Quantum, Nonlinear-Optics and Near-Field Sensors and Tools for Biophotonics

A V Sokolov[1,2,3]

[1] *Electrical & Computer Engineering, Texas A&M University, College Station, TX, USA*
[2] *Department of Physics and Astronomy, Texas A&M University, College Station, TX, USA*
[3] *Institute for Quantum Science and Engineering, Texas A&M University, College Station, TX, USA*
Contact Email: sokol@tamu.edu

Biophotonics is a vibrant interdisciplinary field exploring the interaction between electromagnetic radiation and biological materials such as sub-cellular structures and molecules in living organisms. Biophotonics research utilizes quantum optics techniques leading to applications in agriculture and life sciences and producing tools for medical diagnostics and therapies. In my talk, I will review our recent advances toward ultrasensitive vibrational spectroscopic probing and imaging of various bio-molecules, cells and organisms. One approach is laser spectroscopy aided by plasmonic surfaces, structures, and nanoantennas [1], as in tip-enhanced Raman spectroscopy [2]. An additional enhancement in spectroscopic sensitivity and speed is obtained by employing quantum molecular coherence, as in the multiple versions of coherent Raman [3] and infrared spectroscopy [4]. Nonclassical sources producing squeezed light and entangled photons can further increase spectroscopic signal and suppress noise [5]. I am grateful to all my colleagues and collaborators on the referenced papers. Our ultimate goal is nondestructive label-free biosensing with molecular-level sensitivity and with spatial resolution down to a fraction of a nanometer.

References

[1] Z Gao, D V Voronine and A V Sokolov, Photonics **12**, 125 (2025)

[2] J Wang, Z Jiang, Z He, *et al.*, Appl. Phys. Lett. **127**, 113702 (2025)

[3] K Wang, J T Florence, X Hua, *et al.*, Molecules **30**, 2243 (2025)

[4] J Wang, N Marshall, Z Han, *et al.*, Proc. Natl. Acad. Sci. U.S.A. **123**, e2603591123 (2026)

[5] A Svidzinsky, G Agarwal, A Classen, *et al.*, Phys. Rev. Res. **3**, 043029 (2021)