

CONDENSED MATTER SEMINAR

Thursday 19 October at 14:30

Simpkins Lee room

“Ferroelectric and multiferroic two-dimensional electron gases for oxide spin-orbitronics”

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Just as the apparent incompatibility between ferroelectricity and magnetism prompted the renaissance of multiferroics¹, the research on « ferroelectric » metals – conjectured in the 1960s by Anderson and Blount² – was recently revitalized. Yet, their experimental demonstration remains very challenging due to the contradiction between the presence of free charge carriers and switchable electric dipoles. In this talk we will report on two-dimensional electron gases (2DEGs) formed on Ca-substituted SrTiO₃ (STO). Signatures of the ferroelectric phase transition near 30 K are visible in the temperature dependence of the sheet resistance R_S and in a strong, reproducible hysteresis of R_S with gate voltage³. In addition, spectroscopic explorations of the 2DEG region indicate the presence of switchable ionic displacements. Beyond their fundamental interest in materials physics, ferroelectric 2DEGs offer opportunities in spin-orbitronics: we will show how their spin-charge conversion properties, caused by the inverse Rashba-Edelstein effect, can be electrically tuned in amplitude and sign in a non-volatile way⁴. These results open the way to a whole new class of ultralow-power spin-orbitronic devices operating without the need for magnetization switching. Finally, we will describe how one can introduce magnetism into such systems to achieve multiferroic 2DEGs displaying magnetoelectric coupling⁵.

1. Hill, N. A. J. Phys. Chem. B 104, 6694 (2000).
2. Anderson, P. W. et al. Physical Review Letters 14, 217 (1965).
3. Bréhin, J. et al. Phys. Rev. Materials 4, 041002 (2020).
4. Noël, P. et al. Nature 580, 483 (2020).
5. Bréhin, J. et al. Nat. Phys. 19, (2023).

Host: Dr Hariom Jani