Methods of film preparation other than evaporation have been tried, such as chemical deposition and electrolysis. The films thus obtained had much higher resistivities, in some cases by factors as large as fivefold, and in this respect were comparable to films evaporated under adverse conditions.

Evaporated Cu films have been examined in greatest detail. These films, formed under optimum conditions, show large aging effects immediately after evaporation. Their resistance drops rapidly during the first few minutes, reaching an approximate equilibrium in about 1–2 hours in vacuum. These films, stored in dry air, remain essentially constant in resistance over a period of many months. Fast evaporated Cu films are highly crystallized.

Figure 1 is a plot of $(\rho'/\rho)-1$ *versus* film thickness in angstroms. The solid lines are computed from Dingle's tabulations for the case of inelastic scattering at the film boundaries using values of mean free paths l of 520 and 450 angstroms for Ag and Cu, respectively, to approximate the experimental data. This value of l for Ag is in good agreement with that calculated from Sommerfield's theory assuming N_e/N_a, the number of free electrons per atom, is unity. The experimental value of l for Cu is about 15 percent higher than calculated. It may be of practical interest to note that since these plots are nearly straight lines, Planck's[6] empirical equation, $\rho'/\rho=1+cl/t$, agrees within about five percent with the more exact theory down to thicknesses of $t=l/10$ where c is assigned an arbitrary value of 0.4.

Resistance-temperature coefficients α' have been determined for these fast evaporated films. Results for Cu and Ag are given in Fig. 2. The solid lines are calculated, and the circles represent

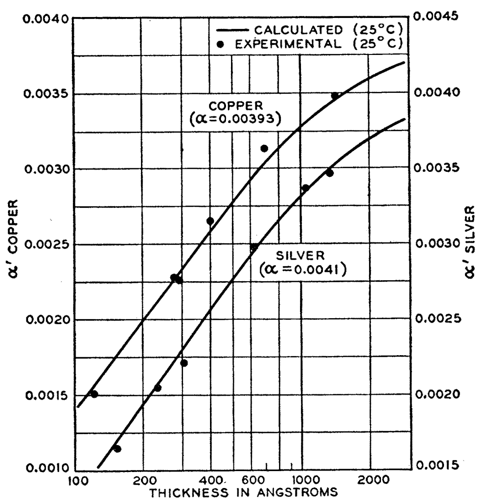

FIG. 2. Comparison of measured and calculated resistance-temperature coefficients.

experimental points. These calculations are based on the assumption that $\rho'\alpha'=\rho\alpha$, where ρ, α are the bulk values, and ρ', α' are the corresponding film quantities. Films not deposited under optimum conditions have smaller values of α' than indicated by these curves. Such films have larger values of ρ' than normal, but the product $\rho'\alpha'$ remains essentially constant for a given metal, indicating that Matthiessen's rule is followed.

The following bulk metal values at 25°C have been used in the calculations:

	ρ(Microhm-cm)	α(deg C^{-1})
Ag	1.623	0.0041
Cu	1.705	0.00393

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The Geometrical Correction in Angular Correlation Measurements*

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THE presence of the effects of mixtures of multipole radiations and disturbing extra-nuclear fields in angular correlation studies necessitates an accurate evaluation of the correlation function. The largest correction that must be applied to the experimental data before an appropriate analysis can be made is that due to finite instrumental angular resolution. The problem of accounting for such effects has been discussed by Walter *et al.*,[1] Frankel,[2] and Frauenfelder.[3] The object of the present note is to present a simple procedure for correcting the data directly in terms of the experimental resolution curve and to indicate that the corrections so introduced are greater than has heretofore been assumed. The method outlined, an extension of the procedure of Frankel, is applied to a particular case and verified at two different geometries. The corrections are found to be large and sensitively dependent on the shape of the resolution curve.

