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Field-controlled spin-density-wave order and quantum critically in Sr3Ru2O7

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The quasi-2D metamagnetic perovskite metal $Sr_3Ru_2O_7$ has been an enigma for the last decade. The application of a large magnetic field of 8T parallel to the c-axis creates a new phase at low temperatures. This phase shows "electronic nematic" properties in that strong anisotropy its resistivity can be created by tilting the field away from the c-axis. In addition, measurement of transport and thermodynamic properties suggest that the phase is at the centre of a quantum critical region. Here we use neutron scattering to show that the magnetic field actually induces spin-density-wave magnetic order in the proximity of a metamagnetic critical endpoint. In fact, $Sr_3Ru_2O_7$ can be tuned through two magnetically-ordered SDW states which exist over relatively small ranges in field (¡ 0.4 T). Their origin is probably due to the electronic fine structure near the Fermi energy. The magnetic field direction is shown to control the SDW domain populations which naturally explains the strong resistivity anisotropy or "electronic nematic" behaviour observed in this material. We find that $Sr_3Ru_2O_7$ is also unique in that its the quantum critical region is controlled by overdamped incommensurate low-energy spin fluctuations with a diverging relaxation time. The low-energy electronic properties reflect the presence of these fluctuations and, in particular, the field-dependent low-temperature specific heat is proportional to the spin relaxation rate. [Based on C. Lester, S. Ramos, R. S. Perry at el. Natural Materials 14, 373 (2015).]