

nance line was found to decrease when the electrodes were cooled to 200°K, however, and the width also varied with the particular gas filling the discharge tube. This would indicate that there is some effect due to the positive ions, or dissociated atoms, the high effective temperature of the discharge averaging out their fine and hyperfine splittings.^{2,3} Initial measurements on various gases are summarized in Table I.

TABLE I. Variation of width with gas in discharge tube.

Gas	Half-widths at maximum intensity (gauss)	
	290°K	200°K
Argon	115	60
Oxygen	135	85
Carbon dioxide	150	110

A systematic survey of other gases, and of the variation in intensity and width of the absorption, with both the pressure, and the temperature, of the discharge, is being made, and will be reported shortly.

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Paramagnetic Resonance Absorption in Graphite Compounds*

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A VERY narrow resonance line had been found, as previously reported,¹ in the bisulfate compounds of graphite. Several other compounds of graphite have also been found to show a similar resonance. The compounds to be described here contain alkali or alkaline earth metals, which act weakly as donor impurities, i.e., furnish some electrons to the graphite conduction band.

The metal-graphite compounds were prepared by reacting a solution of the metal in liquid ammonia with purified flakes of Madagascar natural graphite. The compounds were prepared and washed with liquid ammonia at -78°C and sealed with ammonia into quartz tubes. The compounds contained ammonia in addition to the metal, but consistent analyses have not yet been obtained. The presence of the ammonia was shown to have no effect on the resonance by preparing a potassium-graphite compound (No. 144, Table I) directly in the metal vapor.

The resonance detection equipment was of the regenerative oscillator-detector scheme using the dual-field modulation and has been described previously.² Measurements were made initially at 350 Mc/sec and

TABLE I. Resonance line width in compounds of graphite and metals.

Metal constituent	Sample No.	ΔH , 300°K (milligauss)	ΔH , 77°K (milligauss)
Li (conc.)	137	100	70
Li (dil.)	149	86	60
Na	164	115	77
K	144 ^a	350 ^b	
K	141	275	275
Ca	156	130	75
Ba	140		<300 ^c

^a Compound prepared *in vacuo*, does not contain ammonia.

^b Measured at 4.25 Mc/sec.

^c Measured at 355 Mc/sec.

then at 4.25 and 15.4 Mc/sec to reduce magnetic field inhomogeneities. The results at the latter frequency are shown in Table I for the various metals. The effect of metal concentration has not yet been determined quantitatively because of the difficulty of assaying. When the concentration was obviously high, no resonance appeared. The two lithium compounds (No. 137 and No. 149) showed signal intensities in the ratio 2:1 indicative of comparable concentration ratios.

It may be significant that the metal-graphite compounds show relaxation times of the order anticipated by theory for metallic resonances.³ The lack of such agreement with experimental results in finely dispersed and bulk alkali metals has been attributed to skin depth effects, and thus one might postulate that the layer type (lamellar) structure of the graphite compounds minimizes such effects. The linear dependence of line width on temperature predicted by theory has been found to require modification by, perhaps, a spin-orbit interaction term. The results in Table I appear to bear out this effect.

* Based on work performed under the auspices of the U. S. Atomic Energy Commission.

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InSb Photovoltaic Cell*

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A CRYSTAL of InSb containing a photosensitive junction has been prepared by the crystal-pulling technique. During crystal growth the melt was doped to produce a *p-n* transition. A specimen 1 cm×0.1 cm×0.025 cm was cut from the crystal so as to include the transition region. This specimen exhibited a dark resistance of about 20 000 ohms at 77°K and no noticeable rectification. The photoresponse at 77°K has been determined using the specimen as a photovoltaic cell. The spectral response extended to about 5.7 μ ; this limit agrees very well with the transmission data of

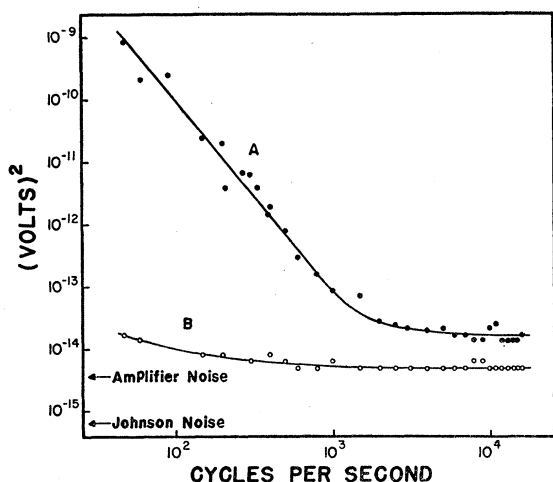


FIG. 1. Noise spectra (13-cps band width) for InSb photocell cooled to 77°K. *A* is for 300°K background. *B* is for 77°K background.

