Coherent and spontaneous Raman with pulsed lasers for investigation of material properties

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Spontaneous Raman is a powerful method for label-free characterization of solid-state materials and molecules. For this reason, it is largely applied in microscopy and time-resolved spectroscopy.
However, spontaneous Raman has two critical shortcomings: a time-energy resolution restriction (dictated by the time-bandwidth product of the light pulse $\Delta E \Delta t \geq 15$ $cm^{-1}ps$), hampering the detection of sub-picosecond structural dynamic and a low cross-section that prevents a real-time Raman imaging.
The development of laser sources with high peak power for non-linear optics has allowed to design new schemes of coherent Raman, overcoming the limitations of spontaneous Raman. In this seminar I will show experimental cases in which coherent Raman is preferable to spontaneous Raman and vice versa. Specifically, the femtosecond and picosecond Raman dynamics of exchange interaction in antiferromagnetic materials, hybrid perovskite, 2D systems (also heterostructures) are illustrated with their implications in the interpretation of electronic and structural ultrafast modification of systems. In the last part, an extension of non-linear optics in the extreme ultraviolet, performed by free electron laser source, is shown.