

## V. NUCLEAR MAGNETIC RESONANCE AND HYPERFINE STRUCTURE

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### A. HIGH-RESOLUTION GRATING MONOCHROMATOR FOR THE SIMULTANEOUS OBSERVATION OF MORE THAN ONE WAVELENGTH

Very high resolution optical studies of hyperfine structure such as are obtainable, for example, with G. R. Harrison's 10-inch blazed diffraction gratings, have been restricted to the observation of one wavelength at one time unless a coincidence occurs, so that other wavelengths are projected at nearly the same angle. For our hfs studies of fairly short-

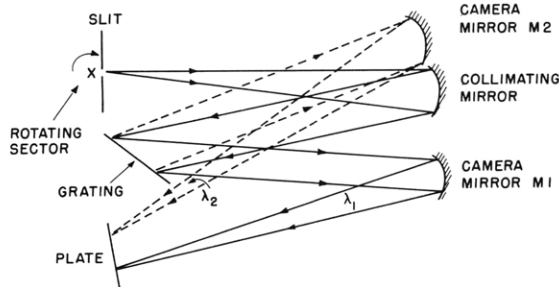


Fig. V-1. Multiple-wavelength monochromator.

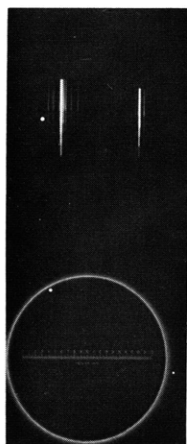
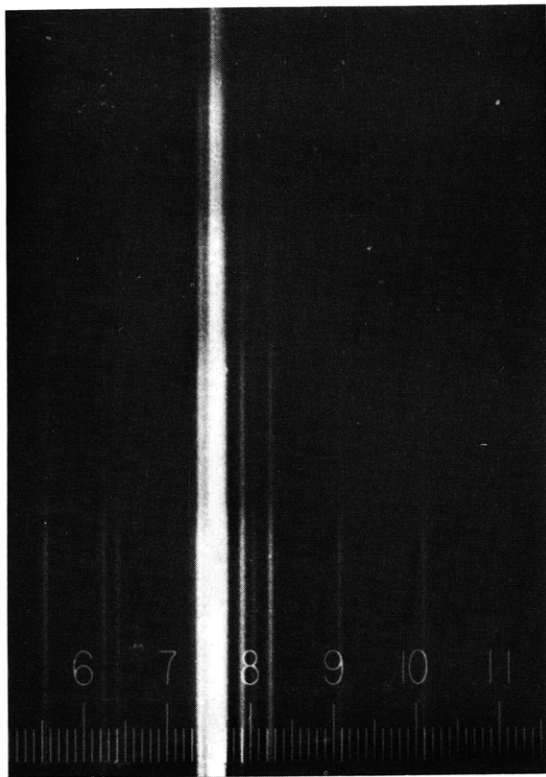
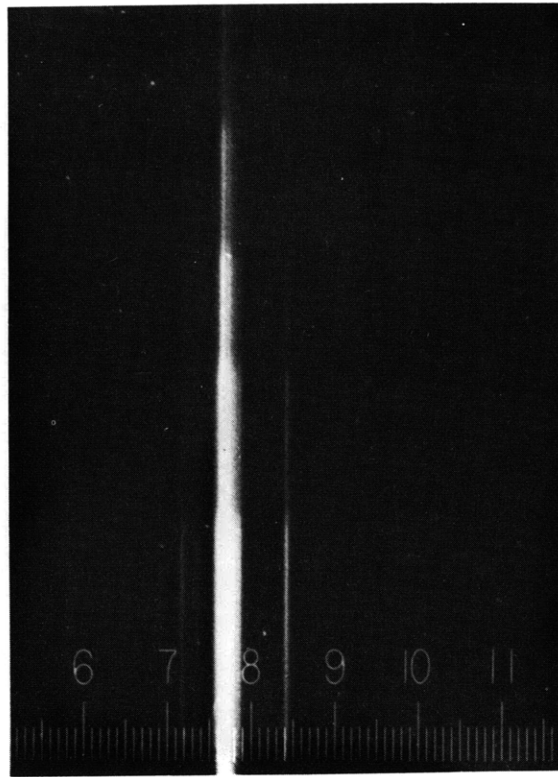


Fig. V-2. Spectra of mercury 4358 Å line (left) and 5461 Å line (right) obtained simultaneously with the arrangement of Fig. V-1.

lived radioactive isotopes, in which time is of great importance and considerable work is involved in light-source preparation, it became clear that we were not making the most efficient use of the grating because only one wavelength is captured by the camera mirror and projected on the plate while other wavelengths are wasted by not being recorded. Our "multiple-wavelength monochromator," an obvious extension of the "Ebert type" of grating arrangement that will be valuable for our radioactive hfs work, is shown in Fig. V-1. For every additional wavelength an extra mirror is required. Suitable orders of the additional wavelengths must be selected in such a manner as not to interfere with any existing light paths. In some cases this may necessitate the use of an order that is not optimum (the optimum order is considered to be the one where the diffraction angle is closest to the blaze angle). We illustrate the results obtained with this arrangement in Figs. V-2, V-3, and V-4, showing spectra of the mercury

