ELECTRIC-FIELD CONTROL OF ELECTRON SPINS IN QUANTUM PARAELECTRICS

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Manipulating electron spins by applying electric instead of magnetic fields is faster, more energy efficient and spatially confined, making the investigation one of the most active research fields in solid-state physics and materials science.

In this report, we demonstrate a significant (up to two orders of magnitude) amplification of the spin-electric coupling in quantum paraelectrics as compared to conventional dielectrics. For measurements, quantum paraelectrics (called also as incipient ferroelectrics) $SrTiO_3$ and $KTaO_3$ weakly doped with paramagnetic Fe^{3+} or Mn^{2+} ions were used. The spin-electric coupling was measured by utilizing both the continuous wave and pulse time-resolved electron spin resonance (EPR) technique at temperatures down to 3.5 K and electric fields of 0–50 kV/cm. High frequency rapid scan electron spin resonance spectrometer (THz-FRASCAN-ESR) operating at frequencies up to 1 THz was used as well [1]. Moreover, it is found that the same amplification is valid for microwave pulses used in coherent manipulation of spin ensembles at *ns* timescale. Applied microwave power decreases to milliwatts as compared to the tens-hundreds of watts used for spins manipulation in conventional materials [2]. The observed effect is related to the very high dielectric permittivity (up to 25 000 in $SrTiO_3$) of quantum paraelectrics. We believe that quantum paraelectrics present an attractive platform to explore electric field control of magnetic properties for quantum applications.

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References

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