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Nanoscale Measurement of Superconducting Nb's Intrinsic Length Scales Using Low-Energy μSR

A superconductor's intrinsic length scales –the London penetration depth λ_L and Bardeen-Cooper-Schrieffer (BCS) coherence length ξ₀ –are closely connected to its electronic structure and govern salient features such at its Meissner response. Leveraging recent advances in the preparation [1] and characterization [2] of Nb metal for technical applications (e.g., superconducting radiofrequency accelerator cavities), we quantify the elemental superconductor's λ_L and ξ₀ from depth-resolved measurements of its Meissner profile using low-energy muon spin spectroscopy (μSR). Accounting for known systematics [3] and subtleties [4] in the measurements, we find values for the lengths that are ~10 nm shorter than those nominally quoted for the metal (see, e.g., [5]), but in good agreement with predictions from electronic structure calculations and compatible with independent measurements of Nb's mass-enhancement factor *Z*. Using our results, we comment on the recently proposed type-I superconductivity of *pure* Nb [6].

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