QPhysics
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Colloquium Notice

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Half-harmonic generation: enabling photonic solutions for molecular sensing and non-classical computing

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], and one-to-one comparisons with the D-Wave quantum annealer.

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

References:
[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)

Monday
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Starts at 12:15 PM
Coffee at 12:00 PM
Physics Conference Room, SB B326