transition from an insulating state to a conductive state. A variety of models has been proposed, but little experimental verification exists for any of them. —GBL

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Is There A New Mechanism For Superconductivity?

The model proposed for the large positive isotope effect that Robert D. Fowler and his collaborators found last year in superconducting alpha uranium (under 10–11 kilobars of pressure) (PHYSICS TODAY, December 1967, page 60) has been criticized by Herbert Capellmann and J. Robert Schrieffer of the University of Pennsylvania (*Phys. Rev. Letters* **21**, 1060, 1968).

The Fowler group at Los Alamos Scientific Laboratory had found that the superconducting transition temperature T_c varied as $m^{2.0}$ for U^{235} and U^{238}; for other known substances T_c goes as m^{α} with α negative or zero. They suggested that the pairing interaction causing superconductivity in alpha uranium is due to an electronic-core polarization involving low lying f states; lighter atoms are more susceptible to lattice vibrations, which would reduce electronic-core polarization.

Capellmann and Schrieffer argue that the Fowler proposal would only account for an α of about 10^{-2}. Assuming that the attractive interaction V in alpha uranium is due to electronic-core polarization, they show that another source of mass dependence of T_c is the dependence of V on interatomic spacing. As $V = |M|^2/E$ where M is the matrix element describing the scattering process and E is the energy of the low lying f states with respect to the Fermi energy, the dependence can occur either through a shift of E or a change in M or both. Since the amplitude of zero-point atomic motions depends upon mass, T_c would depend on mass. A rough calculation using the observed pressure dependence of T_c yields $\alpha = 0.44$.

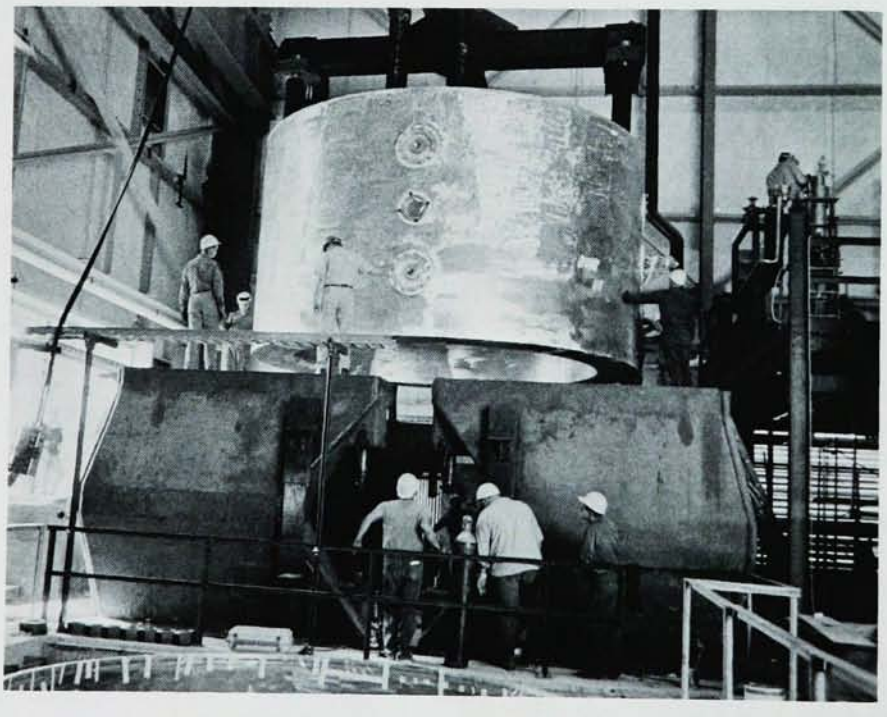
We asked Hunter Hill, one of Fowler's collaborators, to comment on Capellmann and Schrieffer's Letter. Hill was pleased that the Penn physicists had demonstrated that low lying f levels could produce a sizable positive isotope effect through electronic core polarization. He pointed out that $\alpha \approx 2$ is not excluded by their order-of-magnitude calculation.

The Penn physicists note work by James Garland and F.M. Mueller, who pointed out at the Washington APS meeting last spring that the uranium positive isotope effect could still be explained by the phonon mechanism provided it acted in a region of rapidly varying density of states, such as the f bands.

Hill finds it difficult to comment in detail on Schrieffer and Capellmann's belief that the electron-phonon mechanism can explain the positive isotope effect in alpha uranium, since the work of Garland and Mueller has not been published. He says, "It does seem unfortunate, however, that the authors are inclined to revert to this position after having come so close to providing valuable insight into the peculiar properties of alpha uranium."

Since the value of α depends sensitively upon the band structure of alpha uranium and thus cannot be calculated from first principles, Garland and Mueller are using the experimental value of $\alpha \approx 2$ in order to fix the energy of the bottom of the f band in alpha uranium. Garland says they are using the model to attempt to explain the peculiar normal state properties of alpha uranium.

Capellmann and Schrieffer emphasize that there is still no positive proof that a new superconductivity mechanism is required to explain the effect.



WORLD'S LARGEST SUPERCONDUCTING MAGNET is lowered into its steel frame at Argonne National Laboratory. The 110-ton magnet will produce an 18-kG field for the laboratory's 3.7-meter bubble chamber, whose usable volume is 20 m³. The Mirabelle chamber nearing completion at Serpukhov is longer (4.5 m), but its usable volume is only 6 m³.

Batavia Accelerator Staff Plans for Bubble Chambers

Plans involving two bubble chambers for the National Accelerator Laboratory at Batavia, Ill. (née Weston) are going forward. NAL officials are exploring with Argonne National Laboratory and the Atomic Energy Commission the possibility of moving the 3.7-meter hydrogen bubble chamber (photo, left) now under construction at ANL. A decision will be made a year or two before the 200-GeV machine is turned on. At the same time NAL and Brookhaven groups will