Incoherence in coherent microscopy and spectroscopy

Garth Simpson, PhD
Professor of Chemistry
Research Director; Young Advanced Manufacturing of Pharmaceuticals Institute
Purdue Director; NSF Center for Bioanalytic Metrology
Purdue University

Co-sponsored by Morgridge Institute for Research and the Center for Quantitative Cell Imaging

Nonlinear optical light/matter interactions uniquely dependent on symmetry and composition, providing image contrast inaccessible from conventional optical interactions. Such information is particularly insightful in biological microscopy, with collagen exhibiting prominent second harmonic generation (SHG) that is highly dependent on molecular ordering within the triple helical fibrils. Intriguingly, we show that SHG produced from collagen in tissue sections routinely results in significant depolarization in the detected nonlinear response. A mathematical framework based on Mueller tensors is proposed for interpreting such measurements, and mechanisms driving the introduction of incoherence are weighed within that context. While potentially viewed as an annoying interference, the incoherent component of the signal is shown to have the potential to access additional observables that are inaccessible by coherent nonlinear optics. Proof-of-concept measurements support our theoretical predictions of new chiral-specific spectroscopies enabled through incoherent optical interactions. Such measurements open up opportunities both to design new spectroscopic observables and to reinterpret prior ones.

ABOUT the SPEAKER

Garth J. Simpson is a Professor of Chemistry and is currently serving as the Research Director of Purdue's Young Institute for Advanced Manufacturing of Pharmaceuticals, and as the Purdue Director of the NSF Center for Bioanalytic Metrology. Prof. Simpson's research centers on quantitative nonlinear optical microscopy, with an emphasis on the role of molecular chirality in driving unique observables in nonlinear optics. The research program of Prof. Simpson has been recognized by the American Chemical Society (ACS) Division of Analytical Chemistry Spectrochemical Analysis Award (2022), a Purdue College of Science Research Award (2014), the Innovation Award from the Federation of Analytical Chemistry and Spectroscopy Societies (2014), an ACS Findeis Award (2007), a Sloan Research Fellowship (2005), a Cottrell Teacher-Scholar Award (2004), a Beckman Foundation Young Investigator Award (2004), and a Dreyfus New Faculty Award (2001).

Monday, November 18 at Noon
1003 Engineering Centers (Tong Auditorium)