

## The “Odd” Harmonics – harmonics via the four-step model and terahertz harmonics

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### Abstract:

High-order harmonic generation (HHG) is an excellent tabletop source of coherent extreme ultraviolet and soft X-ray radiation. Since high-order harmonics are intrinsically generated in attosecond bursts, it is also opening a new domain of attosecond science. More recently, high-harmonic spectroscopy is evolving to become a unique tool for studying the electronic structure of atoms and molecules. The HHG process from most nonlinear media is well explained by the three-step model. In this talk, I will describe two “odd” cases where the three-step model does not apply. In the first example, I will describe our works on resonant harmonics, where the intensity of a specific harmonic order is more than 100 times higher than the other harmonics. I will show that such harmonics could be well explained by a four-step model, adding an extra step to the conventional three-step model. Such resonant harmonics are also leading to the observation of new phenomena, such as the generation of harmonics involving dressed autoionizing states.



In a second example, I will describe our works on high-order harmonic generation of intense, few-cycle terahertz (THz) pulses. I will show that THz harmonics could be explained by abandoning the microscopic picture, and adopting a macroscopic picture where the current in the nonlinear medium (in our case, n-doped semiconductor) generated by the intense THz pulse undergoes subcycle modulations, thus leading to harmonics. Such effects may be of interest for characterizing various materials for use in the sub-THz to THz frequencies (such as in future 6G devices).

### Biography:

Tsuneyuki Ozaki is a Professor at the Institut national de la recherche scientifique (INRS), serving in the past as the Director of the Advanced Laser Light Source (ALLS) facility from 2006 to 2012. He joined the INRS as Assistant Professor in 2003, after being a Research Associate at the Institute for Solid State Physics, University of Tokyo from 1990 to 2000, and a Research Specialist at Nippon Telegraph and Telephone (NTT) Basic Research Laboratories, Atsugi, Japan from 2000 to 2003. His main research interests include high-intensity THz radiation and its applications, intense high-order harmonic generation, and the use of lasers in medicine. He was a member of the Board (Treasurer) of the International Committee on Ultrahigh Intensity Lasers (ICUIL) from 2008 to 2017, and since 2018 is the Chair of Commission 17 on “Laser Physics and Photonics” of the International Union of Pure and Applied Physics (IUPAP).