in orientation of neighboring moments or to pronounced diffuse scattering effects if there is not such correlation.

Neutron diffraction data have been obtained for polycrystalline samples of V_3Si, Cr_3Si, and Mo_3Si at room temperature and also at 20.4°K, in order to study the magnetic structures of these materials.

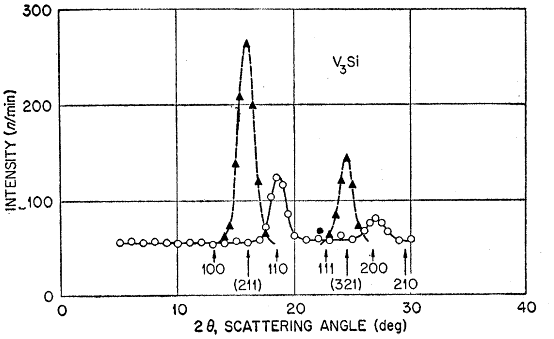

FIG. 1. Room temperature diffraction pattern of V_3Si. The dashed curves are antiferromagnetic intensities to be expected on Zener's model.

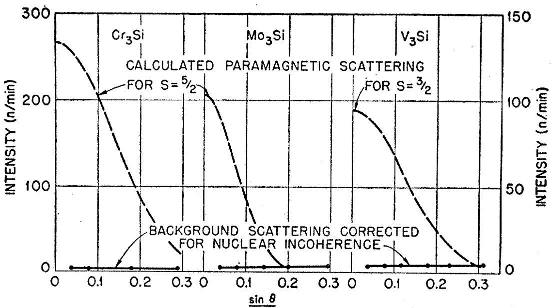

FIG. 2. Comparison of observed and expected diffuse scattering. The observed scattering has been corrected for nuclear incoherent effects.

The neutron diffraction patterns at room temperature of the three silicides exhibit marked differences in relative line intensities because of the relative values of the scattering amplitudes of the several nuclei involved, but in each case the positions and intensities of the diffraction lines correspond to those to be expected from nuclear scattering alone. At 20.4°K the patterns are not essentially different from those at room temperature except for small changes due to different Debye factors at the two temperatures. A portion of the room temperature pattern of V_3Si is illustrated in Fig. 1. Since V has a very small coherent scattering cross section, the coherent scattering is due almost entirely to the silicon lattice. Also illustrated in Fig. 1 are magnetic coherent reflections which are to be expected on Zener's model.[3] This model requires a unit cell whose edges are twice those of the chemical unit cell, and the indices which refer to the doubled cell are enclosed by parentheses. It is clear that any aligned moments present in V_3Si are much smaller than those calculated from free atom configurations; an upper limit of $0.2\mu_B$ has been estimated for these moments from the sensitivity of the measurements. Similar results have been obtained from Cr_3Si and Mo_3Si.

It is also of interest to examine the diffuse scattering data. If moments of the order of several Bohr magnetons are indeed present but are uncorrelated in orientation, a pronounced angularly dependent paramagnetic scattering should be observed. Figure 2 shows the calculated paramagnetic scattering from the several silicides. To compare this with experiment, the observed diffuse scattering has been corrected for isotopic and spin disorder effects, and the residue is plotted as a function of $\sin\theta/\lambda$ for each compound. The angular dependence of the residual background scattering is in every case nearly isotropic and its magnitude is such as to be accounted for by multiple scattering alone. The maximum uncorrelated moment consistent with these data is about $0.2\mu_B$ in each case.

In the course of this work we have redetermined the silicon coherent scattering cross section from elemental silicon to be 2.16±0.06b which is to be compared with Weiss' value of 2.0±0.2b from small-angle scattering measurements.[4]

We are indebted to Mr. D. E. LaValle for chemical preparations, and to Dr. H. Yakel and Mr. R. M. Steele for x-ray analyses of the samples.

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Moseley's Law Applied to Proportional Counter Resolution of Adjacent Elements

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THE proportional counter, by virtue of its ability to furnish information concerning intensity (counts/sec) and energy (pulse amplitude) of incident radiation, can be used in certain applications as an x-ray spectrometer in a nondispersive system.[1] A knowledge of the energy resolution and its variation with energy is important for the maximum utilization of the proportional counter in this manner.

The energy resolution of a proportional counter is determined by the magnitude of the statistical fluctuation in the initial absorption ionization and subsequent gas multiplication. The "half-width" of a peak in the pulse-height distribution (PHD) is an abbreviated term for the amplitude difference between those pulses comprising the PHD that occur at half the maximum rate.

