Interplay of Magnetism and Superconductivity in the Heavy Fermion $YbRh_2Si_2$

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The heavy fermion metal $YbRh_2Si_2$ has been extensively studied for many years as a "canonical" heavy fermion. However, signatures of superconductivity were discovered only recently [1]. Our calorimetry, magnetic susceptibility, and electrical transport measurements down to temperatures well below 1 mK reveal a complex interplay of magnetism and superconductivity, with evidence of spin-triplet Cooper pairing underpinned by antiferromagnetism [2,3,4]. Moreover, at such low temperatures the nuclear degrees of freedom influence the physics. The hyperfine constant of Yb is particularly strong, $A_{hf} = 102\,\mathrm{T}/\mu_\mathrm{B}$, and combined with the strong dependence of $4f$ Yb moment on magnetic field leads to dramatic effects, despite only 30% of Yb nuclear moments carrying a magnetic moment in natural $YbRh_2Si_2$. We discover a large-electronic-moment spin density wave, stabilised by the nuclei, and a boost of superconductivity coinciding with the spin density wave formation. We understand this by the simultaneous formation of a spin-triplet pair density wave. The effect of nuclei can be utilized by isotopic enrichment of the samples, providing a convenient tunnig parameter of the physics.

References:

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