TABLE I. Results of the measurement of ν_0.

Pressure, mm Hg	No. of observations	Frequency,[a] Mc/sec
0.14	35	1420.40572±0.00003
0.18	35	1420.40575±0.00003
0.27	33	1420.40569±0.00002
0 (extrapolated)	···	1420.40580±0.00005

[a] A 10-cycle/sec correction to the frequencies caused by the 0.06-gaus field is included.

The results, together with the value obtained by extrapolation to zero pressure, are given in Table I.

These results are not likely to be changed by more than ±20 cycles/sec by the astronomical time correction to the nominal *WWV* frequencies, which, however, will not be available for several months. The listed uncertainties are probable errors. The present determination is in disagreement with the value of the hyperfine splitting using a molecular beam technique,[3] which gave

$$\nu_0 = 1420.4051 \pm 0.0002 \text{ Mc/sec.}$$

Both of the above results are in agreement with theory within the uncertainties introduced by high-order radiative corrections and proton structure effects.

* This research was supported by the Signal Corps.
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[2] First proposed to E. M. Purcell by N. F. Ramsey and V. F. Weisskopf.
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Hall Effect in Positive Column

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HALL voltage was observed in the positive column of dc gas discharge tubes, and was measured as a function of magnetic field, tube current, distance between probes, and gas pressure by the floating double probe method.

With a Helmholtz coil having a radius of 20 cm, a homogeneous magnetic field was applied perpendicular to the axis and to the line joining two probes which were placed perpendicular to the tube axis.

A hot cathode tube was constructed with a Pyrex cylinder 37 mm in inside diameter and 70 cm in total length, and four probes were inserted in the positive column near the middle part of this tube as shown in Fig. 1. Probes 1 and 2 were used to measure the Hall voltage and variations of the plasma densities at these points, and probes 3 and 4 were used for determining the electric field and density on the axis of the column. Argon and neon were used, with pressures ranging from 0.2 to 15 mm Hg, and the tube current ranged from 0.04 to 4 amperes.

An external magnetic field deflected the column in the same direction as electrons would be bent in vacuum, but the sign of the Hall voltage was opposite to that of an *n*-type semiconductor.

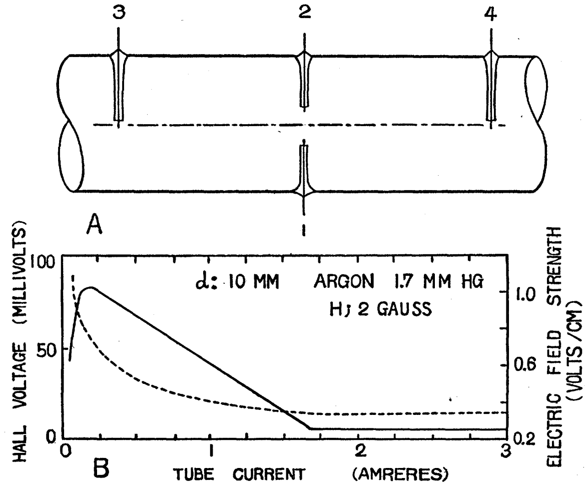

FIG. 1. A: The part of the tube where four probes are inserted. B: The Hall voltage and the electric field in the column *vs* tube current, in a magnetic field of 2 gauss. The tube contains argon at a pressure of 1.7 mm Hg. The solid and dotted lines indicate the Hall voltage and electric field, respectively.

Figure 1 indicates a general relation between the Hall voltage and the tube current at constant magnetic field and pressure. When the tube current was increased, the Hall voltage first increased to a maximum, then decreased, and finally reached a constant value, whereas the electric field in the column decreased monotonically. Therefore three regions were distinguished, corresponding to the character of the Hall voltage.

When the gas pressure was increased, the second region became narrow and the constant value in the third region became larger. It should also be noted that at large tube current and very low pressure the sign of the Hall voltage was reversed.

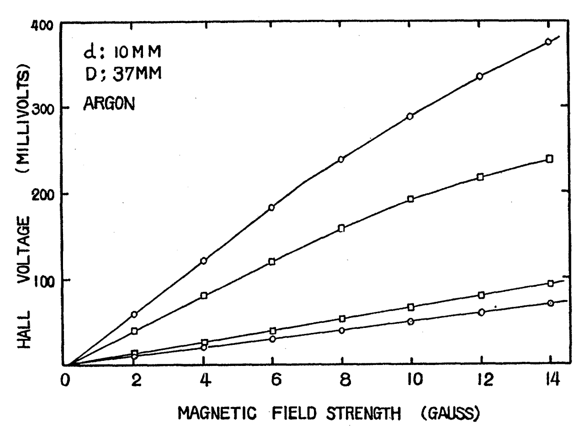

FIG. 2. Hall voltage *vs* magnetic field. The open circles and squares are data taken with the tube containing argon at pressures of 0.7 mm Hg and 1.4 mm Hg, respectively. The upper two lines are taken in the second region (at 1.0 amp) and the lower two lines in the third region (at 2.7 amp).

