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Alpha-plutonium's low-temperature elastic constants[1] J. B. BETTS, A. MIGLIORI, H. LEDBETTER, D. DOOLEY, D.A. MILLER, Los Alamos National Laboratory — Using resonant-ultrasound spectroscopy, we measured alpha-plutonium's polycrystal elastic constants between 18 and 344 K. All elastic constants – bulk, shear, extension, longitudinal moduli and Poisson ratio – behave smoothly during cooling, indicating no significant phase transition: electronic, magnetic, or structural. Both principal elastic constants (bulk and shear) increase about 30% upon cooling from 300 to 0 K, a large change among metals, which we attribute to $5f$-electron delocalization. From the low-temperature elastic constants, we computed that the Debye temperature equals 205 K, exceeding significantly most previous estimates. From the bulk-modulus/temperature slope dB/dT, we computed that the Gruneisen parameter equals 5.1, intermediate among previous estimates using other approaches. Alpha-plutonium shows an unusually high shear-modulus/bulk-modulus ratio G/B, thus a low Poisson ratio: 0.18. Within 0.5%, the Poisson ratio shows temperature invariance; its small negative slope being opposite expectation. Again, we attribute this exceptional behavior to $5f$-electron localization.

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