Atomic, Molecular and Plasmonic Nonlinear Optics

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The nonlinear optical response to light excitation has been studied from the early days after the invention of the laser. A comprehensive theory for nonlinear susceptibilities has been developed and experiments were performed leading to many new observations and even practical devices. Many of the early works focused on the resonant response of atoms, molecules or various crystals. Near resonance the nonlinear response is much stronger, and therefore with the development of tunable laser source, most experiments involved excitation of dipolar transitions on or near resonance.

In recent years, the approach has changed, and instead of tuning the laser to the atomic or molecular transition, Materials are engineered so that their energy levels are tuned to match the laser frequencies. Such approaches have been used for semiconductor quantum wells, and are currently being used in plasmonic transitions in metasurfaces. Modern technologies of nano fabrication enable us to tailor the optical response of metasurfaces almost at will.

In this talk I will briefly review our recent work on the nonlinear plasmonic response: optimization of four wave mixing and third harmonic, phase control and holography and design of functional optical elements. The connection to the work on Ron Naaman will be discussed.