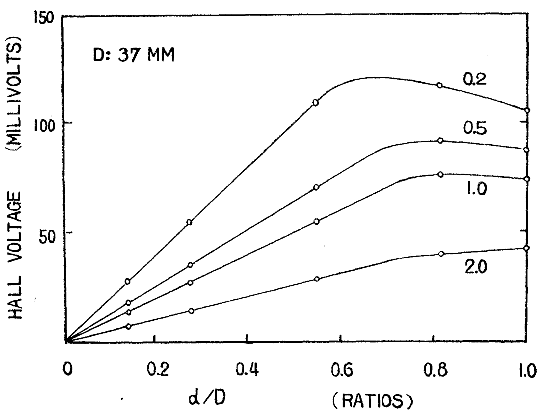

FIG. 3. Hall voltage *vs* fractional distance (d/D) for various values of the tube current (0.2, 0.5, 1.0, and 2.0 amperes), where d is distance between the probes and D is the tube diameter (37 mm). The tube contains argon at a pressure of 2 mm Hg. The magnetic field is 2 gauss.

An experiment with a tube of inside diameter 22 mm indicated that in the second region the Hall voltage was changed through zero to a negative value.

The variation of the Hall voltage with magnetic field strength in the second and third regions is shown in Fig. 2. The Hall voltage is exactly proportional to the magnetic field strength in the third region. However, in the second region deviations appear for magnetic fields greater than several gauss.

Another tube was prepared with five double probes, and the relation between Hall voltage and distance between probes was studied; the results are shown in Fig. 3. The abscissa is the ratio of the distance between probes to the tube diameter, and the parameter is the tube current in amperes. The Hall voltage was nearly proportional to the distance between the probes when these were placed near the tube axis.

To a first approximation, if we neglect the effect of ion current, the observed value of Hall voltage (V_0) is expressed by

$$V_0 = \frac{kT}{e}\log\frac{n_2}{n_1} - \frac{vHd}{c},$$

where e, T, and k are electron charge, electron temperature, and Boltzmann's constant; c, v, H, and d are the velocity of light, the electron drift velocity, the magnetic field strength, and the distance between the probes respectively; n_1 and n_2 are the random plasma densities at probe 1 and probe 2. Here, the ratio of n_2 to n_1 depends not only on H, but also on the tube current. V_0 is considered to be composed of the diffusion term[1] and the ordinary Hall term. Under the usual experimental conditions, the diffusion term is large compared with the ordinary Hall term, because the electron temperature is very high and the magnetic field is weak. This was verified by the fact that the value of $(kT/e)\log(n_2/n_1)$ calculated from the characteristic curves[2] of the double probe agreed approximately with the observed voltage. The measurement of Hall voltage seems to be a valuable method for studying the positive column.

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Alignment of Sodium Atoms*

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IN the course of work on the polarization of sodium atoms by the absorption of circularly polarized resonance radiation,[1] observations were also made with the incident light unpolarized. An effect was observed which is interpreted as a partial alignment induced in the sodium by the scattering of the unpolarized photons. Because of the definite direction of incidence, the unpolarized photons possess some order, and the scattering of such photons induces alignment along the axis of the incident light. The alignment of the sodium affects the polarization ratio $(\sigma-\pi)/(\sigma+\pi)$ of the light scattered at 90°. In Fig. 1 the measured shift in this polarization ratio is plotted against the magnetic field strength applied along the direction of the incident light. The total magnetic field in the two other directions was made as nearly as possible zero by the use of compensating Helmholtz coils. The corresponding plot with the incident radiation circularly polarized differs mainly in the scale of the ordinate, and its features have been described previously.[1] The asymmetry previously observed has been removed by the use of more nearly homogeneous magnetic fields.

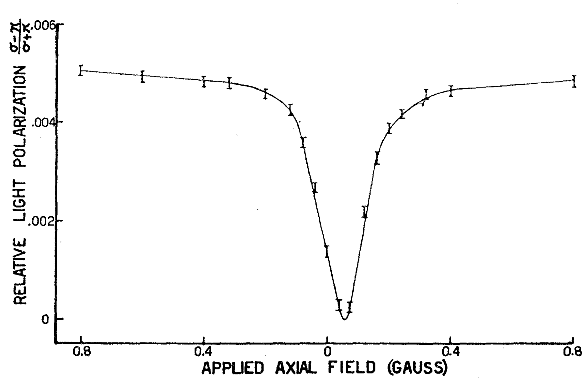

FIG. 1. Polarization ratio of the scattered resonance radiation with incident radiation unpolarized.

From Fig. 1, the polarization ratio of the scattered light for sodium in thermal equilibrium occurs for an applied field of 0.055 gauss, for which the axial com-