Avery *et al.*¹ for pure InSb. The time constant of the response was less than 2 microseconds, the minimum value that could be measured with our present apparatus.

Figure 1 shows noise spectra for the cell at 77°K. Curve *A* was observed when the cell was exposed to room-temperature radiation. Curve *B* was observed when the cell was covered with a light shield at 77°K. Shielding decreased the noise at all frequencies. The noise given by curve *B* is virtually amplifier noise and the slight rise at low frequencies is attributed to a small radiation leak. The Johnson noise for the cell was below amplifier noise. For the cell exposed to 300°K radiation the noise showed a white spectrum above 2 kc/sec while below 2 kc/sec it followed an approximate f^{-d} law with $d \cong 3$. This result is a curious one since the cell was operated without bias.

It is interesting to compare the detectivity of the cell exposed to a 300°K background with the limiting detectivity set by photon noise.² To compute the latter, it is assumed that the cell has unity quantum efficiency for $\lambda < 5.5\mu$ and cuts off abruptly. Considering only the noise created by random arrival of photons, the theoretical detectivity of a 1 mm² cell is calculated to be 1.1×10^{-8} sec/photon. The measured detectivity is 0.09×10^{-8} sec/photon. The conditions of measurement were: cell area 1 mm², responsivity 10.5 volts/(watt/cm²) at 2μ , noise 0.11 microvolt for $f > 2$ kilocycles and a band width of 13 cps.

A more detailed account of this work will be published in the future.

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Energies of the K Transitions of π^- Mesonic X-Rays*

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IN a previous letter¹ we reported on the energy shifts, presumably arising from specifically nuclear interactions, of the $2p \rightarrow 1s$ π -mesonic x-rays in lithium and beryllium. For these elements the energy was measured with the critical absorption technique. Here we wish to report further on measurements of K -transition energy shifts in carbon, nitrogen, oxygen, and fluorine. Since the critical absorption method could not be extended to these elements, the energy was determined by a measurement of pulse height.

The experimental setup has been previously described.² For the present measurements the scale of the pulse height selector was calibrated by means of other mesonic x-ray lines whose energies could be calculated sufficiently accurately (see Table I). The experi-

TABLE I. Computed energies of $2p \rightarrow 1s$ transitions and their calibrating lines.

Element for π $2p \rightarrow 1s$	for calibration	Type meson	Type of transition	Uncorr. trans. energy ^a (kev)	Vac. polar. corr. ^b (kev)	Finite size corr. ^c (kev)	Corrected energy (kev)
Be	P	π	$4f \rightarrow 3d$	40.4	+0.10		40.5
	F	π	$3d \rightarrow 2p$	41.4	+0.13		41.5
	Cl	π	$4f \rightarrow 3d$	43.8	+0.20	-0.12	43.9
C				51.9	+0.15		52.1
	Al	π	$3d \rightarrow 2p$	86.7	+0.37		87.1
	Si	π	$3d \rightarrow 2p$	99.2	+0.57	-0.76	99.0
N				100.6	+0.43		101.0
	P	π	$3d \rightarrow 2p$	115.6	+0.53		116.1
	S	π	$3d \rightarrow 2p$	135.4	+0.84	-1.57	134.6
O				131.6	+0.63		132.2
	Cl	π	$3d \rightarrow 2p$	148.7	+0.74		149.4
	O	μ	$2p \rightarrow 1s$	134.4	+0.77	-1.28	133.9
F				177.3	+1.20	-2.92	175.5
	F	μ	$2p \rightarrow 1s$	170.3	+1.04	-2.31	169.0
	K	π	$3d \rightarrow 2p$	186.0	+0.97		186.9
F				170.3	+1.04	-2.31	169.0
				225.0	+1.60	-5.27	221.3
	Na	μ	$2p \rightarrow 1s$	254.8	+1.73	-5.84	250.7

^a The π^- energies were calculated with the Klein-Gordon equation by using the reduced π^- -meson mass (assuming $m_{\pi^-} = 272.5m_e$) and a point-charge Coulomb potential. The μ^- energies were calculated similarly, but with the Dirac equation and the assumption $m_{\mu^-} = 207.0m_e$.

^b Vacuum polarization correction; H. C. Corben and A. Mickelwait, Phys. Rev. (to be published).

^c Finite size correction; made by using hydrogenic wave functions in a first order perturbation calculation neglecting the specifically nuclear interaction between meson and nucleus.

mental procedure was to bracket each K line under investigation with two or more calibration lines. The line to be measured and its calibrating lines were run alternately at least three times. Usually the reproducibility was excellent, peaks drifting only a fraction of a channel, so that the data could be added to give better statistics. μ -meson transitions were used as the calibrating lines for oxygen and fluorine since for $Z \geq 17$ there may be measurable nuclear shifts in the π $3d \rightarrow 2p$ transition energies