<u>SONDERSEMINAR/SPECIAL SEMINAR</u>
<u>MPQ/LMU</u>

Date:	**Thursday, December 7, 2017**
Time:	**9:30 a.m.s.t.**
Presentation:	**Alireza Marandi** **Rearch Engineer** **E.L. Ginzton Laboratory** **Stanford University** **& Ass. Prof.** **Dept. of Electrical Engineering** **California Institute of Technology** **(CALTECH)**
Title:	**Half-Harmonic Generation: Enabling Photonic Solutions for Molecular Sensing and Non-Classical Computing**
Location:	**Discussion/Seminar Room H 311** **Faculty of Physics/Ludwig Maximilians University (LMU)**

Faculty of Physics
Ludwig-Maximilians Universität/Ludwig-Maximilians University (LMU)
CHAIR of Laserspectroscopy / Director Professor Professor Theodor W. HÄNSCH

Half-Harmonic Generation: Enabling Photonic Solutions for Molecular Sensing and Non-Classical Computing

Abstract:

Our life in today's fast evolving information age is tied to overwhelming technological challenges related to how we capture information on one hand, and, on the other, how we process it. Nonlinear photonic systems are among the growing technologies promising solutions for these challenges by offering paths toward efficient sensing systems for capturing information, and alternative computing platforms for processing it. One example of nonlinear optical processes is half-harmonic generation, which is splitting photons into pairs of photons at half the input frequency that happens in optical parametric oscillators (OPOs) at degeneracy; its intriguing characteristics such as intrinsic phase and frequency locking as well as possibility of generating quantum states of light have opened up unique opportunities for practical and scalable photonic techniques for molecular sensing and non-classical computing.

In this talk, I will overview the concept of half-harmonic generation and present the results of realizing efficient sources of femtosecond frequency combs in the mid-infrared based on it [1]. These coherent broadband sources in the molecular fingerprint region of the optical spectrum enable direct sensing of several molecular species simultaneously; a capability that has potential applications in areas such as analysis of greenhouse gases and medical breath analysis.

Moreover, I will discuss how half-harmonic generation has enabled development of a novel photonic computing platform, namely the optical Ising machine. Various combinatorial optimization problems in biology, medicine, wireless communications, artificial intelligence and social network that are not easily tractable on conventional computers can be mapped to the Ising problem, and hence the optical Ising machine offers a scalable path for tackling these problems. I will overview a sequence of experiments on development of these half-harmonic-generation-based Ising machines, from their first demonstration in 2014 [2], to a recent large-scale realization that can be programmed to arbitrary Ising problems [3].

I will conclude the talk by presenting our ongoing work on chip-scale implementation of half-harmonic generation and potential paths toward quantum photonic engineering.

[1] A. Marandi et al., Optica 3 (3), 324-327 (2016).
[2] A. Marandi et al., Nature Photonics 8 (12), 937-942 (2014).
[3] P. McMahon*, A. Marandi* et al., Science 354 (6312), 614-617 (2016).

Bio:
Alireza Marandi received his PhD in Electrical Engineering from Stanford University in 2013. From 2013 to 2016 he was a Postdoctoral Scholar at the Department of Applied Physics at Stanford University and a Visiting Scientist at the National Institute of Informatics in Japan working with Profs. Y. Yamamoto, R. L. Byer, and M. M. Fejer. His research has been on lasers, nonlinear photonics, and quantum optics with focus on frequency comb techniques and integrated photonic technologies for sensing and information processing. He is currently a Research Engineer at Stanford University and a Visiting Associate at Caltech. In 2018, he will join Caltech as an Assistant Professor of Electrical Engineering.

transition frequency is obtained with a relative uncertainty on the order of 10^{-12}. It is in very good agreement with the CODATA-recommended value. This new measurement contributes to the ongoing search to solve the proton radius puzzle.