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Trace-gas sensing on a fully integrated silicon photonic chip

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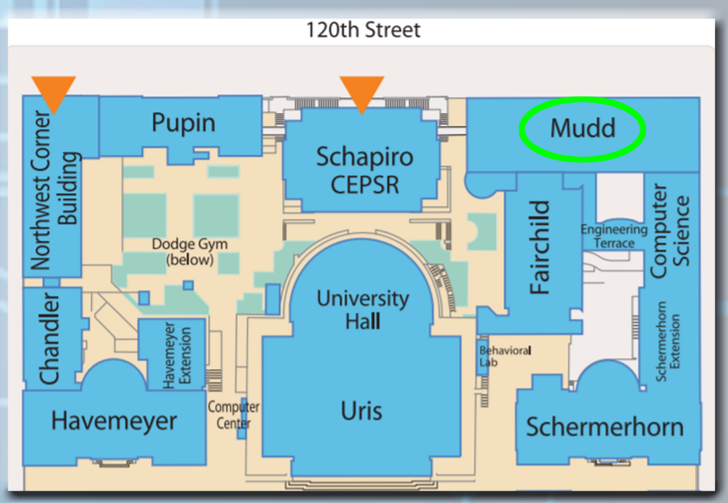
Location:
EE Conference Room
13th Floor Mudd

Date:
May 14
2pm-3pm

FOOD WILL BE SERVED!

Abstract: I will present our efforts towards an integrated silicon (Si) photonic chip sensor for trace-gas absorption spectroscopy of methane (CH4). The chip spectrometer includes a heterogeneously integrated III-V/Si external-cavity laser and detector, on-chip sealed CH4 reference cell, and sensing waveguide. Ambient CH4 spectroscopy is performed using the evanescent field interaction with the ambient environment through a long waveguide path (~ 30 cm). Tunable diode-laser absorption spectroscopy (TDLAS) using the integrated chip sensor and full stack sensing electronics hardware demonstrates sub-100 ppm·Hz-1/2 precision, corresponding to a noise equivalent absorbance of 1.9×10-4 Hz-1/2, consistent with modern free-space optical TDLAS systems and demonstrating our integrated optical sensors as a viable platform for trace-gas sensing. Customized spectral denoising algorithms will be presented for the mitigation of Fabry-Perot etalons resulting from waveguide line-edge roughness and ambient thermal fluctuations. A technological path towards single-ppm sensitivity will be discussed, in addition to techniques for broadband spectroscopy of multiple gases and additional methods for mitigating optical noise. Based on the size, weight, cost, and power (SWaP-C) benefits of chip-scale integration, we envision our integrated sensor as part of a new-generation of highly sensitive and molecule-specific diagnostic toolkit, with applications ranging from wide-area sensor networks to personalized health and wellness monitoring.

Speaker Bio: Eric Zhang is a postdoctoral research at IBM Thomas J. Watson Research Center, where his research focuses on systems-level implementation of optical spectroscopy on an integrated silicon-photonic platform. Eric completed his Ph.D. in the Princeton University Laser Sensing Laboratory, where he specialized in optical spectroscopy for trace-gas detection, particularly Faraday rotation spectroscopy for nitric oxide isotopic ratiometry. He received his B.A.Sc. in Engineering Physics from the University of Toronto, while working in the Micro/Nanophotonics Laboratory developing passive photonic devices for optical sensing. Eric is a recipient of the Walbridge Graduate Fund award (2014) from the Princeton Environmental Institute for his proposal entitled "Nitric Oxide Isotopic Ratiometry for Nitrogen Cycle Studies," and has received the Alexander Graham Bell Canada Graduate Scholarship (NSERC) for his graduate studies at Princeton University. In 2009 he was awarded the Undergraduate Student Research Award (NSERC-USRA) for his work in the University of Toronto Micro/Nanophotonics Laboratory. Eric is also a recipient of the Queen Elizabeth Aiming for the Top scholarship during his undergraduate studies at the University of Toronto.



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