

VI. MAGNET LABORATORY RESEARCH

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A. MAGNETO-OPTIC SCANNING

1. Description of the Method

A new method has been proposed and tested for examining the hyperfine structure and the isotope shift of absorption lines. Its application to the ultraviolet mercury resonance line $\lambda = 2537 \text{ \AA}$ is particularly simple. A mercury arc lamp containing only the isotope of mass number 198 is placed in a magnetic field, and only the light emitted in the direction of the field is used in the experiment, as shown in Fig. VI-1. The resonance line is broken up into a simple triplet by the magnetic field, and only the circularly polarized components having the normal frequency plus or minus the Larmor frequency are emitted in the field direction. Either one of these can be cut out by a quarter-wave plate and an analyzer, so that we are left with a single line whose frequency can be adjusted over a considerable range by means of the applied field intensity.

If this light is allowed to fall on a cell containing mercury vapor having any arbitrary isotopic composition, absorption and re-emission of resonance radiation will take place selectively when the frequency of the incident light is that of an absorption line.

2. Application to Natural Mercury

The results of a run, made with natural mercury in thermal equilibrium at room temperature, are shown in Fig. VI-2. The predicted position of peaks and the predicted intensities of emission lines are shown. The positions agree qualitatively with the observations. Further experiments are required to establish the positions of the

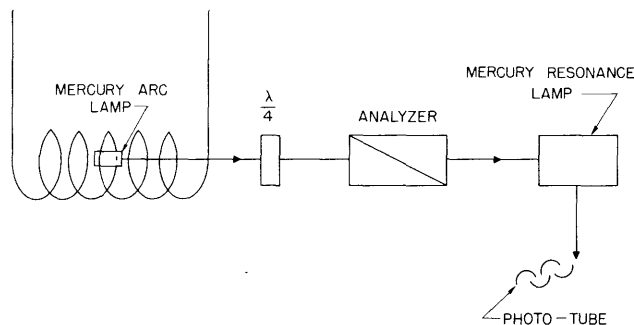


Fig. VI-1

Diagram of the apparatus.

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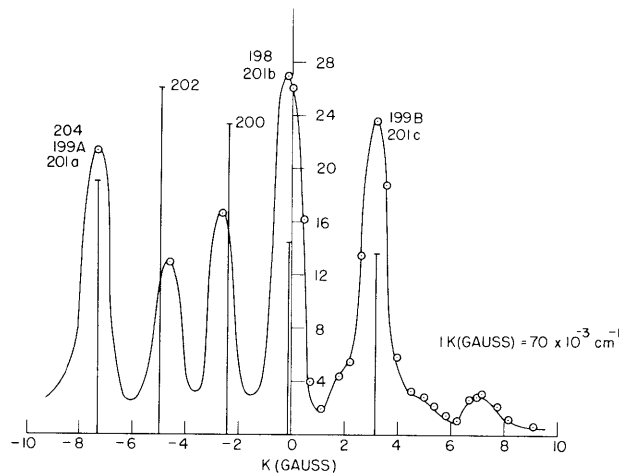


Fig. VI-2

Natural Hg λ 2536 resonance line.

peaks more precisely. The small subsidiary peaks on the right side of the diagram are due to incomplete polarization of the incident light. The relative intensities are very different from the predictions for emission lines because of quenching collisions which convert optical energy into thermal energy. If there were no such collisions, one would expect any one of these peaks to increase as a function of pressure at low pressures and then to approach a saturation value at a pressure determined by the concentration of the isotope responsible for the particular absorption line being studied. Because of inelastic quenching collisions, the intensity of the resonance line falls with increasing pressure at higher pressures. Each of the five lines in Fig. VI-2 will therefore have a maximum at some temperature, and this temperature will be different for the different lines.

Experiments at reduced pressures and temperatures have shown that such behavior is actually observed.

3. Experiments with Radioactive Mercury

Radioactive isotopes of mercury were prepared by bombarding gold with 15 Mev deuterons in the M.I.T. cyclotron. Several new lines were observed in subsequent magneto-optic scanning experiments, indicating that the yield in a 12-hour run was more than ample for work of this kind. Further work is required to identify the observed peaks.

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