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## A HOME-MADE INFRA-RED SPECTROMETER

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**WHILE** great advances have been made of recent years in the technique of infra-red spectroscopy, little work is being done on the behaviour of crystals in this interesting region of the spectrum. Infra-red investigations of crystals should provide us with fundamental knowledge about the dynamics of the atoms composing them and are essential for a proper understanding of the nature of the solid state of matter. Great interest centres round the infra-red spectrum of diamond in particular, since this is the simplest of cubic crystals. Fortunately, the most interesting region in the infra-red spectrum of diamond lies in the near infra-red and is capable of being explored with a rocksalt-prism spectrometer. Two years ago the investigation of the infra-red spectrum of diamond was undertaken by the writer at the suggestion of Sir C. V. Raman. Since there was no infra-red spectrometer available in this laboratory, it was necessary to set up an instrument for this research. With the home-made instrument which has resulted, it has been possible to establish some important facts about the infra-red spectrum of diamond. A description of the construction of the instrument, which may be of interest, is given below.

As a source of continuous infra-red radiation a globar is used. Though the widely used Nernst filament has got a higher operating temperature and consequently higher infra-red radiancy, the globar, in virtue of its large heat capacity, serves as a very steady source. The  $\frac{1}{4}$ " thick 6" long globar element now being used is mounted inside a water-cooled iron jacket cut with a slit 1" by  $\frac{1}{4}$ " in the centre for the exit of radiation.

The arrangement of the optical parts of the spectrometer is indicated in Fig. 1 (not to scale), which is self-explanatory. The spherical glass mirrors  $M_1$  and  $M_5$  which are of 10" focal length and  $3\frac{1}{2}$ " diameter were obtained

