with the dummy cell in the beam, each being accompanied by background readings.

Curves showing the results obtained with iridium are given in Figs. 8 and 9. The resonance levels exist in the region investigated, and they are far enough apart to be quite well represented by the Breit-Wigner equation. Table II shows the values of the constants which give the best fit in each case.

These values of σ_0 and Γ are undoubtedly affected by the resolving power of the instrument, especially at the higher energy peak. The values given for σ_0 must be considered simply as lower limits and those for Γ as upper limits.

TABLE II. Breit-Wigner constants for iridium resonances.

E_0 (ev)	σ_0 (barns)	Γ (ev)
0.620	2930	0.08
1.29	1880	0.14

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Quenching and Depolarization of Mercury Resonance Radiation by Nitrogen and Oxygen

LEONARD O. OLSEN, *Case School of Applied Science, Cleveland, Ohio*

AND

GEORGE P. KERR, JR., *General Electric Company, Nela Park, Cleveland, Ohio**

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The quenching and depolarization of mercury resonance radiation by nitrogen and oxygen in the presence of a weak magnetic field are studied. These effects are proportional to gas pressure. The proportionality constants for each gas are determined. Results of tests on two samples of each gas are given, with generally good agreement between separate tests. Quenching and depolarizing cross sections are computed from the finally selected constants.

The measurements here considered indicate that adiabatic depolarization, a phenomenon tentatively postulated in the theory, is not present in the case of nitrogen and oxygen.

1. INTRODUCTION

A SEMI-CLASSICAL treatment of the theory involved in quenching and depolarization of mercury resonance radiation, and data for a number of common gases were presented in a previous paper.[1] In a subsequent paper by one of the present authors,[2] results for the rare gases were published.

Since the previous study of oxygen was not completed, and the existence of adiabatic depolarization by nitrogen was in some question, these two gases were selected for further investigations. The fact that oxygen very effectively quenches resonance radiation, and nitrogen does not, also makes these two gases a good pair for study.

Much of the same experimental equipment and technique employed in the previous work were again utilized. It was necessary to flame the system before cold traps were installed at the start of each run. This reduced the amount of water vapor released by the walls of the system to a minimum and drove the mercury vapor which had migrated to untrapped portions of the system back into the trapped areas. Agreement with H. F. Olson's[3] data for polarization *vs.*

* The experimental work on the subject presented in this paper was conducted at Case School of Applied Science in partial fulfillment of the requirements for the degree of Master of Science in Physics.

[1] A. Ellett, L. O. Olsen, and R. Petersen, Phys. Rev. **60**, 107 (1941).

[2] L. O. Olsen, Phys. Rev. **60**, 739 (1941).

[3] H. F. Olson, Phys. Rev. **32**, 443 (1928).

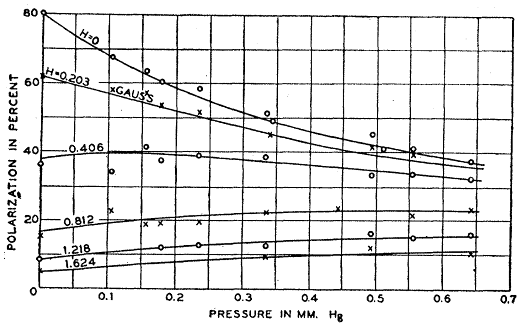

FIG. 1. Polarization in nitrogen—sample 1.

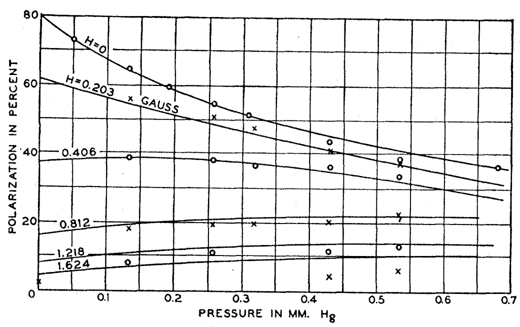

FIG. 2. Polarization in nitrogen—sample 2.

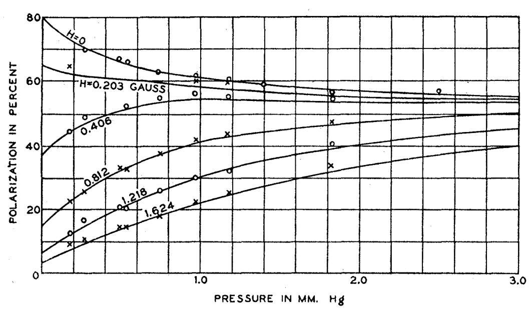

FIG. 3. Polarization in oxygen—sample 1.

magnetic field with no foreign gas present was always secured before any other measurements were made.

2. RESULTS OBTAINED WITH NITROGEN AND OXYGEN

Two samples each of nitrogen and oxygen were used for the experiments. Results for each sample are reported separately with the exception of cross section computations, as changes in technique and operating conditions were made at intervals. The samples will hereafter be referred to as $N_2\#1$, $N_2\#2$, $O_2\#1$, and $O_2\#2$.

