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Wavelength Resolution of X-Ray Proportional Counters

In a recent letter on a "Comparison of Geiger and Proportional Counters for Intensity Measurements in X-ray Diffraction", Arndt and Riley (1952) state that the proportional counter's "response to any particular characteristic wavelength employed can be made as sharp as required". It should be pointed out, however, that the wavelength resolution of proportional counters is fundamentally limited by statistical fluctuations in the number of primary ion pairs formed and in the amount of gas amplification. On the other hand, Arndt and Riley were unable to discriminate completely against harmonic radiation according to the account given of their experiments, whereas the writer has previously shown (Lang 1951) that separation of CuKα radiation from its first harmonic can be complete.

The purpose of this note is to deal quantitatively with the case, important in practice, of detecting CuKα radiation in the presence of slightly softer fluorescent radiations which can be excited by the CuKα rays.

The variation of pulse height from CuKα radiation was found to follow closely a gamma distribution function. The experimental points and the fitted curve are shown in fig. 1. Distribution curves for the other radiations can be computed from the CuKα distribution since the variance of the distribution is proportional to the energy of the radiation. The ratio of variance to the square of the mean pulse height obeys the relation $\sigma^2/\bar{p}^2=C/\bar{N}$ where $\bar{N}$ is the mean number of ion pairs formed before gas multiplication and C is a constant. For CuKα radiation $\bar{N}=298$, taking the value of the energy required per ion pair formation in argon to be 27 ev (Valentine 1952). With this value of $\bar{N}$ the constant C is found to equal 1·1. The distribution curves shown for CrKα, MnKα, FeKα and CoKα radiations are all normalized. The FeKβ curve has an area 0·13 of the Kα curves. The experimentally observed subsidiary peaks centred 3 kev below the main peaks, which are due to loss of

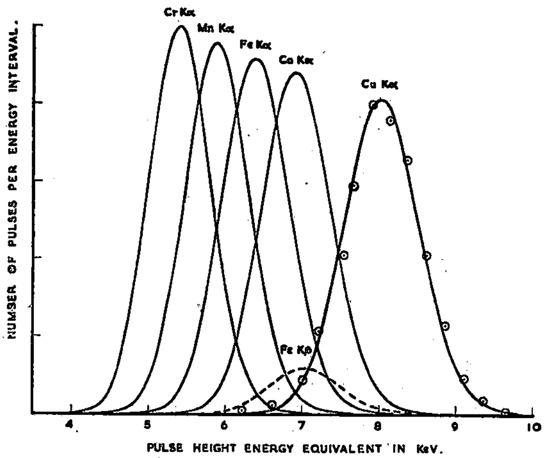

Fig. 1. Pulse height distribution curves for argon proportional counter.

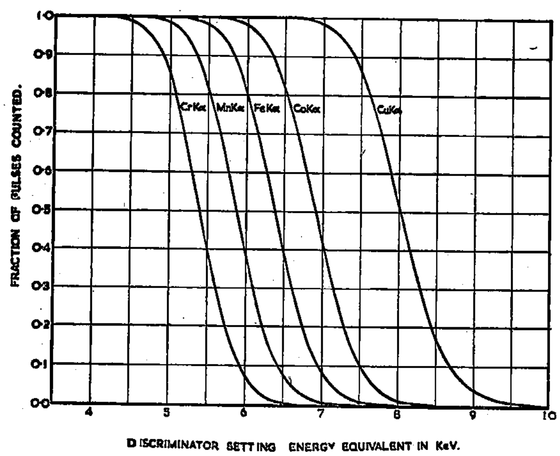

Fig. 2. Computed bias curves for argon proportional counter.

argon K fluorescent radiation in the absorption process, are not shown here since they contain only about 4% of the number of pulses in the main peak (Lang 1951). This fraction will perforce be lost when discrimination against slightly softer radiation is attempted.

From measurements on these curves, or on bias curves computed from them (fig. 2), the degree of discrimination obtainable is readily calculated. It will be seen that CrKα, MnKα and FeKα can be almost completely separated from CuKα radiation. Discrimination at 7·5 kev will pass 85% of the CuKα radiation main peak and only 10% of the CoKα radiation. FeKβ radiation can be largely excluded but not so CoKβ radiation (only the FeKβ pulse distribution is shown in the figure).

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20th February 1952.

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Arndt, U. W., and Riley, D. P., 1952, *Proc. Phys. Soc.* A, **65**, 74.
Lang, A. R., 1951, *Nature, Lond.*, **168**, 907.
Valentine, J. M., 1952, *Proc. Roy. Soc.* A, **211**, 75.