Contribution ID: **75** Type: **Oral**

Advancing the Sample Space to Elevate the Power of Resonant X-ray Scattering.

Tuesday, 7 October 2025 14:15 (25 minutes)

Deploying in-situ strain with electrical multi-modal x-ray scattering measurements has allowed for powerful experimental configurations deepening our understanding of complex quantum phenomena. Touching upon a few recent topics e.g., nematic behavior in Fe superconductors (1-4) and quantum paraelectric behavior in SrTO3 membranes (5) I'll demonstrate the value-added power of investing in the sample space and overview our plans to explore dopant-vacancy color center qubit behavior with symmetry and strain combining photoluminescent spectroscopy and x-ray scattering.

The ability to measure and control structure, symmetry or domain population of a twinned system, like an orthorhombic crystal or magnetic orientated domains can be a critical sample control parameter to study intricate quantum behaviors. In the iron based superconductor, electronic nematicity is coupled to both the lattice and the conducting electrons leading to both structural and transport measurements sensitive to nematic fluctuations. While spin driven nematicity is prevalent in Fe pnictides, the role of spin versus orbit in the chalcogenide nematic behavior has been under investigation. The consortium of electrical and x-ray scattering measurements keenly addresses the relationship of lattice, spin and orbital order in the nematic phase space. SrTO3 is a ubiquitous prototype material but is itself an intriguing enigmatic host of quantum behaviors, using strain as a tuning parameter we investigate the transition from classical to quantum behaviors and consider the unbounded potential studies deploying this combination of strained single crystal membranes with resonant x-ray scattering.

1. Strain-Switchable Field-Induced Superconductivity, Joshua J. Sanchez, Gilberto Fabbris, Yongseong Choi, Jonathan M. DeStefano, Elliott Rosenberg, Yue Shi, Paul Malinowski, Yina Huang, Igor I. Mazin, Jong-Woo Kim, Jiun-Haw Chu, Philip J. Ryan*, Science Advances 9, eadj5200(2023). DOI:10.1126/sciadv.adj5200 Incommensurate
2. Suppression of superconductivity by anisotropic strain near a nematic quantum critical point, P. Malinowski, Q Jiang, JJ Sanchez, J Mutch, Z Liu, P Went, J Liu, P.J. Ryan, JW Kim, Jiun-Haw Chu, Nature Physics, 1-5, (2020)
3. Spontaneous orbital polarization in the nematic phase of FeSe. Connor A. Occhialini, Joshua J. Sanchez, Qian Song, Gilberto Fabbris, Yongseong Choi, Jong-Woo Kim, Philip J. Ryan and Riccardo Comin, Nature Materials 22, 985 (2023). doi:10.1038/s41563-023-01585-2
4. Joshua J. Sanchez, Paul Malinowski, Joshua Mutch, Jian Liu, J.-W. Kim, Philip J. Ryan, Jiun-Haw Chu, The transport–structural correspondence across the nematic phase transition probed by elasto X-ray diffraction. Nat. Mater. (2021). https://doi.org/10.1038/s41563-021-01082-4
5. Li, J., Lee, Y., Choi, Y. et al. The classical-to-quantum crossover in the strain-induced ferroelectric transition in SrTiO3 membranes. Nat Commun 16, 4445 (2025).

Primary author: RYAN, Philip (Argonne National Laboratory)

Presenter: RYAN, Philip (Argonne National Laboratory)

Session Classification: Talks Tuesday Afternoon