of one of the authors (R.T.E.), based on the results of a single experiment, that there was no great difference between the degree of excitation produced by a combination of alpha- and beta-particles and the excitation produced by the same source with the alpha-particles removed. Others at the conference maintained that beta-particles are completely ineffective and that only the alpha-particles produce excitation.

The experiment has been repeated here with considerable care; the results are shown in Fig. 1. The crosses show the increase in brightness, measured under constant, low intensity infra-red radiation of a Standard VII sample excited for various times by a source consisting of a radium salt on a metal plate covered by a gold foil thin enough to allow alpha-particles to pass through it. The foil serves to contain the products of disintegration, and the excitation in this case is due to a combination of alpha- and beta-particles. The circles show the increase in brightness of the same sample excited by the same source, but with the alpha-particles removed by an absorber. As is evident from the curve, the beta-particles produce a final brightness about three-fourths as large as the combination source does. The thickness of the paper absorber used was fifty percent greater than that needed to remove all alpha-particles, as shown by the rate of discharge of an electroscope. This absorber removed about thirty percent of the beta-particles also. It may be significant that the fraction of the beta-particles removed by the absorber is about equal to the fractional decrease in the brightness with the absorber over the exciting source. In any case, there seems to be no doubt but that beta-particles are effective in exciting the Standard VII phosphor.

The phosphor sample used was supplied to us by Professor R. Ward of the Polytechnic Institute of Brooklyn, to whom we are greatly indebted. We wish also to acknowledge the assistance of Mr. Paul Hansen, who made the absorption measurements, and Mr. Robert Scott, who built the electron multiplier apparatus with which the brightness measurements were made.

* Supported by the Office of Naval Research.

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Extension of Crocco's Theorems to Flows Having Non-Uniform Stagnation Enthalpy*

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November 28, 1947

TWO remarkable theorems relating the vorticity and pressure in plane and in axially symmetric steady flow of an ideal gas (non-viscous, thermally non-conducting, with constant specific heats) in the absence of body forces have been established by Crocco.[1] The first theorem states that the pressure and vorticity are proportional along each streamline of a plane flow in a region between two shock fronts. The second theorem states that the vorticity and the product of pressure and radial distance are proportional along each streamline of an axially symmetric flow in a region between two shock fronts.

As has been shown by Vazsonyi[2] and Emmons,[3] these theorems are valid only for flows of uniform stagnation enthalpy ("tank" flows). However, in terms of the reduced velocity field $\bar{w}$ defined by

$$\bar{w}=v/v_{\text{ultimate}}=\bar{v}/[2\gamma/(\gamma-1)][p/\rho]+v^2$$

(where $\bar{v}$ denotes the actual velocity vector, γ the adiabatic exponent, p the pressure, and ρ the density) more general theorems are valid:

Theorem 1: Along each streamline of any steady, plane flow of an ideal gas in the absence of body forces, the pressure is proportional to the vorticity of the reduced velocity field in a region between two shock fronts.

Theorem 2: Along each streamline of any steady, axially symmetric flow of an ideal gas in the absence of body forces, the vorticity of the reduced velocity field is proportional to the product of the radial distance and the pressure in a region between two shock fronts.

These extended theorems are readily established by recourse to the substitution principle established by Munk and Prim.[4] First, for any *tank flow* the extended theorems are valid by virtue of Crocco's theorems and the simple proportionality between reduced velocity and actual velocity in a tank flow. Second, by the substitution principle, for any steady flow of an ideal gas in the absence of body forces there exist *tank flows* having the *same streamline pattern, reduced velocity field, and pressure distribution.* Since the extended theorems are valid for these substitute tank flows, they are valid for the original flow as well.

In the paper cited above, Crocco establishes the differential equations for stream functions for steady plane and axially symmetric gas flows having a uniform stagnation enthalpy. An argument paralleling that used above easily shows that these stream-function equations are also valid for flows of non-uniform stagnation enthalpy.

Alternative proofs to those employed here can be constructed by formal vector manipulations.[5]

* This generalization was undertaken at the suggestion of P. F Nemenyi.

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[2] A. Vazsonyi, "On two-dimensional rotational gas flows," Bull. Am Math. Soc. 50, 188 (1944).
[3] H. W. Emmons, "The numerical solution of compressible fluid flow problems," NACA TN932, pp. 24–25, May 1944.
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Ultraviolet Transmission of "Counting" Diamonds

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December 1, 1947

DIAMONDS that exhibit crystal counting properties are relatively rare. It has been observed thus far that gamma-ray counting diamonds are "water-white," but this quality in itself is not sufficient to guarantee counting properties. Van Heerden,[1] who first demon-

