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PORTABLE RADIATION SOURCE FOR X-RAY INVESTIGATIONS

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As is well known, the beginnings of x-ray structure analysis go back to the year 1912. Since then down to the present x-ray tubes have served as the source of the characteristic x-ray spectrum. Contemporary x-ray units employing such tubes are quite satisfactory and convenient in use; they make it possible to carry out an analysis of the atomic structure rapidly by photographic methods or with the use of scintillation detectors.

However, present-day techniques suffer from two fundamental shortcomings which are by no means easily overcome. First, the x-ray tube produces together with the "useful" characteristic spectrum also a harder bremsstrahlung which gives rise to an additional background on the x-ray pattern and decreases the precision of the quantitative measurements. Crystal monochromators, employed to remove the bremsstrahlung, reduce the intensity of the "working" radiation and complicate the apparatus.

Secondly, the dimensions, weight, and power of the x-ray units are comparatively large. The smallest of the present-day devices weighs over 10 kg and requires about 1 kW power. This makes it difficult to carry out x-ray investigations under conditions prevailing during an expedition when no electric power is available.

Recently, S. I. Lobov and V. A. Tsukerman proposed the use of radioactive sources of the characteristic x-ray spectrum in x-ray structure investigations.[1] Comparatively few radioactive isotopes exist whose decay consists of capture of the K electron by the nucleus without the emission of hard gamma radiation; for example, the Fe^{55} isotope of iron (half-life T = 2.9 years) decays by K capture and is transformed into the stable manganese isotope Mn^{55}. In filling the electron shells the manganese atom emits a pure characteristic spectrum ($\lambda_{K\alpha}$ = 2.103 Å). In the same way radioactive vanadium V^{49} (T = 330 days) is transformed into Ti^{49}, emitting the characteristic titanium radiation ($\lambda_{K\alpha}$ = 2.749 Å).

The Fe^{55} isotope was obtained by irradiation of the stable Fe^{54} isotope with thermal neutrons. In fluxes with an integrated intensity of about 10^{21} neutron/cm^2 the Fe^{55} content amounted to 0.25%. A 1 × 4 mm strip of such a foil exhibited an activity of about 3 μCi. It was set up in place of the slit in a small Debye-Scherrer camera with a cassette 28.65 mm in diameter. It was found that under such conditions one can record the diffraction lines of a copper sample after an exposure of about five hours.

The radioactive devices for the analysis of the atomic structure of substances are distinguished by very small dimensions. They are light and transportable, weighing 0.5 kg. They require no electrical energy and permit x-ray investigation of minerals and deposits under field conditions. The safety precautions are also more simple. For a well-purified Fe^{55} isotope the material and the thickness of the shielding layer depend entirely on the energy of the most intense lines of the characteristic spectrum (5.9 keV for the Kα line). In this case a 2—3 mm thick brass layer completely prevents the leakage of radiation into the space around the camera.

[1] S. I. Lobov and V. A. Tsukerman, DAN SSSR **165**, 1278 (1965), Soviet Phys. Doklady, in press.

Translated by Z. Barnea