

relative to one another about the central bond, as suggested by Grubb and Kistiakowsky; furthermore, as can be seen from Table 3, resolution of disubstituted dianthrones into optical isomers will not necessarily be sufficient to decide the exact molecular shape of this type of compound.

We wish to thank Drs. L. Haskelberg and J. Szmuszkowicz for samples of 1:4:5:8-tetraphenyl naphthalene and 3:4:5:6-dibenzphenanthrene respectively, both of which were prepared by new syntheses. Full details of this work will appear elsewhere.

E. HARNIK  
F. H. HERBSTEIN  
G. M. J. SCHMIDT

Department of X-Ray Crystallography,  
Weizmann Institute of Science,  
Rehovoth, Israel. March 4.

- <sup>1</sup> Bell, F., and Waring, D. H., *J. Chem. Soc.*, 2689 (1949).  
<sup>2</sup> Newman, M. S., and Wheatley, W. B., *J. Amer. Chem. Soc.*, **70**, 1913 (1948).  
<sup>3</sup> Herbstein, F. H., and Schmidt, G. M. J., *Bull. Res. Council, Israel* (in the press).  
<sup>4</sup> Iball, J., *Z. Krist.*, (A), **100**, 234 (1938).  
<sup>5</sup> Schönberg, A., and Asker, W., *Chem. Rev.*, **37**, 1 (1945).  
<sup>6</sup> Grubb, W. T., and Kistiakowsky, G. B., *J. Amer. Chem. Soc.*, **72**, 419 (1950).  
<sup>7</sup> Theilacker, W., Kortum, G., and Friedheim, G., *Ber.*, **83**, 508 (1950).  
<sup>8</sup> Wilson, A. J. C., *Acta Cryst.*, **2**, 318 (1949).  
<sup>9</sup> Howells, E. R., Phillips, D. C., and Rogers, D., *Acta Cryst.*, **3**, 210 (1950).

### Fourier Synthesis by Optical Interference

THE expression of the electron density in a crystal as a Fourier series is the mathematical equivalent of the process of image formation by light waves in an optical instrument. Thus, if the X-ray diffraction data can be converted into appropriate light waves, it should be possible to produce an image of a crystal optically instead of by the more arduous process of calculation. Making use of this idea, Bragg<sup>1</sup> produced an image of the projection of the crystal diopside,  $\text{CaMg}(\text{SiO}_3)_2$ , on the (010) plane.

This crystal, however, provides only a special case, in that no phase differences exist between the scattered waves. Buerger<sup>2</sup> has solved the problem of introducing phase differences by the use of mica plates, tilted to produce the required retardation. Marcasite,  $\text{FeS}_2$ , the crystal to which he has applied the method, is centrosymmetrical, and so the phase differences in the scattered beams are either 0 or  $\pi$ ; thus mica plates need be placed only in certain of the interfering beams, and only a fixed tilt is required.

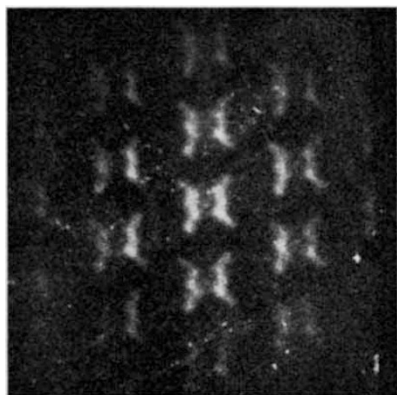


Fig. 1. Optical synthesis of durene

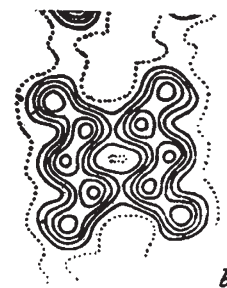


Fig. 2(a) One molecule from Fig. 1 enlarged  
Fig. 2(b). Electron density map for comparison with Fig. 2(a)

We have made use of another method which, although it can be used only for centrosymmetrical crystals, appears to us to be simpler and more easily adaptable to experimentation. An opaque plate is drilled with equal holes at the points of the reciprocal lattice section of the crystal; in each hole is placed a small tube fitted with a disk punched from an optically uniform sheet of mica, and the whole is viewed through crossed nicols. Each mica plate transmits an intensity of light depending upon its orientation, and thus each may be turned to transmit an intensity proportional to the intensity of the corresponding X-ray reflexion. It may easily be shown that the amplitude of the transmitted light is proportional to  $\sin 2\phi$ , where  $\phi$  is the angular displacement of a disk from one of its extinction positions; thus, on passing through  $\phi = 0$  the amplitude changes sign, and in this way phase changes of  $\pi$  can be simulated.

We have applied the method to the data given by Robertson<sup>3</sup> for durene, and the result, together with the calculated electron-density map for comparison, is shown in Figs. 1 and 2. Although the representation is not perfect, the molecule is quite recognizable, and the method would certainly serve to distinguish between possible and impossible combinations of signs.

A more complete account of the method, together with plans for obtaining a clearer image, and for making use of it in crystal-structure determination, will be published elsewhere.

A. W. HANSON  
C. A. TAYLOR  
H. LIPSON

Physics Department,  
College of Technology,  
Manchester 1.  
May 1.

<sup>1</sup> Bragg, W. L., *Nature*, **143**, 678 (1939).

<sup>2</sup> Buerger, M. J., *J. App. Phys.*, **21**, 909 (1950).

<sup>3</sup> Robertson, J. M., *Proc. Roy. Soc., A*, **141**, 594; **142**, 650 (1933).

### Cold Emission of Electrons in Spark Gaps

STUDIES<sup>1,2</sup> of sparks in short gaps have shown that under suitable conditions breakdown can occur within times, after the application of the gap voltage, which are considerably smaller than those expected if the initial ionization in the gap were due only to natural processes such as natural radioactivity, cosmic rays, or the break-up of gaseous ions. It is clear, therefore, that there must be another source of initiatory electrons. There is, however, considerable doubt concerning the nature of these sources, and the mechanism of electron liberation from them.