AIP Journal of Applied Physics

Energy Transference between Wave Numbers in Isotropic Turbulence

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Citation: Journal of Applied Physics **23**, 698 (1952); doi: 10.1063/1.1702284
View online: http://dx.doi.org/10.1063/1.1702284
View Table of Contents: http://scitation.aip.org/content/aip/journal/jap/23/6?ver=pdfcov
Published by the AIP Publishing

a highly insulating binder, such as polystyrene dissolved in benzene. Preliminary experiments were made by the author with such a condenser consisting of ten layers with a thickness of 10 mm and an effective area of 4×4 cm^2. The condenser was mounted in a paraffin-filled aluminum box in order to avoid ionization of the surrounding air.

In a preliminary experiment x-rays were pulsed (60/sec) and their intensity was reduced by large distance, small tube current, and filtering (13 mm Al) to 0.001 R/min. The condenser was charged with 250 volts over 2.5 megohms. The signal due to the periodic change in capacity of the condenser was preamplified (500 times) and observed at an oscilloscope. It amounted to 160 microvolts corresponding to a capacity change of 0.57×10^{-6}. In a similar experiment 50 R of gamma-irradiation (radium) changed the capacity (3040 $\mu\mu f$) of a condenser ($50\times60\times11$ mm) by 30 $\mu\mu f$, as measured by a capacity bridge.

If the condenser is exposed to strong irradiation (about 1000 R), the occupancy of the traps and the change in capacity reaches a saturation value and therefore the ac signal, caused by the intermittent irradiation, disappears completely. The traps in the phosphor discharge almost completely in about one day, and then the original state of the condenser is restored. It is well known that the discharging of the traps can be accelerated by heating of the condenser (250–300°C), but in this case the phosphor has to be used without a polystyrene binder.

The excitation process itself, i.e., the lifting up of electrons into the conduction band and filling of the traps, does not have any time lag. Therefore, also pulses of gamma-radiation of a few microseconds duration, produced by beta-ray pulses of accelerators, should be effective in such receivers. The experiment mentioned was undertaken with a wide band amplifier; the sensitivity of the receiver can be greatly increased by tuned amplification using narrow bands.

Such receivers can be used with x-rays and beta-rays, which do not affect phosphors. It is obvious that in such condensers cadmium electrodes can be used for the detection of neutrons, as has been proposed for the combination of crystal phosphor and photomultiplier.[3] Also experiments with lead foils inserted for the production of pairs seem to be possible with such condensers. If the radiation is not periodically chopped, the change in dielectric constant can be measured with a heterodyne circuit of high sensitivity. It is even possible, if the decay curves of the dielectric change are determined for all energy levels, to measure the change in capacity at a given time after the irradiation and to extrapolate to the value obtained during the irradiation.

It is intended to continue this investigation.

The author wishes to express his thanks to the General Electric X-ray Department, Milwaukee, Wisconsin for the loan of the x-ray apparatus and to E. I. duPont de Nemours and Company, Towanda, Pennsylvania for help in selecting the phosphor used.

* This work is sponsored by the Bureau of Ships, Department of the Navy, Washington 25, D. C.

[1] See G. F. J. Garlick, *Luminescent Materials* (London, 1949), pp. 130 *ff*.
[2] L. Wesch, Ann. Physik. 40, 263 (1941).
[3] W. H. Jordan and P. R. Bell, Nucleonics 4–5, 30 (1949).

Intensity Calculation for Determining Weight Percentage in a Binary Alloy by X-Ray Fluorescent Analysis

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(Received March 17, 1952)

THE difficulties encountered in the theoretical calculation of fluorescent intensity for the determination of the percentage of a component element in metallic alloys have been enumerated in a paper by the writers.[1] When a binary alloy consisting of two neighboring elements in the periodic table is concerned, the effect of mutual excitation, absorption edge, and difference in absorption becomes insignificant so that a simple calculation gives weight percentages of the alloying elements in good agreement with chemical analysis.

Table I.

