Ferroelectricity in 2D materials and their polarisation switching behaviour

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A fundamental limitation with current computing architecture is the von-Neumann bottleneck; the delay in feeding data between the processing unit and the memory. Higher speed memory would help alleviate this problem, however, our memory technology currently presents us with a difficult choice: We can either have high-speed memory, but that 'forgets' when unpowered (the *volatile* RAM and caches), or we can have memory that 'remembers' even when shutdown (the *non-volatile* solid-state drives), but is not as fast. We currently cannot have both non-volatile *and* high-speed memory.

Ferroelectric memory (FeRAM) based on certain 2D materials may present an answer to this problem, able to retain their state even when depowered and still operate at high speeds. The observation of ferroelectric polarisation switching in certain 2D materials remains novel and underexplored. Compared to their 3D bulk counterparts, we expect 2D ferroelectrics to behave quite differently due to their spatial confinement. Understanding the atomic structural changes and relationships that facilitate polarisation switching will let us better tailor these materials to future devices.

You will work on the fabrication of special ferroelectric 2DM devices compatible with being operated at the same time as being imaged at the atomic level, using a transmission electron microscope (TEM). This will allow you to directly reveal the atomic level mechanisms behind ferroelectric switching in 2D materials, and thus how we can design more effective 2D ferroelectric devices. The University of Warwick has recently acquired new equipment that will allow us to directly image the polarisation state in a material down to the nanoscale with TEM, while at the same time imaging the material's atomic structure. You will use this to identify polarisation switching in your devices, and correlate it with atomic scale features such as dislocations and grain boundaries.

You will have the opportunity to learn skills in nanomaterials, electronic device fabrication, and advanced TEM, and will interact with the Department's leading ferroelectric and 2D material communities.