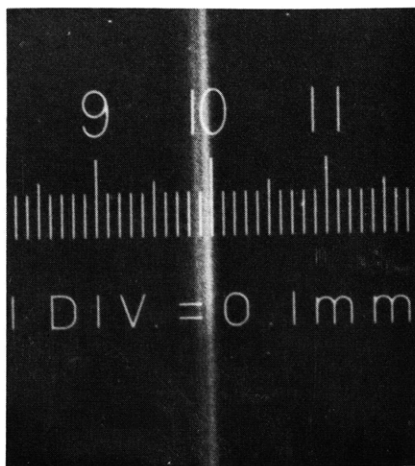


(a)

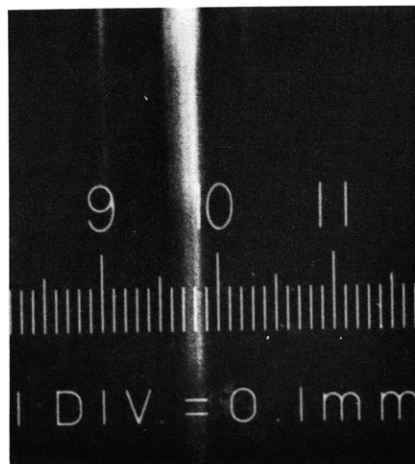


(b)

Fig. V-3. Enlargement of the spectra of Fig. V-2: (a) 4358 Å; (b) 5461 Å. (One division = 0.1 mm.)



(a)



(b)

Fig. V-4. Enlargement of the central component of the mercury 5461 Å line: (a) the spectrum taken with M1; (b) the grating angle was shifted approximately  $3^\circ$  to make the light fall on M2.

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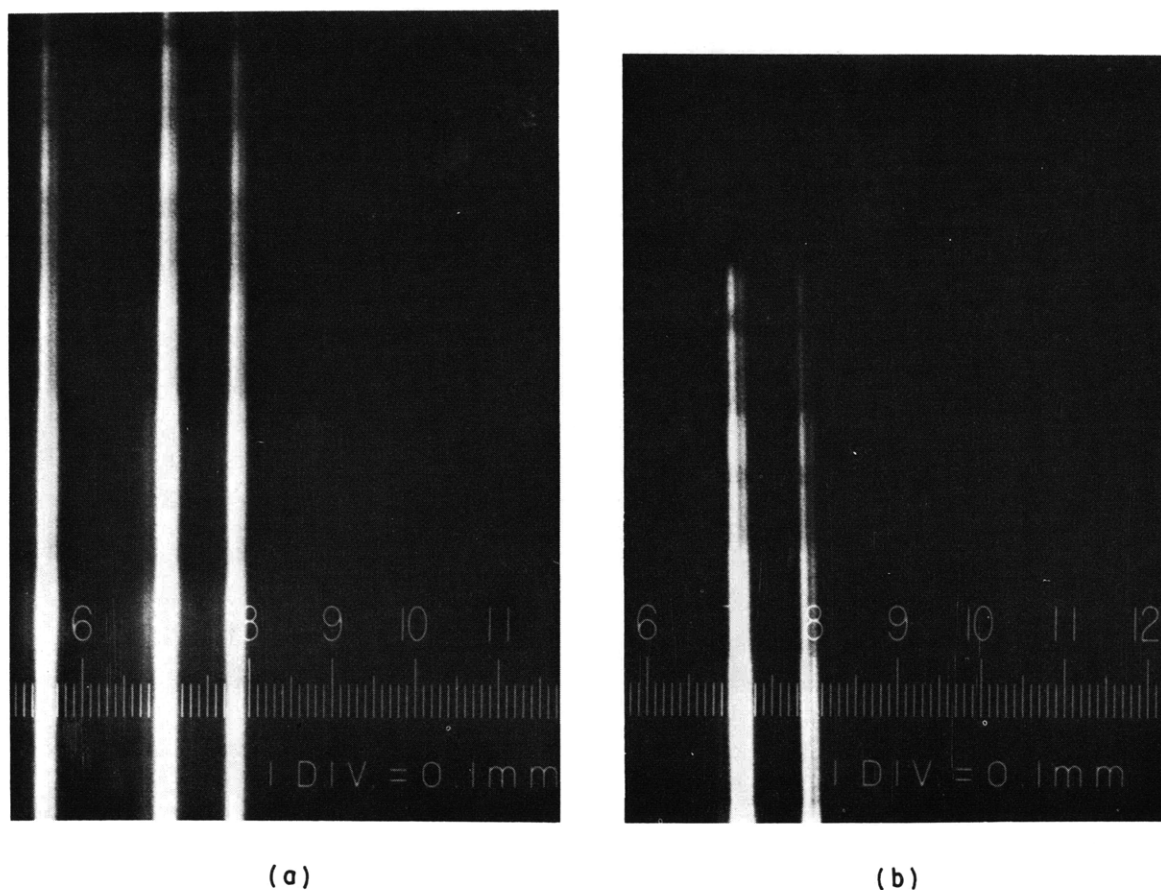


