# HL 90: Intersectional Joint Session: Nano Plasmonic

Time: Friday 10:30–13:00 Location: BAR 205

**Invited Talk** HL 90.1 Fri 10:30 BAR 205

**Plasmon Driven Higher Harmonics Generation** — In-Yong Park, Seungchul Kim, Joon-Hee Choi, and •Seung-Woo Kim — Ultrafast optics for ultraprecision research group, KAIST, Daejeon, Republic of Korea

Plasmonic resonance enables field enhancement of a low-intensity fs pulse, permitting high harmonic generation without an additional amplifier. This new concept of generating ultrafast higher harmonic pulse was previously demonstrated using Au bow-tie antennas. The resulting intensity enhancement factor reached ~20 dB and successfully produced up to the 21st harmonic. Notwithstanding the high enhancement factor, the 2-dimensional configuration of the bow-tie nanostructure was found sensitive to thermal damages preventing practical usage. To cope with the problem, a 3-dimensional solid nanostructure is newly proposed and tested in this investigation. The newly designed nanostructure takes the shape of an ellipsoidal tapered waveguide fabricated in a cantilever micro-structure. The tapered waveguide functions as a plasmonic device that induces field enhancement by exploiting surface-plasmon polaritons being created as a femtosecond pulse propagates through. In comparison to bow-tie nano-antennas, the use of surface plasmon polaritons offers a much larger volume of enhanced laser field due to counter-propagating surface plasmon modes within the waveguide in response to the incident femtosecond pulse. The intensity of incident NIR pulses is enhanced by a factor of ~350, being strong enough to produce EUV harmonics up to the 43rd order directly from a modest input intensity of 1012 Wcm-2 in interaction with Xe gas.

**Invited Talk** HL 90.2 Fri 11:00 BAR 205

**Structure and Dynamics of Free Nanoparticles: From Charging to Time-Resolved Photoemission** — •Eckart Rühl — Physikalische Chemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin

Nanoscopic systems prepared from nanoparticles as unique building blocks have the advantage that their properties depend critically on the single nanoscopic units and their assembly on substrates. Single nanoparticles show often size and composition dependent optical, electronic, structural, and dynamical properties. This includes quantum size effects, which are efficiently modified by the internal structure of the nanoparticles and their surroundings. Recent progress in chemical syntheses of structured nanoparticles as well as properties of single nanoparticles is presented. This includes controlled preparation of dimers or small aggregates of nanoparticles. Single, free nanoparticles without any contact to other particles or substrates are either prepared in traps or focused nanoparticle beams. These approaches allow us to study the intrinsic size- and composition dependent properties of isolated nanoscopic matter and their photon-induced dynamics. Results from a variety of different experimental approaches making use of synchrotron radiation and ultra-short laser pulses are presented. These provide specific information on the electronic structure, plasmonic excitations, the location of the emitted electrons in nanoparticles, the dynamics of electron emission and cation formation, as well as the dynamics of collective electronic excitations in the femtosecond time domain.

**Invited Talk** HL 90.3 Fri 11:30 BAR 205

**Terahertz Nano Plasmonics** — •Dai-Sik Kim — Center for Subwavelength Optics, Department of Physics and Astronomy, Seoul National University, Seoul, Korea

In this talk, we will focus on how terahertz electromagnetic waves, with wavelengths in the millimeter scale, can funnel through nano slits and nano slot antennas. The field enhancement is enormous, three orders of magnitudes, which can be used for nonlinear processes and ultrasensitive probing of underlying structures. Optics in extreme subwavelength regime resembles electro-statics involving capacitors, in contrast to the electromangetic waves in free space.

**Invited Talk** HL 90.4 Fri 12:00 BAR 205

**Coulomb complexes: Electron emission from clusters in strong FEL pulses** — •Ulf Saalmann — MPI for the Physics of Complex Systems

The response of atomic clusters to short intense pulses at extreme-ultraviolet (XUV) and Xray wavelengths — as available from short-wavelength free-electron laser (FEL) sources like FLASH in Hamburg/Germany, the SCSS in Japan or LCLS in Stanford/California — is studied theoretically. Due to the high photon flux the clusters become multiply charged by massive electron emission. We device a model, which we call Coulomb complexes [1], in order to investigate the emission process. It turns out that the electron spectra strongly depend on the ionization rate. For low rates the electron release occurs sequentially and our model allows for an analytical description of the plateau-like electron spectra [1]. At high rates a dense nanoplasma is formed and ionization occurs through energy-exchanging collisions resulting in exponential electron spectra [2]. Both mechanisms can be understand in terms of our model containing only very few parameters available from experiments.

[1] Gnodtke, Saalmann, Rost, New J. Phys. in press (2011).
[2] Bostedt et al., New J. Phys. 12, 083004 (2010).

**Invited Talk** HL 90.5 Fri 12:30 BAR 205

**Appearance of Surface and Volume Plasmons in Fullerenes** — •Sanja Korica[1], Axel Reinköster[1], Markus Braune[1], Jens Viefhaus[1], Daniel Rolles[1], G. Fronzoni[2], D. Toffoli[2], M. Stener[2], P. Decleva[2], O. Al-Dossary[3], Burkhard Langer[4], and Uwe Becker[1,3] — [1]Fritz-Haber-Institut der MPG, Berlin — [2]Universitá di Trieste, Italy — [3]King Saud University, Riyadh, Saudi-Arabia — [4]Freie Universität Berlin

Since the discovery of the $C_{60}$ molecule in 1985 many studies have been performed to investigate its fundamental properties. These properties are mainly driven by its unique molecular structure like its spherical shell. One of the important characteristics of this molecule is the collective response of its valence electron cloud to electromagnetic radiation. This collective behavior gives rise to the occurrence of the giant dipole resonance a surface plasmon in the absorption spectrum centered around 20 eV, which has been analyzed theoretically by various authors. In addition, our photoionization cross-section measurements reveal a resonance near 40 eV, a volume plasmon analogous to observations made for $C_{60}$ ions. Time-dependent density functional calculations confirm the collective nature of this feature as corresponding plasmon excitation. A third excitation of this kind is predicted but not experimentally confirmed. Concerning photoelectron emission, plasmonic excitations are characterized by a particular intensity behavior near threshold. They follow the threshold behavior law predicted for the first time by Thomas Derrah. Our measurements of the $C_{60}$ plasmon excitations above the C 1s ionization threshold confirm this law very well and are in unexpectedly good agreement with the corresponding behavior of K-shell satellite excitations in atoms such as neon.