Specimen	$\dfrac{I_{K\alpha}\text{ Cobalt}}{I_{K\alpha}\text{ Iron}}$	Calculated atomic percent Fe	Calculated atomic percent Co	Calculated wt percent Fe	Calculated wt percent Co
Small crystal	2.066	32.33	67.67	31.17	68.83
Tape	1.883	34.39	65.61	33.19	66.81
Comparison standard	1.002	49.60	50.40	48.25	51.75
Chemical analysis of comparison standard:		Fe 48.80 weight percent Co 50.59 weight percent			

An occasion arose when it was necessary to compare the cobalt content of two iron-cobalt alloys; one in the form of a $3\times3\times0.1$ mm small single crystal, and the other, 5×0.1 mm thin tape. Since it was essential that the specimen be preserved in the original form, no microchemical technique could be used.

An iron-cobalt alloy of known chemical analysis was used as a standard of comparison. The intensity ratio of $Co_{K\alpha}$ to $Fe_{K\alpha}$ on each specimen was obtained under identical operating conditions. The intensity in counts per second was the average of several readings obtained by scaling at $\frac{1}{2}$ to 2 percent relative probable error (16,384 to 1024 total counts, respectively).

The relative excitation efficiency of cobalt *versus* iron was obtained as follows:

$$\frac{\text{(excitation efficiency) cobalt}}{\text{(excitation efficiency) iron}}=\frac{I_{K\alpha}\text{ (remelted carbonyl cobalt)}}{I_{K\alpha}\text{ (electrolytic iron)}}=0.987.$$

The atomic percentage of Fe in the Co-Fe alloys was calculated according to the following equation:

$$\mathrm{Fe}\left(\frac{I_{K\alpha}\text{ cobalt}}{I_{K\alpha}\text{ iron}}\times\frac{1}{0.987}+1\right)=100.$$

The results in Table I show the validity of the preceding equation.

[1] P. K. Koh and Betty Caugherty, J. Appl. Phys. 23, 427 (1952).

Energy Transference between Wave Numbers in Isotropic Turbulence

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ONE of the most important features of turbulent motion is the energy transference between different ranges of wave numbers. Experimental information on this subject has recently

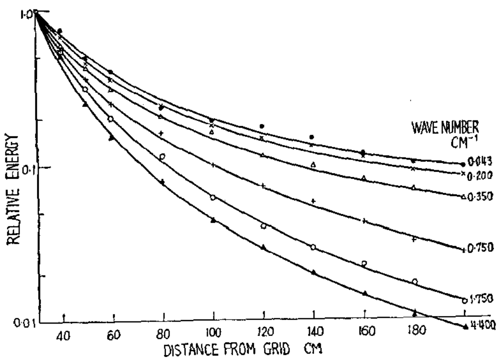

Fig. 1. Decay of spectral components.

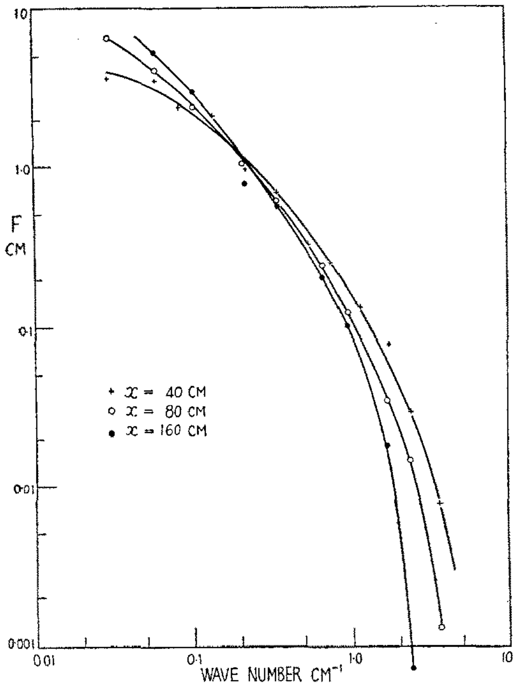

FIG. 2. One-dimensional spectrum of $\bar{u}^2$.

been obtained by measuring the triple correlation of velocity fluctuations.[1] It is possible, however, to estimate the transference directly from energy spectrum. With usual notations, the Fourier transform of Kármán-Howarth's equation of correlation propagation is

$$\frac{\partial}{\partial t}(\bar{u}^2F)+2(\bar{u}^2)^{\frac{1}{2}}W(k)=-2\nu\bar{u}^2\left(Fk^2+4\int_k^\infty Fkdk\right), \qquad (1)$$

where k the wave number, F the one-dimensional spectrum of $\bar{u}^2$, and W is the energy transference function. The first term on the left side may be derived from measurement of decay of spectral components, an improved method being proposed by the present author.[2] Terms on the right side may be obtained from the measured curve of spectrum.

