Highlights

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Thermometric Calibration of the Ultrafast Relaxation Dynamics in Plasmonic Au Nanoparticles

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The impulsive excitation of matter by ultrashort laser pulses sets in motion a complex relaxation process, occurring on the femto-to-picosecond time scale, that involves the initial absorption of the electromagnetic energy by the system electrons, the gradual equilibration of the electron gas, and the subsequent release of energy to the ion-lattice, and to the environment. Thus, on the ultrafast time scale, the temperature of the electron gas (T_{el}), the ion lattice (T_L), and the environment (T_{bath}), differs (Fig.1, left), only to become equilibrated on the *ps* time scale. In order to have insights about these ultrafast processes, it is paramount to extract the dynamic evolution of the system temperature, yet such measurements are intrinsically complex. In this work, we report a measurement of the ultrafast dynamics of the ion-lattice temperature in Au nanoparticles following ultra-short-pulse excitation. To this end, we compared the ultrafast optical fingerprint of Au nanoparticles with their corresponding static optical spectra as a function of the increasing temperature of the thermodynamic bath (Fig.1, right). Evaluating the analogies and differences between the two sets of data allowed us to evaluate the experimental conditions upon which electrons and lattice are in thermal equilibrium, and henceforth extract the ultrafast temperature evolution of the plasmonic particles as a function of time (Fig.2).

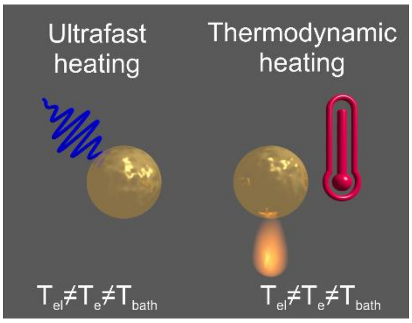

Fig. 1: The principle of the thermos-optical temperature calibration of impulsively excited plasmonic Au nanoparticles.

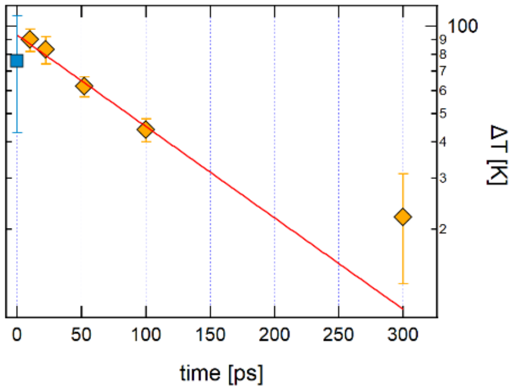

Fig. 2: dependence of the ion-lattice temperature of Au nanoparticles as a function of the delay time elapsed since impulsive electromagnetic excitation, extracted by means of a static thermos-optical calibration method.