$N_2\#1$ was obtained by exploding a limited quantity of sodium azide in a vacuum. $N_2\#2$ was commercially obtained but better than 99.5 percent pure. $O_2\#1$ and $O_2\#2$ were both from a commercial source, but also of high purity. The determinations of the quenching and depolarization collision probabilities for each gas sample are shown in Table I. The quantities determined by field-free measurements are omitted for $O_2\#1$, as a source of error existed during some of these measurements which was later removed. However, the final results show that the constants selected apply quite well to the field-free polarizations for $O_2\#1$. The cross sections for each type of collision are given in Table II. By way of review, the constants involved are identified as follows: α, probability of a quenching collision per mm gas pressure; α', probability of a non-adiabatic depolarizing collision per mm; α'', probability of an adiabatic depolarization collision; $\sigma_\alpha{}^2$, $\sigma_{\alpha'}{}^2$, $\sigma_{\alpha''}{}^2$, the corresponding cross sections for quenching and depolarization.

By using the average values for α and α' shown in Table I, polarization values were calculated for all the conditions of gas pressure and magnetic field at which measurements were made. Figures 1–4 illustrate the comparison of computed and observed data for the four gas samples used. The smooth curve in each figure results from computed polarizations, while the observed polarizations are shown by individual points.

During much of the work the mercury arc current was lower than that previously used,[1,2]

TABLE I. Quantities determined by polarization measurements involving the collision probabilities ($\times 10^{-7}$ sec.$^{-1}$ mm^{-1}).

Gas	α	$\alpha'+\alpha''$	$\alpha+\alpha'$	α'	α''
$N_2\#1$	0.1	2.3	2.4	2.3	0
$N_2\#2$	0.1	2.5	2.6	2.5	0
Average	0.1	2.4	2.5	2.4	0
$O_2\#1$			2.0		
$O_2\#2$	1.1	0.9	2.0	0.9	0
Average	1.1	0.9	2.0	0.9	0

TABLE II. Cross sections for quenching and depolarization ($\times 10^{16}$ cm^2).

Gas	$\sigma_\alpha{}^2$	$\sigma_{\alpha'}{}^2$	$\sigma_{\alpha''}{}^2$
Nitrogen	1.92	47.2	0
Oxygen	22.3	18.1	0

where a "broad line" exciting source was assumed. For this reason the calculations were also made on the basis of a "narrow line" source according to methods described by Larrick and Heydenburg.[4] However, only insignificant differences in computed values of $\alpha+\alpha'$ resulted on this basis when applied to the data for nitrogen and oxygen.

The effect of increasing magnetic-field strength on polarization can be visualized more clearly by curves showing this variation for constant pressure conditions. Figure 5 shows a family of such curves and the corresponding observed values for O_2 at two widely separated pressures. The effect of magnetic field alone on polarization is also shown for comparison.

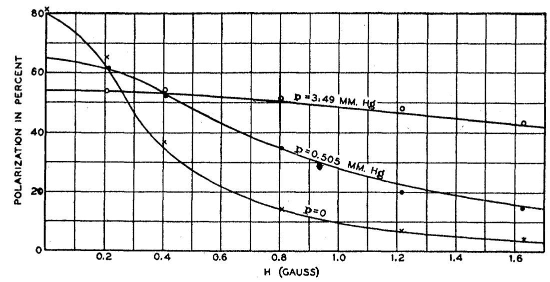

FIG. 5. Effect of magnetic field on polarization in oxygen.

CONCLUSIONS

The results here presented on two samples each of nitrogen and oxygen are determined from a large number of individual polarization measurements. The probability coefficients determined for oxygen are greater than those applied previously, but this is not surprising. The earlier values were necessarily based almost entirely on field-free data, which gives merely the linear relations of the coefficients. A considerable amount of magnetic-field data is necessary to obtain accurate absolute values.

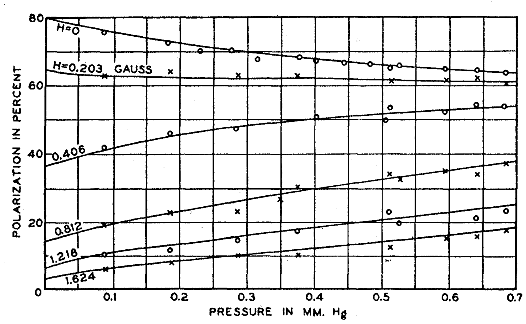

FIG. 4. Polarization in oxygen—sample 2.

Experimental results obtained with both gases indicated that an assumption of the existence of adiabatic depolarization is unnecessary. As discussed in the preceding paper,[2] the introduction of α'' was found of advantage only in regard to the rotation of the plane of polarization *vs.* magnetic-field data, for both nitrogen and the rare gases. α'' could readily be zero for the rare gases without appreciable effect on the agreement between calculated and observed results. In the experimental work described in this paper, results obtained on rotation of the plane of polarization were the least dependable. A thorough examination of the first partial derivatives of the probability coefficients with respect to each measured parameter showed this method of determining $\alpha+\alpha'$ to be less accurate and its useful range smaller than is the case with determinations based on actual polarization values. Further work will be done on other gases, with careful consideration given to these factors.

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[4] L. Larrick, and N. P. Heydenburg, Phys. Rev. **39**, 289 (1932).