LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

The Frequency of Resonance Radiation

It is of considerable importance in many astrophysical studies to know whether the atom emits as resonance radiation exactly the same frequency which it absorbs. If one supposes, following Eddington, that it does emit this precise frequency, then an atom which absorbs light of frequency slightly off "resonance" will also emit off resonance. A preliminary test was made by illuminating mercury vapor with a line (2536A) having a narrow and sharp reversal, and observing the resonance radiation. This was accomplished by using a water-cooled quartz arc shining through a quartz absorption cell onto the resonance chamber. The temperature of the absorption cell could be regulated electrically and with ice, and consequently the vapor pressure of the absorbing column of mercury vapor could be controlled. With the absorption cell cold (0°C) resonance radiation was observed; and as the temperature of the cell was raised the resonance radiation became fainter, until at 45°C the resonance could barely be detected on a long exposure photograph. This absorption cell produces a narrow and sharp reversal in the center of the emission line of the arc, the amount of the reversal being of course determined by the temperature of the cell. Yet at no time was any reversal of the line in resonance observed. Careful tests were made for stray scattered light. The spectrograph used was of the quartz Cornu prism type with a dispersion of about 3A per mm at λ2536.

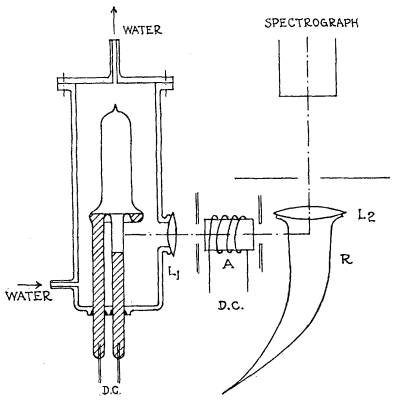

Fig. 1.

The physical interpretation of this effect is not fully understood. If one supposes a slight change in frequency to take place between the acts of absorption and emission, then energy which is absorbed in the wings would be reradiated in the center, as observed. The difference in energy between that of the absorbed and reradiated quantum presumably appears as thermal energy of motion. It will be noted that this change in energy, though apparently small, is far greater than the extremely minute Doppler width of mercury vapor at room temperature could possibly account for. If on the other hand we postulate detailed balancing and require the exact frequency absorbed to be reemitted, then the emission of a nonreversed line becomes something of a puzzle unless the upper state is more sharply quantized than the ground state—an improbable eventuality.

It is proposed to continue these experiments with a spectrograph of greater dispersion and to attempt to resolve the resonance radiated line more completely.

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