The directional correlation function for a $\gamma-\gamma$ cascade may be written in the form

$$W(\theta)\equiv N(\theta)/N(\tfrac{1}{2}\pi)=\Sigma_M A_{2M}P_{2M}(\cos\theta), \qquad (1)$$

where the coefficients A are functions of the cascade parameters. The resolution curve $f(\delta)$, corresponding to a particular geometry, is determined using annihilation radiation and is conveniently expanded as

$$f(\delta)=N(\pi-\theta)=\Sigma_m B_m P_m(\cos\delta). \qquad (2)$$

Assuming the counters to be individually symmetric, the observed correlation function $W'(\theta)$ may be compounded out of (1) and (2) as

$$W'(\theta)=\int W(\theta')f(\delta')d\Omega', \qquad (3)$$

where θ,θ', and δ' are the three sides of a triangle on the surface of the unit sphere. The integral (3) can be evaluated by an application of the addition theorem for spherical harmonics as shown by Frankel.[2] One finds

$$W'(\theta)=\sum_M\left[\left(\frac{4\pi}{2M+1}\right)B_{2M}\right]A_{2M}P_{2M}(\cos\theta)\equiv\sum_M A_{2M}'P_{2M}(\cos\theta). \qquad (4)$$

The effect of finite counter geometry is therefore one of altering the original coefficients by a simple factor.

The coefficients B_{2M} are obtained by direct numerical integration over the experimental resolution curve as shown below. To within an arbitrary factor which cancels in the subsequent normalization of $W(\theta)$,

$$\left(\frac{4\pi}{1}B_0\right)=\int f(\mu)P_0(\mu)d\mu,\ \left(\frac{4\pi}{5}B_2\right)=\int f(\mu)P_2(\mu)d\mu,\ \left(\frac{4\pi}{9}B_4\right)=\int f(\mu)P_4(\mu)d\mu, \qquad (5)$$

where $\mu\equiv\cos\delta$.

If the resolution curve can be approximated by a triangular or Gaussian distribution, these coefficients can be estimated by means of the expansions[4]

$$\begin{aligned}\left(\frac{4\pi}{1}B_0\right)&=1-\genfrac{}{}{0pt}{}{6.092}{7.325}(-5)\delta_0^2+\ldots,\\ \left(\frac{4\pi}{5}B_2\right)&=1-\genfrac{}{}{0pt}{}{6.092}{7.325}(-4)\delta_0^2+\genfrac{}{}{0pt}{}{1.609}{2.930}(-7)\delta_0^4-\ldots,\\ \left(\frac{4\pi}{9}B_4\right)&=1-\genfrac{}{}{0pt}{}{1.889}{2.271}(-3)\delta_0^2+\genfrac{}{}{0pt}{}{1.460}{2.659}(-6)\delta_0^4\\ &\qquad-\genfrac{}{}{0pt}{}{0.631}{2.133}(-9)\delta_0^6+\ldots,\end{aligned} \qquad (6)$$

where δ_0 is the half-width at half-maximum of the resolution curve expressed in degrees. The upper coefficients refer to a triangular, and the lower to a Gaussian distribution.

In practice, directional correlation results are usually represented in the form

$$W'(\theta)=1+a_2' \cos^2\theta+a_4' \cos^4\theta, \qquad (7)$$

where the coefficients a' have been determined by a weighted least squares fitting procedure to the experimental data. The corresponding coefficients A' in (4) may then be determined by relationships such as those given by Lloyd.[5] After calculation of the unprimed coefficients A by the appropriate divisions of A' by (5), the data may then be returned to the original form (7) in a reverse fashion.[5]

To verify the usefulness of the above procedure, the directional correlation of Rh^{106}, with no appreciable bias on the counters, was measured with $\delta_0=6.6°$ and $12.0°$ with effectively a point source. The values of a_2 and a_4 obtained for the two cases before and after applying the calculated geometrical corrections are shown in Table I. It is seen that the correction is considerable and

TABLE I. Directional correlation coefficients for Rh^{106}.

	$\delta_0=12.0°$		$\delta_0=6.6°$		Theor. (0–2–0)	
	a_2	a_4	a_2	a_4	a_2	a_4
Uncorrected	−1.718 ±0.074	+2.294 ±0.085	−2.086 ±0.049	+2.782 ±0.056		
Corrected	−2.248	+2.921	−2.244	+2.968	−3.000	+4.000

that the adjusted values for the two geometries are in agreement within the indicated rms statistical errors.