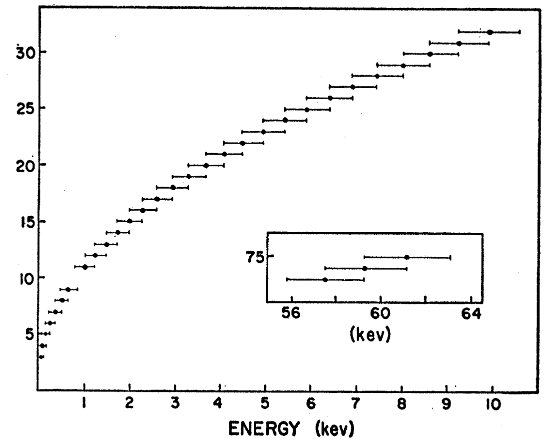

FIG. 1. $K\alpha$ energies and calculated PHD half-widths as a function of atomic number, based on 15 percent half-width for $_{29}$Cu. Insert shows the half-widths for the $K\alpha$ of $_{73}$Ta, $_{74}$W, and $_{75}$Re.

A more generally used quantity is the "percent half-width" which is the ratio of the half-width to the pulse amplitude at maximum rate (×100).

From an extension of some work by Frisch[2] and Fano[3] on the statistical fluctuations in multiplicative processes, it was found for the peaks in the PHD of a proportional counter, that

$$(\text{half-width}) \propto (\text{energy})^{\frac{1}{2}}. \qquad (1)$$

This has been experimentally verified[4] in this Laboratory using rare-gas filled proportional counters to detect x-radiations ranging in energy from 5 to 50 kev. Although radiations below 5 kev have not been directly checked, the escape pulses from the counter offered a means of extending this range into the soft x-ray region to 1 kev.

It is interesting to note that Moseley's Law, giving the relation between energy of characteristic lines and atomic number,

$$(Z-\sigma) \propto (\text{energy})^{\frac{1}{2}}, \qquad (2)$$

has a similar form. Two consequences follow: (a) The half-width of the PHD produced by the characteristic radiation of an element is approximately proportional to the atomic number of the element. The percent half-width, therefore, is a means of identifying elements, provided the half-width for a known energy has been determined. (b) The ability of a proportional counter to resolve characteristic x-radiations of adjacent elements is approximately constant over all the elements. That is,

$$B(Z)/[E(Z+1)-E(Z)] \cong \text{const}, \qquad (3)$$

where $B(Z)$ is the half-width of the PHD given by x-rays from an emitter of atomic number Z, and $E(Z)$ is the energy of the x-rays.

In order to determine the degree of approximation and the validity of (b), Eqs. (1) and (2) are combined:

$$B(Z) \propto [E(Z)]^{\frac{1}{2}} \propto (Z-\sigma). \qquad (4)$$

Then,

$$\frac{B(Z)}{E(Z+1)-E(Z)} \propto \frac{Z-\sigma}{(Z+1-\sigma)^2-(Z-\sigma)^2} = \frac{Z-\sigma}{2(Z-\sigma)+1}. \qquad (5)$$

For K x-radiations, σ is approximately 1 and the last term of (5) reduces to

$$(Z-1)/(2Z-1).$$

Over the range of all elements above $Z=10$, this ratio does not vary by more than $2\frac{1}{2}$ percent.

Figure 1 demonstrates these principles, showing the nominally constant fractional overlap of the calculated half-widths with respect to the $K\alpha$ emission energies and indicating that the counter can resolve the K emission equally well over the range of elements $Z>10$.

It has been shown that the resolution of x-rays of adjacent elements is a constant intrinsic property of the proportional counter over all the elements. Beyond that limitation, its use as a spectrometric device for the identification of elements is contingent on the absorption properties of the gas-filling and window and the x-ray intensity available from the source.

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Molecular Microwave Oscillator and New Hyperfine Structure in the Microwave Spectrum of NH_3†

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AN experimental device, which can be used as a very high resolution microwave spectrometer, a microwave amplifier, or a very stable oscillator, has been built and operated. The device, as used on the ammonia inversion spectrum, depends on the emission of energy inside a high-Q cavity by a beam of ammonia molecules. Lines whose total width at half-maximum is six to eight kilocycles have been observed with the device operated as a spectrometer. As an oscillator, the apparatus promises to be a rather simple source of a very stable frequency.

A block diagram of the apparatus is shown in Fig. 1. A beam of ammonia molecules emerges from the source and enters a system of focusing electrodes. These electrodes establish a quadrupolar cylindrical electrostatic