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DETERMINATION OF SOURCE EXCENTRICITY IN ANGULAR CORRELATION EXPERIMENTS

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DETERMINATION OF SOURCE EXCENTRICITY IN ANGULAR CORRELATION EXPERIMENTS * **

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A method for elimination of source excentricity is presented, which is free from systematic errors, less affected by electronic drift and quicker in application than the usual one.

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It is well known that the presence of a small excentricity in the source position in angular correlation experiments affects seriously the correctness of the results; the source distance, r, to one of the detectors will depend upon the angle between detectors and, since the detection probability is proportional to $1/r^2$, an additional angular dependence will appear, superimposed to the true correlation.

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To cope with those effects one takes care for centering the source by trial and error, untill an isotropic angular distribution within about 1%, is obtained for an isolated line; next the data are corrected for any residual excentricity by dividing the triple coincidence counting rate by the singles counting rate at the pertinent counter [1].

That procedure is subjected to the following restrictions: a) trial and error method is time consuming; b) the accuracy in centering is usually estimated through the asymetry coefficient $(N_{180} - N_{90})/N_{90}$, and this coefficient may be zero or very small even for fairly large excentricities; c) correcting the data for residual excentricity, by taking the ratio triple-to-singles, as mentioned above, yields statistically correct and accurate estimates but leads to results which are more dependent upon electronic drift.

For those reasons we find it preferable, whenever weak correlations are involved and accurate results are required, to establish a method of successive approximations at each step of which the excentricity is accurately determined and the centering is correspondingly improved, untill the smallest excentricity compatible with the precision of the centering instrument is obtained; finally allowance is made for the residual excentricity by properly correcting the estimates of the angular correlation parameters as indicated bellow.

Excentricity Correction

Let us consider the case in which the source is fixed with respect to the fixed detector (the opposite case is treated in exactly the same way); an observer moving with the movable counter will see the source describing a circle of radius δ, as that counter spans the available angular positions, lagging behind an angle ϕ with the direction of the "fixed" detector (Fig. 1).

The detection probability for the movable detector is proportional to $1/r^2$, that is, to

$$W_f(\theta) = 1 + (2\delta/R)\cos(\theta - \phi) \; , \qquad (1)$$

to first order in δ/R.

The false correlation, W_f, modulates the true one if care is not taken to reduce δ to negligeable values: for that purpose one proceeds as follows:

1) fit the singles counting rate at the movable detector to a function of the type:

$$W_f(\theta) = 1 + b\cos(\theta - \phi) \qquad (2)$$

2) from the value of b obtained in step 1) one obtains the excentricity δ through

$$\delta = (R/2)\, b \qquad (3)$$

3) from the value of ϕ obtained in step (1) and the value of δ from (3) one can reduce the excentricity by displacing the source in the plane of the detectors by an amount equal to δ, at the direction ϕ and in the sense that brings it nearer the

center of rotation; visual inspection of the behaviour of W_f and a consideration about the location of its extreme values will indicate unambiguously the sense of dislocation. Displacements may be accurately obtained by means of an x-y micrometric device, such as the movable stage of some research microscopes.

One attains quickly a value of the excentricity whose further reduction is limited only by the accuracy with which readings can be performed with the micrometric x-y device; one allows for the residual excentricity by fitting the correlation data to a function of the type:

$$W(\theta) = \left[1 + b \cos (\theta - \phi)\right] \sum_n a_{2n} P_{2n}(\cos \theta) \qquad (4)$$

where b and ϕ correspond to the smallest value of δ.