The possible discrepancy between the measured correlation function of Rh^{106} and that expected for a 0–2–0 cascade will be discussed in a subsequent publication,[6] both in the light of the above data and the recent work of Arfken *et al.*[7]

We wish to acknowledge helpful discussions of this problem with M. Fuchs.

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High Frequency Breakdown in Neon

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The breakdown electric field in neon gas at frequencies in the 3000-Mc/sec region has been measured for a pressure range of from 0.5 mm of Hg to 300 mm of Hg. The method used is similar to that employed in the investigation of He and H_2, and the experimental equipment and procedure are described in detail elsewhere.[1-3] Spectroscopically pure neon was used. The vacuum system was such that the pressure remained at less than 10^{-6} mm of Hg for a period longer than that required for a run. The breakdown fields are shown in Figs. 1 and 2 for cylindrical cavities of heights 0.317 cm and 0.634 cm, respectively. The accuracy of the pressure measurements is one percent and of the electric field measurements five percent. On the same plots are shown theoretically derived curves. The theory is similar to that reported for helium and hydrogen[2,3] in that the electron velocity distribution function is derived as a solution of the Boltzmann Transport equation, considering diffusion to the walls to be the predominant electron loss mechanism. The changes in electron energy produced by the field and by elastic and inelastic collisions are included in the equation. The theory differs from that previously used in that the collision cross sections have different functional forms for neon, and these lead to more complicated differential equations. These equations have not yielded exact solutions over the whole pressure range. Separate approximations are made for the cases where the pressure is either higher or lower than that at which the collision frequency is equal to the radian frequency of the electric field. This is indicated by the break in the theoretical curves in the figures. As in previous theories, the derived distribution functions are combined with kinetic theory formulas and the diffusion equation to give an equation from which breakdown fields may be computed. It may be seen from the figures that these breakdown equations which use no gas discharge data other than collision cross sections predict breakdown field within the accuracy determined by these cross sections over a large range of experimental variables.

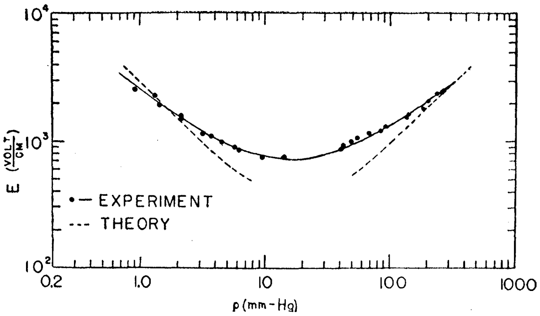

FIG. 1. Breakdown electric field in neon gas at 3000 Mc/sec. The height of the cylindrical cavity is 0.317 cm.

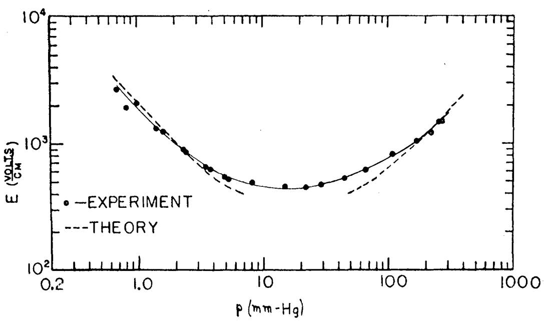

FIG. 2. Breakdown electric field in neon gas at 3000 Mc/sec. The height of the cylindrical cavity is 0.634 cm.

A detailed report, including the mathematical derivation, will be published at a later date in the Canadian Journal of Physics.

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Photomesons from the Deuteron

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The theory of Chew and Lewis[1] is applied here in the calculation of the coincidence cross section between a meson or its decay product and a recoiling nucleon of the disintegrated deuteron. It is desirable to do this in order that theory might be compared with the interesting results of Keck and Littauer[2] on π^- production and also in anticipation of possible future study of π^0's from neutrons by this method.

That P, θ_p, μ, and θ_μ, if restricted to a plane, are four independent variables follows from four-momenta conservation and velocity addition, $P\cos(\theta_p-\theta_D)=\mathbf{k}_f\cdot\mathbf{D}/D+D/2$, where $\mathbf{P}=\mathbf{k}_f$