

evaluation of the zero band  $\nu_0$  and of the ground frequency; formula II for the calculation of the dissociation energies  $D'$  and  $D''$ . Thus we obtain (in electron volts):

$\nu_0 = 2.88$  volts,  $D' = 2.91$  volts,  $D'' = 1.20$  volts, and, from that, the atomic term  $\nu_a = \nu_0 + D' - D'' = 4.6$  volts, a value equal to the term difference  $2^3P_0 - 1^1S$  (4.65 volts) of the mercury atom. This remarkable agreement supports strongly the assumption that the ground state of the HgCl molecule is built up from a Hg atom in its lowest term ( $1^1S$ )—and not from an excited one—and from a Cl atom also in its normal term. The same will presumably hold for the other diatomic iodides, bromides and chlorides of mercury, cadmium and zinc, the spectra of which are very similar to the spectrum of HgCl. Further work is needed to confirm that and to ascertain whether the fluorides of these metals behave in a different manner.

Experiments on the spectra of HgBr and HgI are in progress.

K. WIELAND.

Physikalische Anstalt,  
Universität, Basel.  
Feb. 21.

- <sup>1</sup> *Phil. Mag.*, **21**, 41 (1936). NATURE, **138**, 411 (1936).
- <sup>2</sup> Asundi, Samuel and Zakki-Uddin, *Proc. Phys. Soc.*, **47**, 235 (1935).
- <sup>3</sup> Sponer, *Z. phys. Chem.*, B, **11**, 425 (1931). Oeser, *Z. Phys.*, **95**, 699 (1935).
- <sup>4</sup> Wieland, *Z. Phys.*, **76**, 801 (1932) and **77**, 157 (1932).
- <sup>5</sup> Birge, *Trans. Faraday Soc.*, **25**, 707 (1929).
- <sup>6</sup> Elliott, *Proc. Roy. Soc.*, A, **127**, 638 (1930).

Gold Deuteride Bands

AN arc between gold poles in heavy hydrogen gas of high concentration at a pressure of about 12 cm. mercury was photographed in the second order of a 15-ft. concave grating. 723 AuD lines lying between  $\lambda$  3370 A. and  $\lambda$  4440 A. were analysed into eleven bands of a  $^1\Sigma \rightarrow ^1\Sigma$  system as,  $2 \rightarrow 0$  ( $\lambda$  3382),  $1 \rightarrow 0$  (3502),  $2 \rightarrow 1$  (3585),  $0 \rightarrow 0$  (3646),  $2 \rightarrow 2$  (3775),  $0 \rightarrow 1$  (3872),  $1 \rightarrow 2$  (3935),  $2 \rightarrow 3$  (4005),  $0 \rightarrow 2$  (4117),  $1 \rightarrow 3$  (4183) and  $0 \rightarrow 3$  (4384) vibrational transitions. The  $1 \rightarrow 1$  band was of such low intensity that no single line of it could be identified.

Preliminary evaluation of molecular constants, based on the rotational energy function ending in the  $J^2(J + 1)^2$  term for both the  $^1\Sigma$  states, and adjusted for the region of  $J = 6 \sim 10$  to  $J = 30 \sim 35$  in each vibrational level, has yielded the values given in the accompanying table, with calculated probable errors for the rotational constants.

MOLECULAR CONSTANTS OF AuD

	Lower $^1\Sigma$ state	Upper $^1\Sigma$ state
$T_0$	0	27644.1
$\omega_0$	1634.98	1195.24
$x_0\omega_0$	21.66	34.81
$y_0\omega_0^2$	-0.0288	
$B_0$	$3.6413 \pm 0.00008$	$3.041 \pm 0.003$
$\alpha$	$0.07608 \pm 0.00002$	$0.1075 \pm 0.001$
$D_0$	$-0.7090 \times 10^{-4} \pm 0.0002 \times 10^{-4}$	$-0.79 \times 10^{-4} \pm 0.01 \times 10^{-4}$
$\beta$	$3.36 \times 10^{-7} \pm 0.04 \times 10^{-7}$	$-6.2 \times 10^{-8} \pm 0.4 \times 10^{-8}$

$D_0$  of the upper  $^1\Sigma$  state decreases with  $v$  in a markedly non-linear way, but as only three vibrational levels are found in this state, the most probable values of  $D_0'$  and  $\beta'$  for the linear formula are provisionally given in the table.

The electronic isotope shift from the corresponding AuH system ( $0 \rightarrow 0$ ,  $\lambda$  3650 A.) is + 14 cm.<sup>-1</sup>. Other isotope relations between the constants of the two

molecules will be considered in a coming number of the Institute's publication (*S.P.I.P.C.R.*), together with frequency tables and other details of the observed deuteride bands.

SUNAO IMANISHI.

Institute of Physical and Chemical Research,  
Komagome, Tokyo.  
Jan. 30.

Correlation of Ionization Constants of Organic Acids with Dipole Moments

SINCE ionization constants and dipole moments are both measures of polarity, it is logical to suppose that a connexion will exist between them. Interesting results have followed an examination of the elementary possibility that the difference between the strengths of substituted and unsubstituted acids in the benzoic and phenylacetic series, and the dipole moments of monosubstituted benzenes (virtually the substituent groups), are simply related. The ionization constant values ( $K_{therm}$ ) were all derived in this Department and the dipole moments were those employed by Dippy and Watson<sup>1</sup> in connexion with the logarithmic relationship observed previously. These sets of data possess the advantage of being comparable.

In the benzoic series the points representing *m*-nitro-, *m*-methoxy-, unsubstituted and *p*-methyl-substituted acids are distinctly colinear. A second straight line of much smaller angle can also be drawn through *m*-nitro-, *m*-chloro-, *m*-iodo-, unsubstituted and *p*-methyl phenylacetic acids. In the benzoic acids the *m*-halogens show a small disparity (cf. Dippy and Watson<sup>1</sup>) but the abnormality has been so diminished in the phenylacetic acids that it is not distinguishable. The inclusion of the *p*-methyl acids, and not the *m*-acids, as at first expected, is especially important, and it must mean that the polar effect of the methyl group measured in toluene, is the effect of a *p*-methyl substituent, that is, the two permanent components (the inductive and mesomeric effects) are operative.

A fuller account of this relationship, accompanied by figures, will be published shortly.

J. F. J. DIPPY.

Technical College,  
Cardiff. Feb. 24.

*J. Chem. Soc.*, 436 (1936).

Electron Inertia as the Cause of Harmonics in Valves

THE Lagrangian form<sup>1</sup> of Benham's equation<sup>2</sup>, connecting the total current density with the rate of change of acceleration of particles of charge  $e$ , mass  $m$ , moving in a one-dimensional, non-uniform\* electric field, may be written, for electrons,

$$\ddot{x} = 2.00_2 \times 10^{28} \dot{x} \dots (1)$$

in which the numerical value of  $\frac{4}{10} \pi \frac{e}{m} c^2$  is in dynes

coulomb<sup>-1</sup> gm.<sup>-1</sup> and  $\dot{x}$  is in amp. cm.<sup>-2</sup>. The electric field, which may vary with time in any manner, is proportional to  $\ddot{x}$ . Omitting the constant, and writing  $q = \int i dt$ , we obtain from (1), on integration over the interval  $(t - t_0)$ :

$$\ddot{x} = \ddot{x}_0 + q(t) - q(t_0) \dots (2)$$

\* The non-uniformity is caused only by the electrons themselves.