Fig. V-5. Enlarged spectra obtained simultaneously with the arrangement of Fig. V-1: (a) thallium 3776 A line; (b) thallium 5350 A line.

blue line (4358 A) and green line (5461 A) obtained simultaneously. The diffraction angles for all of these pictures were within  $2^{\circ}$ - $3^{\circ}$  of  $64^{\circ}$ . Here, M1 and M2 have 40-ft and 36-ft focal lengths, respectively. Figure V-2 is a contact print. Figure V-3 shows enlargements of the individual lines. In Fig. V-4 we show the central component of the green line taken for resolution comparison, using M1 and then M2.

We also set up the spectrograph for further hfs studies of radioactive thallium (1) in the ultraviolet (3776 A) and green (5350 A) lines. Figure V-5 shows the enlarged spectra of these two lines obtained with this arrangement. Since the separation in the focal plane of these two wavelengths can be chosen arbitrarily large by suitably rotating M1 or M2, it becomes possible to use in the same plate holder the most sensitive type of photographic plate for each wavelength. Also, in order to obtain properly exposed lines, we have found it possible to mount a rotating step sector a few millimeters in front of the slit so that all of the recorded wavelengths appear on the plate with varying intensity sections. The step sector must be calibrated if photometric work is required.

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K. K. Y. Li, H. H. Stroke

#### References

1. R. J. Hull and H. H. Stroke, Hyperfine structure of radio-thallium, Quarterly Progress Report No. 51, Research Laboratory of Electronics, M.I.T., Oct. 15, 1958, p. 51.

#### B. WATER-COOLED ELECTRODELESS MERCURY-DISCHARGE LAMP

A water-cooled electrodeless discharge lamp containing  $\text{Hg}^{198}$  was constructed. Its stability with respect to time and changing magnetic field conditions is superior to the stability of similar lamps cooled by a stream of dry nitrogen.

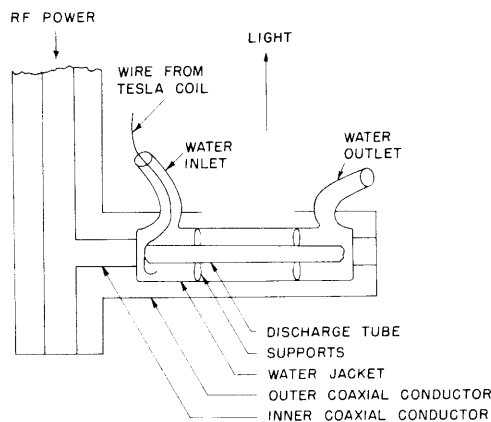


Fig. V-6. Cross section of water-cooled lamp.

Since the lamp is used for magnetic scanning, it has been designed to fit into a 4-inch solenoid. Approximately 50 watts of power, part of which is lost, is fed to the lamp through 7/8 inch coaxial waveguide from a 10-cm QK61 magnetron. The quartz discharge tube is concentric with the coaxial line and is surrounded by a quartz water jacket. (See Fig. V-6.) Holes cut in the coaxial line allow the water and light to pass.

The lamp must be ignited by means of a Tesla coil. In order to get the Tesla spark as close as possible to the mercury, a wire is run down to the discharge tube through the water outlet.

H. R. Hirsch

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C. HYPERFINE STRUCTURE OF  $\text{Hg}^{201}$  IN ZERO FIELD

The hyperfine structure of the  $^3\text{P}_1$  state of  $\text{Hg}^{201}$  has three components:  $F = 1/2, 3/2, 5/2$ . An optically detected microwave resonance between the levels  $3/2$  and  $1/2$  was observed earlier (1), and the resonant frequency has now been measured with high accuracy. The frequency is  $7551.60 \pm .05$  mc.

The observed line shape was Lorentzian, in accordance with theory. The lifetime, which can be computed from the linewidth, is approximately  $0.7 \times 10^{-7}$  sec. An earlier measurement (2) of the lifetime gave  $1.56 \times 10^{-7}$  sec. The shorter lifetime is probably due to more collision damping by foreign gases or to less imprisonment of resonant radiation.

R. H. Kohler

References

1. R. H. Kohler, Hyperfine structure of the P state of mercury by double-resonance methods, Quarterly Progress Report, Research Laboratory of Electronics, M.I.T., Jan. 15, 1958, p. 39.
2. J. Brossel and F. Bitter, A new "double-resonance" method for investigating atomic energy levels, application to  $\text{Hg } ^3\text{P}_1$ , Phys. Rev. 86, 308 (1952).