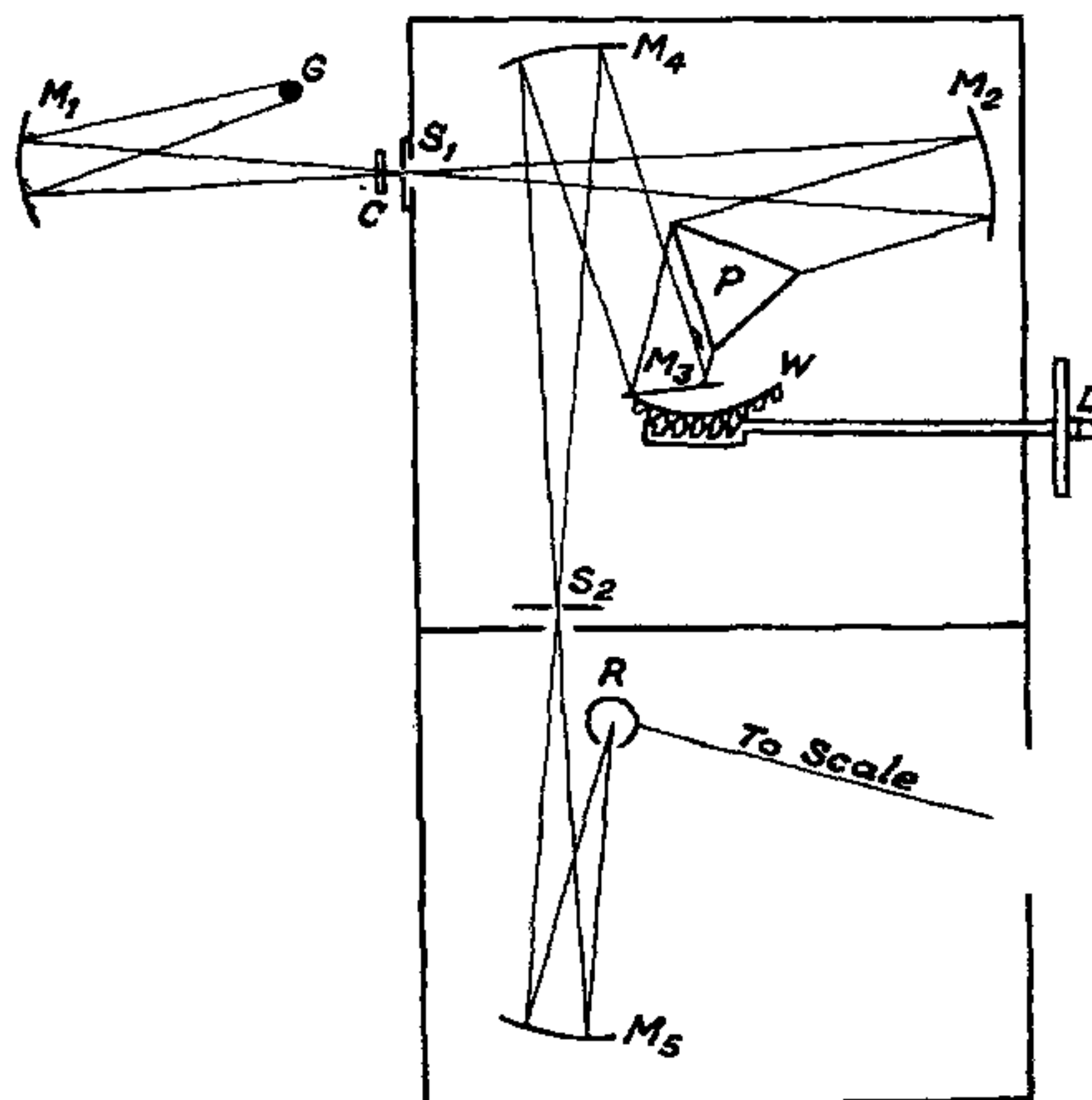


FIG. 1.—Arrangement of the Home-Made Spectrometer. G.—Globar;  $M_1$  and  $M_5$ —Focussing mirrors; C—Crystal under investigation;  $S_1$ —Entrance slit;  $M_2$  and  $M_4$ —Spectrometer mirrors; P—Rocksalt prism;  $M_3$ —Plane mirror; W—Worm wheel; D—Graduated drum;  $S_2$ —Exit slit; R—Radiomicrometer.

from Dr. Parameswaran of Trivandrum and aluminized by the writer. The plane mirror  $M_2$  is 2" by 3" and the focussing mirrors  $M_1$  and  $M_3$  are of 3" diameter and 5" focal length. They were all coated with a strongly reflecting film of aluminium by the well-known evaporation technique. The rocksalt prism  $P$  (with a refracting angle of  $53^\circ 30'$  and faces 2" square) was cut, ground and polished from a big crystal in Sir C. V. Raman's collection. The optical parts are all enclosed in a urelite box 12" by 12" by 10". A worm wheel  $W$ , attached to the prism table, is capable of being rotated by very small amounts (28 seconds of arc at a time) from outside the box by means of a graduated drum attached to the rod engaging the wheel.

A Boys' radiomicrometer  $R$ , also constructed locally, is used for detecting the radiation. The instrument is fitted with a rocksalt window to make it air-tight. The deflections of the instrument on a scale at two metres distance are of the order of 6 centimetres in the  $8\mu$  region of the spectrum with a slit width of a quarter of a millimetre.

The infra-red absorption curves of four typical diamonds obtained with the above instrument are reproduced in Fig. 2. They show very well the differences in the structure and intensity of the  $8\mu$  band for diamonds which differ in their luminescence properties. The band is most prominent in the weakly blue-fluorescent diamond (Curve  $a$ , N.C. 71, 0.78 mm. thick), less prominent in the strongly blue-fluorescent diamond (Curve  $b$ , N.C. 79, 1.20 mm. thick), least prominent in diamond N.C. 110 luminescing blue and yellow with great intensity (Curve  $c$ , 0.80 mm. thick), and altogether absent in the non-luminescent diamond N.C. 60 (Curve  $d$ , 1.27 mm. thick). While all the diamonds show in the  $5\mu$  region the octaves of the peaks appearing in the  $8\mu$  band, the general lack of detail in this region is due to the inadequacy of dispersion of rocksalt. On the other hand, the dispersion in the  $8\mu$  region is sufficient to show up a great deal of detail, as is seen from the curves reproduced. Along

with several other maxima, the curves show the well-known  $1332\text{ cm.}^{-1}$  Raman frequency

