Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **322** Type: **Poster Competition (Graduate Student) / Compétition affiches (Étudiant(e) 2e ou 3e cycle)**

# (G*) POS-E37 – Advanced modelling in computational nanophotonics

*Wednesday 9 June 2021 14:03 (2 minutes)*

With advances in nanofabrication, modelling the optical properties of nanoscale systems is critical.

The optical response of nanostructures can be simulated using the bulk permittivity of the constituent materials (1). The permittivity is generally assumed time-invariant and spatially dispersionless. While these approximations are enough for the simulations of most systems, in some cases the physics must be modelled more precisely.

We present three recent projects on the modelling of complex optical properties with implications in active nanophotonics (2), ultrafast physics and nonlinear plasmonics. The algorithms we developed are unavailable in commercial or open-source software.

1.) Nonlocal models: for small nanostructures (< 10 nm) spatial dispersion cannot be neglected, and we need to account for the electron degeneracy pressure (3).

2.) Nonlinear hydrodynamics: The hydrodynamic plasma model is required to properly model conduction electron dynamics in strong optical fields (4).

3.) Time-variant permittivity: Electrodynamics combined with two-temperature modelling is required to calculate the optical response induced by nonlinearity in ITO under strong optical fields (5).

Our models combined with high-performance computing allow us to achieve accurate results and significant agreement to experiments.

References

1. Pernice, W. H. P. Finite-Difference Time-Domain Methods and Material Models for the Simulation of Metallic and Plasmonic Structures. J. Comput. Theor. Nanosci. 7, 1–14 (2010).
2. Shaltout, A. M., Shalaev, V. M. & Brongersma, M. L. Spatiotemporal light control with active metasurfaces. Science 364, eaat3100 (2019).
3. Baxter, J., Lesina, A. C. & Ramunno, L. Parallel FDTD modelling of nonlocality in plasmonics. ArXiv200506997 Phys. (2020).
4. Bin-Alam, M. S. et al. Hyperpolarizability of plasmonic meta-atoms in metasurfaces. ArXiv200705142 Phys. (2020).
5. Alam, M. Z., Schulz, S. A., Upham, J., De Leon, I. & Boyd, R. W. Large optical nonlinearity of nanoantennas coupled to an epsilon-near-zero material. Nat. Photonics 12, 79–83 (2018)

**Author:** BAXTER, Joshua (Department of Physics and Center for Research in Photonics, Uni)

**Co-authors:** Prof. RAMUNNO, Lora (University of Ottawa); Prof. CALÀ LESINA, Antonino (Hannover Centre for Optical Technologies, Cluster of Excellence PhoenixD, and Faculty of Mechanical Engineering, Leibniz Universität Hannover, Germany); Prof. DE LEÓN, Israel (School of Engineering and Sciences, Tecnológico de Monterrey, Mexico)

**Presenter:** BAXTER, Joshua (Department of Physics and Center for Research in Photonics, Uni)

**Session Classification:** W-POS-E #28-40 Poster Session (DAMOPC) / Session d'affiches (DPAMOC))

**Track Classification:** Atomic, Molecular and Optical Physics, Canada / Physique atomique, moléculaire et photonique, Canada (DAMOPC-DPAMPC)