**Department of Physics**
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

# CONDENSED MATTER PHYSICS SEMINAR

Thursday 30 April at 14:30
Simpkins Lee Seminar Room, Department of Physics
(https://maps.app.goo.gl/WjG71uLF2D48n85B6)

## Tracking and Harnessing Chemical Dynamics in Halide Perovskites

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Metal halide perovskites are a class of materials that combine exceptional optoelectronic performance with an unusually soft and reactive lattice. Their mixed electronic–ionic nature, low formation energies, and strong coupling to the environment make them fundamentally different from conventional semiconductors. While this chemical and ionic mobility lies at the heart of many of the key challenges faced by these materialssu (ch as degradation, hysteresis, and performance variability) it also underpins many of their unique advantages and can be deliberately exploited.

We will illustrate several material-level phenomena enabled by the intrinsic dynamical nature of halide perovskites, including ionic-driven resistive switching in memristive devices and chemically assisted healing strategies to mitigate degradation. Capturing and understanding these effects requires characterization approaches that operate beyond static descriptions of structure and performance.
Operando characterization strategies provide direct access to the evolving material state. Impedance spectroscopy, when reinterpreted for chemically dynamic semiconductors, enables the decoupling of processes occurring on distinct time scales, from fast electronic recombination to slower ionic redistribution and interfacial polarization. When combined with the operando evolution of luminescence, this framework provides quantitative insight into non-radiative recombination losses, quasi-Fermi level splitting, and their response to electrical and environmental stress. Together, these approaches allow reversible and irreversible degradation pathways to be identified as they emerge, offering new routes to harness chemical dynamics as a design parameter rather than a limitation.

*Host: Professor Nakita K. Noel*