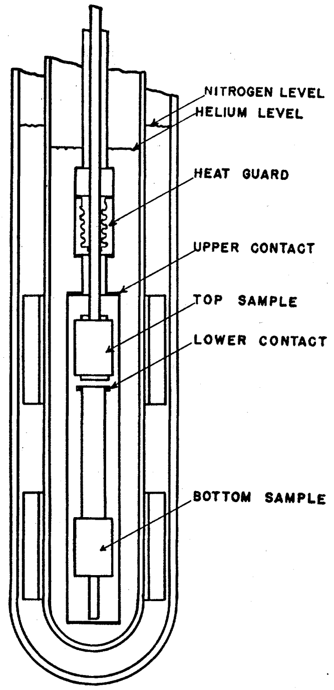

FIG. 1. Cyclic demagnetization system.

temperature which is determined principally by the magnitude of the heat leaks and the strength of the magnet.

Heat generated in the system by mechanical vibration seems to be much more important than thermal conduction of the supporting members. It is also more elusive with respect to control measures.

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Energy Band Structure in Silicon Crystal

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THE energy band structure in silicon has been calculated in a way quite similar to that used by Von der Lage and Bethe[1] for sodium. The levels evaluated are the lowest three having the wave vector $k=0$. Angular functions were constructed from the Von der Lage-Bethe cubic harmonics, and radial functions were computed numerically up to $l=6$, making use of the effective nuclear charge given in Mullaney's paper.[2] Results are shown in Table I, with the results obtained by Mullaney[2] and Holmes.[3]

TABLE I. Energy values for the lowest three levels at $k=0$, in ev.

Type of wave function	Our results	Mullaney's results	Holmes' results
$(\alpha+\beta)_A{}^a$	0.405	very high	4.24
$(\delta+\epsilon)_S{}^b$	−0.675	−3.24	−5.72
$(\alpha+\beta)_A{}^c$	−15.8	−18.71	···

[a] Bottom of conduction band.
[b] Top of filled band.
[c] Bottom of filled band.

The notation $\alpha, \alpha', \beta, \beta', \cdots$ denotes the type of cubic harmonics after Von der Lage and Bethe.[1] The point group for the diamond type lattice is the tetrahedral group which is a subgroup of the cubic group. Therefore, function subspaces of this group are combined into the five types $(\alpha+\beta)$, $(\alpha'+\beta')$, $(\gamma+\gamma')$, $(\delta+\epsilon)$, $(\delta'+\epsilon')$. The symmetric and antisymmetric properties of the wave functions for a translation to an adjacent atomic cell polyhedron following an inversion operation are indicated by the suffixes S and A. Function subspaces of the space group for $k=0$ are split into the types $(\alpha+\beta)_S$, $(\alpha+\beta)_A$, $\cdots$. For instance, the $(\alpha+\beta)_S$ type wave function is expanded in terms of α- and β-type harmonics, and has the same form in the adjacent polyhedron referring to inverted coordinate axes. As boundary conditions, the expansion coefficients are calculated according to the symmetry property and Bloch periodicity, and fitting is performed at the center and on a circle which is an intersection with the equal volume sphere, on the hexagonal face of the atomic polyhedron, just as in the case treated by Von der Lage and Bethe.

It seems from our results that the more precise method gives better agreement with the experimental data. (See Table II.)

TABLE II. Comparison of results of calculations with experimental data.

	Our results	Mullaney	Holmes	Experiment
Energy gap of band in ev	1.08	very large	9.96	1.1
Band width in ev	15.1	15.5	···	19.2

[In fact, the $(\delta+\epsilon)_S$ type wave function includes contributions from $l=3$ and $=4$ of the same order as those from $l=1$ and $=2$.] Therefore, from this agreement, the highest point of the filled band and lowest point of the conduction band presumably occur at the center of the Brillouin zone.

[1] F. C. Von der Lage and H. A. Bethe, Phys. Rev. **71**, 612 (1947).
[2] J. F. Mullaney, Phys. Rev. **66**, 326 (1944).
[3] D. K. Holmes, Phys. Rev. **87**, 782 (1952).

The Phosphorescence of Thoria*

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WHILE observing luminescent effects resulting from the irradiation of various metallic oxides with nuclear particles, the writers chanced to note a continuous light emission from thoria. This luminescence was detected prior to application of any primary excitants such as alpha-particles, beta-rays, gamma-rays, or ultraviolet light. The property is exhibited by both Norton's reddish arc-melted coarsely crystalline thoria and white pieces of thoria sintered from powdered ThO_2.[1,2] The measurements of light intensity were performed with the use of phototubes RCA-5819 and RCA-1P28 as detectors.

Owing to the natural radioactivity of Th^{232} and its daughter elements, ThO_2 emits ~22 000 α's per gram per second, ~15 000 β's per gram per sec, and ~20 000 γ's per gram per sec. These internally emitted nuclear radiations give rise through self-absorption in the thoria to the observed luminescence which has apparently attained a nearly constant intensity, decaying with the enormous half-period of Th^{232}. When a small piece of crystalline thoria was placed before the slit of a small Hilger quartz spectrograph, no noticeable darkening of the photographic plate was produced after an exposure of two weeks. However, when the

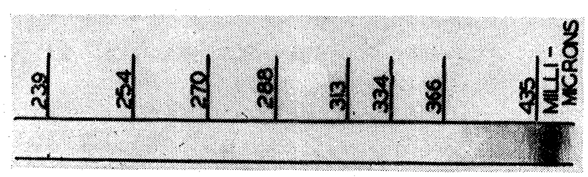

FIG. 1. Luminescent emission of thoria under alpha-irradiation.