds represent one of the most studied perovskite families, due to the presence of strong electronic correlations, layered structure, and low spin configuration. The key microscopic parameter determining the ground state and Mott temperature is the Ni-O-Ni bonding angle, whose amplitude varies from about 144° in $LuNiO_3$ (T_{MIT}=600 K) to 161° in metallic $LaNiO_3$. Being on the verge of a Mott transition, nickelates display a high susceptibility with respect to small external perturbations, in terms of chemical pressure, oxygen reduction, interfacial doping and dimensionality.

It was shown in nickelate thin films that a photoexcitation at 20 THz, resonant with a normal mode of the $LaAlO_3$ substrate allows inducing an ultrafast insulator to metal transition (IMT). It is believed that the IMT is due to the coupling of the Al-O stretching mode of the substrate with a rotational mode thereby affecting, through interfacial strain, the Ni-O-Ni bonding angle. The role of the $LaAlO_3$ substrate is to provide a vibrational mode at a wavelength accessible to the employed experimental set-up. Due to the lack of high peak power THz sources emitting in the so-called Reststrahlen band-gap, nothing is known at present on the possible outcome of the direct pumping on nickelate's vibrational modes.

We will explore possible novel electronic IMT to be induced with long wavelength excitations at and below 5 THz on high quality nickelate thin films and heterostructures of different chemical composition. To achieve this goal we will exploit different unconventional mechanisms, from non-resonant quasi-static field induced IMT to THz ionic Raman scattering. These studies will be conducted at the TeraFERMI beamline of the FERMI free-electron-laser, producing single-cycle, broadband, high-power THz pulses.

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