the phase and amplitude in the forward direction, using Kirchhoff's diffraction formula, for each zone. Some of the results are shown in the accompanying table. The value of K calculated for the first maximum is 3·66 compared with 3·8 from electromagnetic theory[4,5]. Considering that elementary diffraction theory is not expected to be very exact for particles only $3\lambda/2$ in diameter, the agreement is fairly satisfactory.

Values of $2\pi r/\lambda$ corresponding to Successive Maximum and Minimum Values of K, for Water Drops

	Max.	Min.	Max.	Min.	Max.
Calculated from equation 1	4·7	9·4	14·1	18·8	23·5
Calculated by Lothian and Chappel[3]	5·0	10·0	14·7	20	25
Calculated from electromagnetic theory	6·2	11·6	16	21	

The name for the coefficient K is not yet generally agreed. Different authors[1–5] have used the terms 'extinction', 'scattering area coefficient' and 'total scattering coefficient'. It is suggested that the first term should be avoided because it is generally used—in Great Britain at least—to denote the quantity $\log_{10}(1/t)$. I myself prefer the term 'total scattering coefficient'.

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[1] Paul, W., and Jones, R. V., *Nature*, **168**, 554 (1951).
[2] Van de Hulst, H. C., *Recherches Astr. de l'Observ. d'Utrecht*, **11**, Pt. 1 (1946).
[3] Lothian, G. F., and Chappel, F. P., *J. App. Chem.* (in the press).
[4] Houghton, H. G., and Chalker, W. R., *J. Opt. Soc. Amer.*, **39**, 955 (1949).
[5] Lowan, A. N., *Nat. Bur. Stand., App. Maths. Ser.*, No. 4 (1949).

Calculation of χ^2 for a 2×2 Table

SEVERAL algebraically equivalent methods are in use for calculating χ^2 for a 2×2 contingency table; but there is one attractive algorithm that does not seem to have been described. Write the table and its marginal totals in the usual notation:

a	b	$a + b$
c	d	$c + d$
$a + c$	$b + d$	N

where $N = a + b + c + d$. Let A be the difference between the two observed ratios when the table is read across, so that

$$A = a/(a + b) - c/(c + d).$$

Similarly, let D be the difference when the table is read downwards, so that

$$D = a/(a + c) - b/(b + d).$$

Then it can be shown that

$$\chi^2 = ADN.$$

The computer may write in the four ratios instead of, or in addition to, the marginal totals. This method is easily memorized, leads to a simple computation, and has the advantage of bringing prominently to notice the actual ratios being compared. To apply the Yates correction, add or subtract 0·5 in the usual way before calculating A and D.

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Enhancement of the Normal Reversion-rate of a Serineless *Escherichia coli* Mutant by Certain Organic Acids

SOME mutant genes involving loss of function are known to be capable of reversion at the specific locus; this fact implies that in mutant organisms particular genes are not necessarily destroyed, but may be merely altered, or 'inactivated' with respect to the specific reaction they once controlled. The gene is, so to speak, in an inactive allelic state—but one which can revert or back-mutate to the active allelic state of the wild-type parent. Can environmental conditions other than general mutagenic agents enhance the reactivation of a mutated gene to its original allelic state? It is conceivable that the presence of certain common metabolites, the configuration of which is related to the damaged enzyme – gene system, might, by some as yet unknown mechanism, have such an influence. In various connexions, 'substrate-induced mutations' have been previously discussed[1–3].

It has been found that the normal back-mutation rate of a mutant of *E. coli* (*P.A.*1.5), requiring either serine or glycine, is strikingly enhanced in the presence of certain organic acids not serving as substitutes for serine, but sharing the configuration $\left(\begin{array}{c}\text{COOH}\\ |\\ \text{CHOH}\\ |\end{array}\right)$ namely, 3-phosphoglyceric, glyceric, lactic, tartaric and malic acids. Malate is apparently the least active. Natural D(+) tartaric acid is active; the L(−) form is inactive. The reversions in the presence of these acids give rise to cell types both partially and fully independent of serine or glycine. In control experiments with other acids (or none) the great majority of reversions are to full independence, or wild type; intermediate types are rare.

The fluctuation test of Luria and Delbrück[4] for determining mutation-rates was used. Forty 2·5–3·0 ml. cultures were shaken at 37° C. in 20-ml. Freudenreich flasks for 39 hr. Control cultures, as well as cultures containing glycerate, lactate, etc., contained a glycerol-minimal medium, pH 6·2, supplemented with an amount of glycine in slight excess of that necessary for maximum growth of the (inoculated) dependent mutant. This mutant grows in such a medium with about the same generation time (1·5–2·0 hr. at 27° C.) as does the reverted, fully or partially independent cell type. Plating 1-ml. samples from the individual cultures (20 experimental and 20 control) to minimal agar revealed the numbers of independent cells which had arisen and multiplied during incubation.

The results of a typical experiment are given in the accompanying table; essentially the same results are obtained if (1) each culture is centrifuged, the cells washed, and plated to purified agar; (2) the same amount of tartrate which is transferred to the plates from the primary experimental cultures is also added to the control plates. Therefore, selective survival of mutants on the plates due to the transfer of tartrate, glycerate, or some unknown substance does not occur. Microscopic examination at various times of regions with no reversions on the control and experimental plates reveals no differences with respect to cell density or distribution. Reverted types are referred to as fast, intermediate, or slow synthesizers, depending upon their ability to