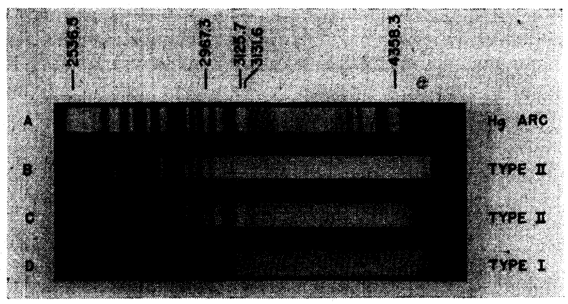

FIG. 1. Spectral transmission of Type-I and Type-II diamonds. A. Mercury spectrum from H-4 lamp. B. Transmission of Type-II diamond (borrowed from Bureau of Standards). C. Type-II diamond (NRL). D. Type-I diamond.

strated the phenomenon of crystal counting in AgCl, experimented unsuccessfully with a diamond of gem quality. Curtiss and Brown[2] recently examined 100 industrial diamonds out of which only two responded well to gamma-rays. This experience has since been duplicated at this and other laboratories. In the experiments reported thus far no comparisons of other physical properties of counting and non-counting diamonds were included.

The existence of two types of diamonds, one much rarer than the other, was described by Robertson, Fox, and Martin, in 1934.[3] The rarer type, which they designated Type II, is characterized by transparency in the ultraviolet down to $\lambda 2250$, and in the infra-red at 8μ. Type I, the common variety, is opaque below $\lambda 3000$ and also at 8μ. Among all the physical properties examined by Robertson and his colleagues, the most striking difference between the two diamond types was this greater optical transparency of the rare Type II. Type II also exhibited much greater photo-conductivity and was more nearly optically isotropic. As evidence of the rareness of Type-II diamonds, they remark that, following the discovery of their first Type-II diamond, between two and three hundred diamonds were examined without another being found transparent in the ultraviolet. We have examined a number of counting diamonds, sorted out of a collection of industrial diamonds at this laboratory and one borrowed from L. F. Curtiss of the National Bureau of Standards, for transparency in the ultraviolet. The diamonds were also tested here for their counting characteristics. The amplitude of the largest pulses in Curtiss' diamond was about 50 microvolts,[2] which was roughly 10 times background noise as observed without equipment; those in the best NRL diamond were only 5 times background.

Figure 1 shows the mercury line spectrum of an H-4 lamp, together with the spectral transmission of the two best counting diamonds and the corresponding transmission of a non-counting diamond, which was typical of ten examined. The ten non-counting diamonds each showed a similar abrupt absorption below $\lambda 3000$, whereas, the two best counting diamonds transmitted well below $\lambda 2536$. Two relatively poor counting diamonds showed correspondingly faint transmission in the ultraviolet, beyond the limit exhibited by non-counting diamonds. From this correlation between counting and ultraviolet transparency, it appears that the counting characteristic is another exclusive property of the Type-II diamond.

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The Beta- and Gamma-Spectra of Ga^{72} *

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THE beta- and gamma-spectra of Ga^{72} have been investigated with a thin lens spectrometer. The results are given in Table I where a parenthesis means that the line intensity is so close to the statistical fluctuations that its existence is not certain. The energies are accurate to better than two percent, while the relative intensities are probably accurate to twenty percent except for the two highest energy beta-ray groups and the very weak gamma-ray lines. The large uncertainty in the intensities of the two highest energy beta-particle groups arises from the assignment to these groups of the particles associated with an additional apparent end point at 1.48 Mev with an apparent abundance of 10.5 percent. The intensity of the most intense gamma-ray line (0.84 Mev) has been arbitrarily taken as 100 percent in the table. The four most intense gamma-ray lines have been previously reported.[1–3] The four beta-ray groups are in qualitative agreement with the absorption results of Siegel and Glendenin.[4]

Although a complete decay scheme cannot be given on the basis of these spectra, the four most intense gamma-ray lines can be assigned with very little uncertainty as shown in the accompanying partial decay scheme (see Fig. 1). The assignment of the 0.84-Mev gamma-ray to a position in series with all or nearly all of the transitions is necessitated both by its very high intensity and by the value of 2.6 Mev of gamma-ray energy per beta-particle given by Barker,[5] which is in good agreement with the beta-ray energies and intensities of Table I, provided the 1.48-Mev group is not considered real. The four weak gamma-rays probably all help to make up the fourteen percent discrepancy between the 0.64-Mev beta-ray group and the 2.51-Mev gamma-ray line. Considering energy alone the

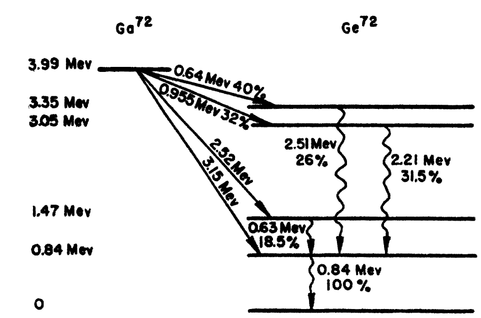

FIG. 1. A partial decay scheme of Ga^{72}.