permission of the Director of the Atomic Energy Research Establishment.

Note added in proof. An extension of the first series of computations to the case where n varies slowly from one resonant value to the next while an orbit is being computed shows that the oscillation amplitude can become very large, even though for fixed n values in the same range it remains quite limited. Such a variation of n is likely to occur during saturation of the magnet iron.

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¹ Courant, E. D., Livingston, M. S., and Snyder, H. S., *Phys. Rev.*, **88**, 1190 (1952).

Beta-Spectrum of Arsenic-71

FOR the past few months, the 225-cm. cyclotron¹ and the electromagnetic isotope separator² of this Institute have been used as the basic tools for a series of investigations on radioactive isotopes. Radioactive samples produced by cyclotron bombardment have been separated in the isotope separator both for obtaining mass assignments and for providing sources for beta-spectroscopic work. Due to the high intensity and high energy of the beam available in this cyclotron (200–300 μ amp. internal beam of 25-MeV. deuterons), very intense beta-sources of separated isotopes can be obtained. The present communication reports the preliminary results of such an investigation on arsenic-71. The work is still in progress and a more detailed paper will be published later.

Arsenic-71 of half-life 60 hr. is obtained among several other arsenic activities by bombarding germanium with deuterons. The isotope is reported to decay by positron emission (energy 0.6 MeV., absorption measurements) and K -capture³. Mei *et al.*⁴ reported an electron line of energy 162 keV., which was ascribed to arsenic-71.

In the present investigation, arsenic-71 has been studied in the intermediate image beta-spectrometer⁵. Germanium metal (fused on to a copper plate by using a special soldering flux) was bombarded in the cyclotron with 25-MeV. deuterons (180 μ amp.hr.). The active arsenic, together with some arsenic carrier, was then converted into arsenic hydride. The hydride gas was introduced into the ion source of the isotope separator and the ions of mass number 71 were collected on a thin aluminium foil (0.15 mgm./cm.²). This foil was used as a beta-source in the spectrometer (resolution about 4.5 per cent; the Geiger-Müller counter window had a 'cut-off' of about 6 keV.).

The Kurie plot of the positron spectrum obtained gives an upper limit of 815 ± 20 keV. There is also an indication of the presence of a weak component having the end point at about 300 keV. In addition to Auger lines, we have found three conversion electron lines at 12.2, 22.0 and 164 keV. The former two are interpreted as the K and L lines of a gamma-ray of energy 23.3 ± 0.3 keV. The 164-keV. line is interpreted as arising from the K and L conversion of a gamma-ray of energy 175 keV. This line is probably identical with the 162-keV. line reported by Mei *et al.*⁴.

The positron continuum and the 164-keV. electron line appeared to decay with a period which was in accord with the half-life found for arsenic-71 (see below).

In another separation of arsenic from germanium bombarded with deuterons, we collected ions of all mass numbers from 69 to 77 on an aluminium foil, which was then cut into narrow strips. In order to check the half-lives, the decay of the activity corresponding to each mass number was followed for several days. The strip corresponding to mass number 69 showed a comparatively weak activity with a half-life of about 35 hr., indicating the presence of some germanium-69 in the arsenic hydride gas. The half-life of arsenic-71 was found to be 65 ± 5 hr.

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¹ Atterling, H., and Lindström, G., *Nature*, **169**, 432 (1952).

² Bergström, I., Thulin, S., Svartholm, N., and Siegbahn, K., *Ark. f. Fysik*, **1**, 281 (1949).

³ Nuclear Data, N.B.S. Circular 499.

⁴ Mei, J. Y., Mitchell, A. C. G., and Huddleston, C. M., *Phys. Rev.*, **79**, 19 (1950).

⁵ Slätis, H., and Siegbahn, K., *Ark. f. Fysik*, **1**, 339 (1949).

Creep of Copper under Stress Pulses

A GENERAL treatment of the problem of creep under intermittent, as distinct from alternating, stress has already been given¹ and applied to the creep of lead. The behaviour of copper conductors is of particular interest² because of the stress conditions to which they are subjected in alternators, and because of the important consequences of their failure. Experiments on high-conductivity copper have now been completed with the view of testing in more detail certain deductions which followed from the original analysis.

The character of the creep of the copper wires when tested under 730 kgm.cm.⁻² at 258° C. depended strongly on the previous anneal time. The instantaneous extension increases, and the creep-rate at any chosen time decreases, with increase in the time of anneal. Detailed discussion of this is outside the scope of this communication: it must suffice to say that all the specimens were annealed in the furnace for 17 hr. prior to the creep test, a time sufficient for the effect to attain equilibrium.

The original analysis indicated that the recovery effect could be formulated in terms of one parameter, n . This was the fraction of the material which recovered in full, during the off-load period, its original transient flow properties. It was shown that for lead the flow exactly fitted the Andrade β , or cubic, function³ $\beta t^{1/3}$, where t is time.

The fraction n satisfied the relation

$$1/n = 1 + A(\tau/R)^{1/3}, \quad (1)$$

where τ is time of load, R the recovery time (restricted to values less than some critical value R_0) and A a constant characteristic of the material. On this basis, approximations involving n can be developed for the case of regular repetitive stressing. In the case of copper under the test conditions quoted above, accurate cubic creep parabolas were again exhibited, with an instantaneous strain recovery on unloading