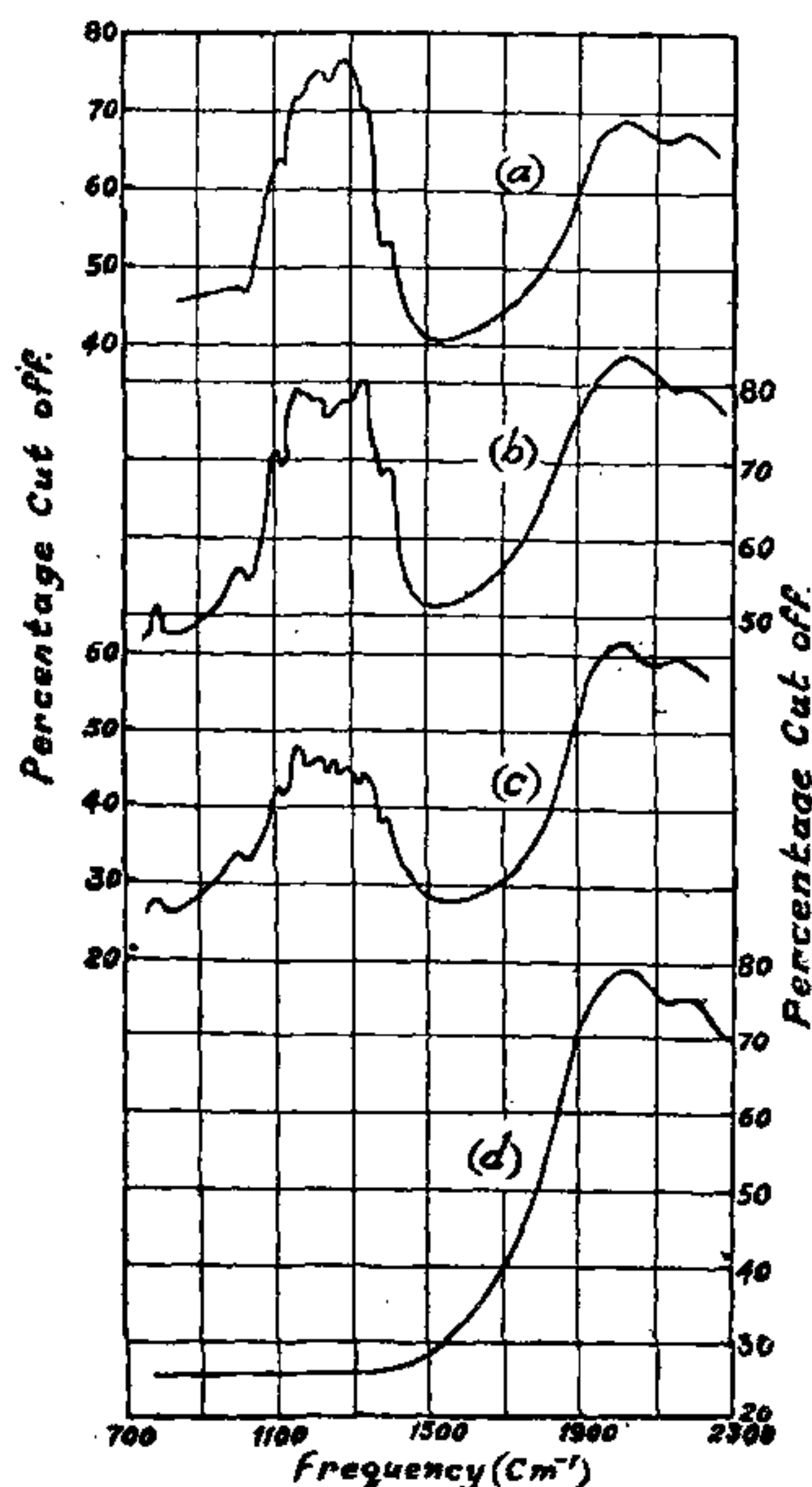


FIG. 2.—*Infra red Absorption Curves of Diamonds.*

( $a$ ) Weakly blue-fluorescent diamond. ( $b$ ) Intensely blue-fluorescent diamond. ( $c$ ) Diamond fluorescing blue and yellow with great intensity. ( $d$ ) Non-fluorescent diamond.

as an absorption peak. The positions of this and the other peaks agree well with the lattice frequencies of diamond determined from its luminescence and absorption spectra.

## MERCURY STANDARD OF WAVE-LENGTH

THE best wave-length standard of the near future will no longer be the red cadmium line which has been standard since 1893, but a green line due to a mercury isotope transmuted from gold. *Science Service* reports on the work done by Drs. Jacob H. Wiens and Luis Alvarez, who used the cyclotron of the University of California to bombard atoms of gold with neutrons. When the gold atoms capture neutrons they become radioactive and after emitting electrons become mercury of atomic weight 198, with a purity better than one atom in a million. This purity is reflected in the sharpness and clarity of the spectrum

line, which does not vary by more than one 50-billionth of an inch in wave-length.

This mercury line is further superior to the cadmium standard because the mercury can be brought to incandescence at a much lower temperature—actually below freezing, whereas cadmium must be heated to  $300^\circ\text{C}$ . Also, mercury atoms, being heavier, do not move about as fast when heated. Both the mass and the temperature of atoms influence the sharpness of spectrum lines; needless to say, the sharper a line is, the more accurately it can be measured.

—Courtesy of *Sky and Telescope*, 1946, 3, 10.