A New Electronic System for Detecting Microwave Spectra*

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August 11, 1947

IN an earlier report[1] we described a single-crystal detecting system for microwave spectroscopy which employs a low frequency cut-off filter to eliminate the contour of the oscillator mode and the spurious signals caused by reflections in the microwave line. We have now improved the sensitivity of our system by a modulation technique which allows the signal to be amplified at higher frequencies.

Upon the slowly varying sawtooth voltage used to sweep the microwave oscillator over its mode we superimpose a radiofrequency voltage ($\approx$100 kc) of low amplitude which causes the oscillator to be frequency modulated over a small range of frequencies, at a rate determined by the superimposed radiofrequency. An absorption line of a gas then acts as a discriminator to produce intensity modulation of the output radiation at a frequency corresponding to that of the modulating voltage. A single-crystal detector is used with an amplifier tuned to the modulating frequency. After pre-amplification at this frequency a second detector is employed followed by the filter mentioned above and by an audio amplifier. The filter we find effective against reflections. There are sharp, strong signals caused by the abrupt beginning and ending of the mode which are not eliminated by the filter. These are easily identified and are useful as indicators for crystal tuning and as markers to define the limits of tube oscillation.

Using the method described here with a 3.6-meter K-band wave-guide cell we easily detected the stronger lines of $N^{15}H_3$ in its naturally occurring concentrations of 0.3 percent in ordinary NH_3. A photograph of the 3,3 line of $N^{15}H_3$ thus obtained is shown in Fig. 1. The photograph of the 3,3 line of $N^{14}H_3$ in Fig. 2 demonstrates that good resolution can also be obtained. The distortions apparent in these photographs are not caused by the modulation but by the narrow band pass of the receiver used. Objectionable distortions can, of course, be produced by an incorrect modulation, but the adjustment of the modulation voltage is not critical.

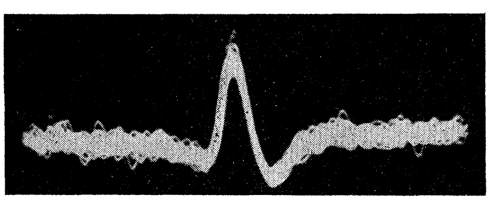

FIG. 1. Cathode-ray scope display of the 3,3 line of $N^{15}H_3$ at natural concentrations of 0.3 percent in normal ammonia. Cell length, 3.6 meters. Pressure, 2×10^{-3} mm of Hg. Modulation frequency 100 kc.

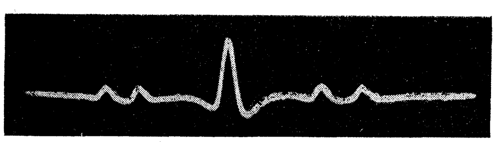

FIG. 2. Cathode-ray scope display of the 3,3 line $N^{14}H_3$ showing satellite structure. Cell length, 3.6 meters. Pressure, 4×10^{-3}. Modulation frequency 100 kc.

No greater sensitivity can be claimed for the system described above than for the Stark-effect modulation method of Hughes and Wilson.[2] In both systems the reception depends upon an intensity modulation produced by a high frequency motion of the signal in time (or components of the signal in the Stark-effect case). The present method has the advantage of being convenient to use with a cell of indefinite length. It is in general easier to modulate the oscillator than the molecules. The Hughes-Wilson method has the advantage of not requiring a filter to eliminate reflections.

A more complete description of the system will be reported elsewhere.

* This research was supported by a Frederick Gardner Cottrell Special Grant from the Research Corporation and by a loan of equipment from the Office of Naval Research.
[1] W. Gordy and M. Kessler, Phys. Rev. **71**, 540 (1947).
[2] R. H. Hughes and E. B. Wilson, Jr., Phys. Rev. **71**, 562 (1947).

New Atomic Lines in the Infra-Red Solar Spectrum

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August 20, 1947

THE infra-red region of the solar spectrum offers a rich and unique field for astrophysical study, for it is here that one is most likely to encounter atomic lines of high excitation potential. Studies of infra-red lines may be expected to yield important information on the extent to which the solar atmosphere departs from thermodynamic equilibrium. They may also serve to provide a check on current theories of the solar continuous absorption coefficient, and can furnish valuable supplementary data for the laboratory analysis of spectra.

During the past two months, a Cashman lead-sulfide photo-conductive cell has been employed in conjunction with the McGregor tower and spectrograph of the McMath-Hulbert Observatory to map the solar spectrum in the region 1 to 2μ. The spectrograph is of the Littrow type, consisting of a 15,000-line plane grating and 25-foot lens collimator, the dispersion being 2.1A/mm in the first order. The spectrum was traced on a Speedomax recorder, the dispersion on the record being 1.63 mm/A. The limiting resolution on the tracings was determined by the widths of the entrance and exit slits, 0.25 mm, which corresponds to about $\frac{1}{2}$A in the focal plane of the spectrograph. The resolution appears adequate to register clearly faint Fraunhofer lines with equivalent widths as low as 0.01A.

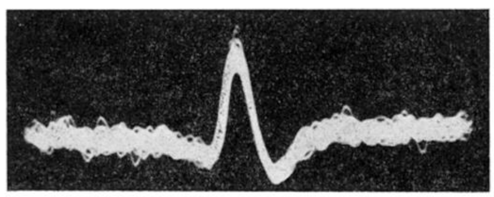

FIG. 1. Cathode-ray scope display of the 3,3 line of $N^{15}H_3$ at natural concentrations of 0.3 percent in normal ammonia. Cell length, 3.6 meters. Pressure, 2×10^{-3} mm of Hg. Modulation frequency 100 kc.

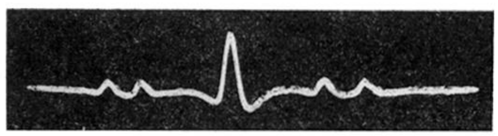

FIG. 2. Cathode-ray scope display of the 3,3 line $N^{14}H_3$ showing satellite structure. Cell length, 3.6 meters. Pressure, 4×10^{-3}. Modulation frequency 100 kc.