Experiments were made in a closed wind tunnel with a grid of 1-in. mesh length and at a wind speed of 10 m/s. Relative energy of spectral components was observed by traversing hot wire longitudinally with tuning frequency of filter fixed (Fig. 1). Decay of components is found to become more severe as the wave number increases, whereas a somewhat complicated tendency was observed in a previous study,[2] where the measurements were carried out in an open jet-type wind tunnel. Figure 2 shows the energy spectrum obtained at various positions, from which we estimated terms on the right side of Eq. (1). From faired curves of results, the energy transference is determined as Fig. 3, where positive value of W denotes flow-out of energy and negative value flow-in. It is seen that the wave numbers of no transference as well as of maximum flow-in decrease wtih decay of turbulence. Integral $\int_0^\infty Wdk$ becomes nearly zero, indicating the reliability of results.

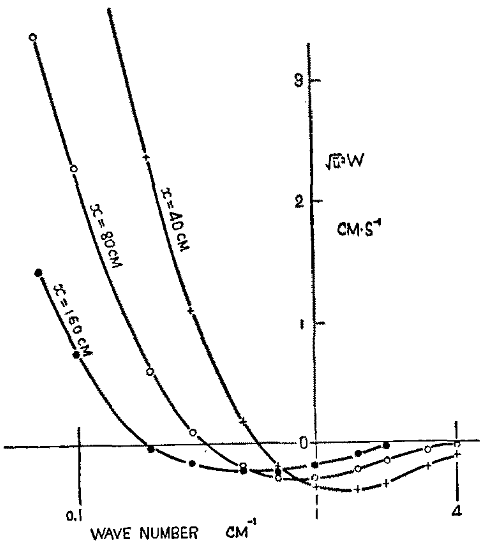

FIG. 3. Energy transference between wave numbers.

The author wishes to thank Professor I. Tani and Professor H. Kumagai for their valuable advice.

[1] R. W. Stewart, Proc. Cambridge Phil. Soc. **47**, 146 (1951).

[2] H. Sato, J. Appl. Phys. **22**, 525 (1951); H. Sato, J. Phys. Soc. (Japan) **6**, 387 (1951).

Dielectric Image Line

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(Received March 19, 1952)

THE behavior of dielectric rods as wave guides has been discussed both experimentally and theoretically.[1,2] It is the purpose of this note to describe a modification of the dielectric wave guide which offers several important advantages over the simple rod.

Inspection of the theoretical expressions for the fields in a rod excited in the lowest or dipole mode shows that the distribution possesses a plane of symmetry. This permits the use of a half-round rod and an image plane, as shown in Fig. 1.

The extent of the field is determined by the ratio of conductor diameter to the wavelength. The percent power within a radius b for a dielectric rod of radius a is shown in Table I for the case $2a/\lambda_0=0.282$.

TABLE I.

b/a	3.5	10.6	35.5
%	30.5	82.5	99.9

For relatively thin rods such as this, most of the power is carried outside the rod, and the field intensities are, therefore, relatively low. The losses in the dielectric, and in the image conductor are minimized by the resulting low displacement and conduction current densities.

A polystyrene image line with $2a=0.42$ cm for use at $\lambda_0=1.23$ cm was constructed on a dural image surface 20 cm wide. A resonator was obtained by mounting 10×20 cm vertical end plates on the image surface. Holes in the base of the end plates permitted the polystyrene half-round rod to pass through the end faces. By measuring the Q of this resonator as a function of line length, the attenuation was determined as 31.5db/100 ft.

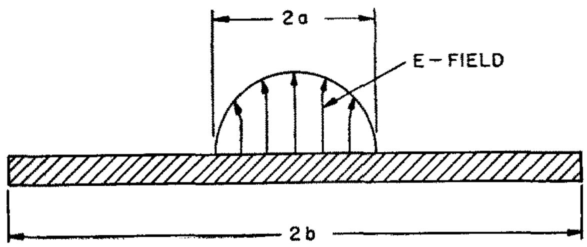

FIG. 1.