Step 1) above mentioned can be better acomplished by fitting the observed singles counting rate to the function:

$$W_f'(\theta) = 1 + u \cos\theta + v \sin\theta \qquad (2')$$

where u and v, are related to b and ϕ in (2) through

$$b = (u^2 + v^2)^{\frac{1}{2}} \qquad (5)$$
$$\phi = tg^{-1}(v/u)$$

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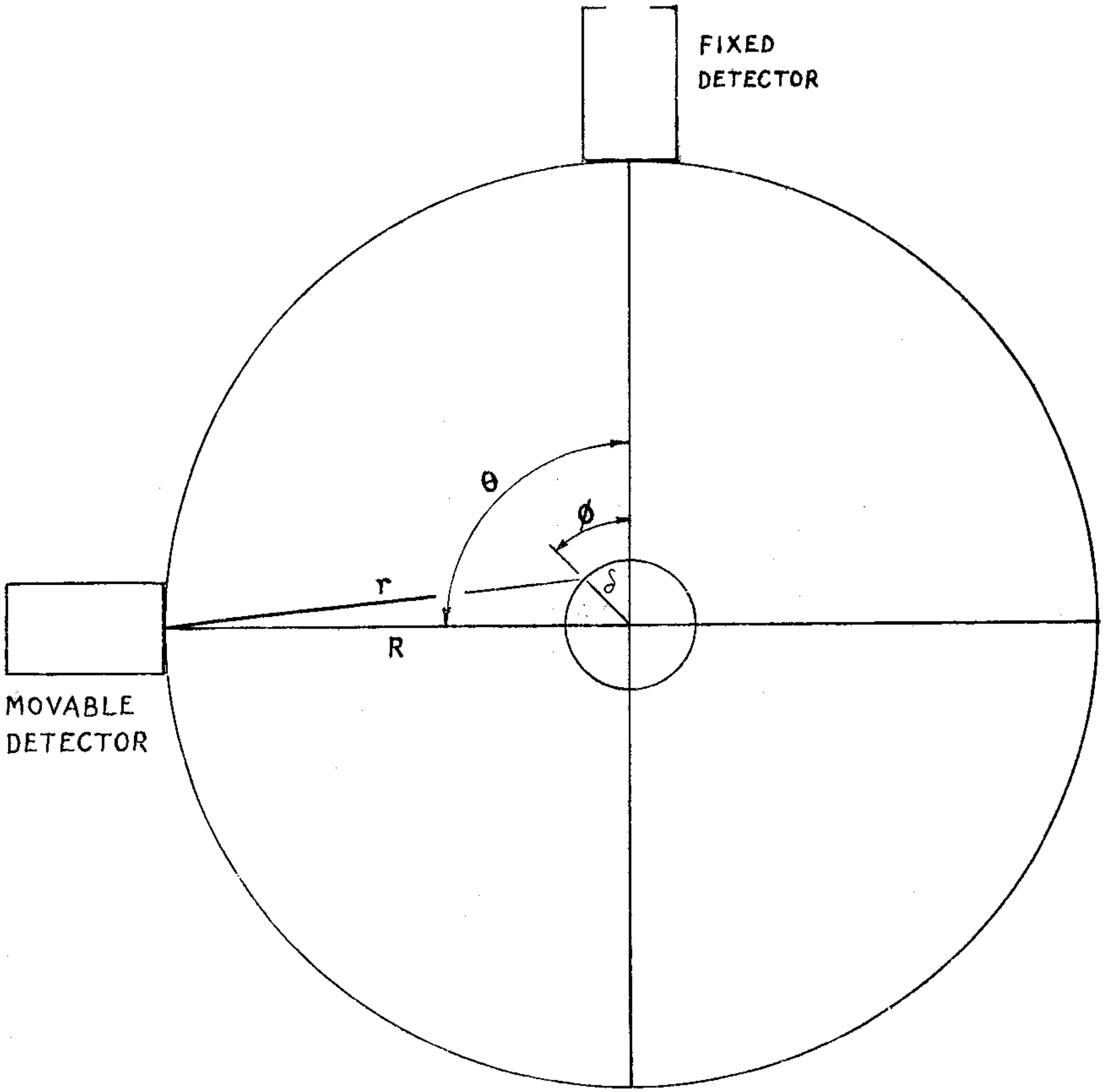
1. H. Frauenfelder and R. M. Steffen in Alpha Beta and Gamma Ray Spectroscopy, edited by K. Siegbahn, North Holland 1965.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