TABLE I. *Values of μ/ρ.*

Source	Absorbing Screen		
UX_2	Celluloid	Range (mg/cm^2)	0 – 116 – 300 – 460 – 600 – limit of β-ray
		μ/ρ	3.6 5.3 6.6 8.2 10.1
UX_2	Al	Range (mg/cm^2)	0 – 70 – 160 – 385 – 610 – limit of β-ray
		μ/ρ	4.2 4.8 6.0 7.4 8.9
UX_2	Cu	Range (mg/cm^2)	0 – 75 – 230 – 470 – limit of β-ray
		μ/ρ	3.1 6.3 7.4 9.2
RaE	Celluloid	Range (mg/cm^2)	0 – 170 – limit of β-ray
		μ/ρ	16.6 19.7
RaE	Al	Range (mg/cm^2)	0 – 200 – limit of β-ray
		μ/ρ	16 19.4
RaE	Cu	Range (mg/cm^2)	0 – limit of β-ray
		μ/ρ	19

different to the condition of measurement. When the absorbers are thin, the material of the disk, upon which the UX preparation is placed and which acts as a reflector of the radiations, is quite influential for the determination of μ. Disks made from heavy and thick materials give large values of μ, and lighter materials give smaller ones.

The absorption screens were placed on a cylindrical support, which on account of its simultaneous action as a canalizer, is mostly responsible for the alteration of the values of μ under various conditions. According to our experiments, the slopes of absorption curves are usually more flat, especially at large thickness of absorbers, when made with thin screen supports so that the complete logarithmic absorption curve shows only four segments; while it shows five segments with increased values of μ when made with thicker screen supports. However no indication of further increase of μ is observed if the support is thicker than 800 mg/cm^2. The radius and the material of the screen support have no appreciable effect on μ.

The distance between the active source and the screen (that is, the height of the screen support) and that between the former and the window of the ionization chamber, play also a considerable role in the value of μ thus determined especially when the screen is not thicker than 150 mg/cm^2. Low screen supports or large distances between the source and the ionization chamber often give small values of μ.

The variation of μ with measuring conditions and the resolution of the complete absorption curve into segments occur in using copper or celluloid screens as well as in using aluminum screens, but with different values. It is independent of the instrument used in measuring and of the method applied. The same phenomenon also happens when RaE is used instead of UX_2.

If a sufficiently thick ebonite disk is used to hold the source, if the screen support is 6 mm high and is thicker than 800 mg/cm^2, and if the preparation is about 4 cm distant from the ionization chamber, Table I shows the different values of μ/ρ of UX_2 and RaE.

It is worth while to note that the value of μ/ρ as obtained by most observers is very near to the mean value of those given above.

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[1] J. A. Gray, Proc. Roy. Soc. **A87**, 487 (1912).

[2] Kovarik and McKeehan, Physik. Zeits. **15**, 434 (1914).

[3] V. Douglas, Roy. Soc. Canada Trans. **16**, Section 3, 113 (1922).

[4] Geiger, Trans. Faraday Soc. **5**, 505 (1910); Jungfeld, Physik. Zeits. **14**, 507 (1913).

[5] A. F. Kovarik, Phys. Rev. [2] **3**, 150 (1914); Phys. Rev. [2] **6**, 419 (1915).

Temperature Study of X-Ray Diffraction by Diamond

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SIR C. V. Raman and Dr. P. Nilakantan have recently[1] suggested that observations on the temperature changes in the intensity of diffuse diffraction by diamond should provide a crucial test as to whether the optical or acoustical vibrations are involved in the occurrence of such diffraction in crystals generally. They also state that, in fact, the intensity of the diffuse maxima found for diamond is practically unaffected by cooling the crystal down to liquid air temperatures.

We have shown,[2] by experiment on a number of diamonds kindly provided by Professor W. T. Gordon, that the diffuse maxima are of two kinds. The "primary" diffuse diffraction, common to all diamonds examined, is really diffuse. It consists of a broad maximum accompanying the sharp Laue spot over an angle of incidence varying by not more than about ±3° from the Bragg angle, and it is quite strongly *temperature-sensitive* over a range of $650°C \rightleftarrows 30°C \rightleftarrows -180°C$.[3] This type of diffuse maximum, which increases in diffuseness as the angle of incidence diverges from the Bragg angle, corresponds to that found for all other crystalline substances examined.[4] The "secondary" diffuse diffraction is not really diffuse at all. It consists, according to the diamond orientation, of a sharp spot overlaying the primary diffuse maximum, sometimes accompanied by well-defined streamers of uneven intensity; or of three small sharp spots surrounding the primary diffuse maximum; or of other related groups of spots and streaks. Geometrically it corresponds in reciprocal space to the existence of sharp horns of reflecting power extending out from the lattice points along cube directions. This secondary diffraction is *structure-sensitive*, in that its intensity varies markedly with the diamond used. For the strain-free, mosaic diamonds classed as of type II[5] it is entirely absent; diamonds of type I, even if of uniform size and shape, may show it in very varying intensity. It is also temperature-sensitive (tested over the same range) but much less so than the primary diffraction. It persists over a range of angles of incidence more than three times as great as the range of primary diffuse diffraction, and the sharpness of the secondary maxima not only does not diminish but indeed increases as the angles of incidence and diffraction diverge.

It appears, from the description given by Raman and Nilakantan of the sharpness, persistence and relatively small temperature-sensitiveness of the effects observed by them, that they have only observed the secondary diffraction, and that only on a diamond or diamonds which show this secondary effect strongly. The photographs published by them[6] indicate further that they were using a rather large slit or a large diamond or both. The best conditions for observation of the primary maxima are (1) a fine slit and small diamond (our best photographs were taken with a 0.5-mm slit and an octahedron weighing 1 mg), (2) a crystal orientation in which the primary and secondary maxima are separated, or (3) a diamond in which secondary effects are weak or absent, (4) a high temperature. Provided that conditions (1) and (2) are fulfilled, however, the primary maxima are easily observable not only for the {111} planes but also for the {220}{113}[{004}{331}] planes of diamonds, with filtered or unfiltered radiation from an iron or copper target. If diamond is to be taken as a typical crystal, it is certainly these diffuse, temperature-sensitive primary maxima which must be discussed.

As far as the secondary phenomena are concerned it is clear that these maxima, which, though slightly temperature-sensitive, are only present in diamonds showing signs of considerable internal strain (type I), cannot be regarded as due entirely, or even mainly, to temperature movements. Further, attempts to explain the effects in terms of any theory, static or dynamic, classical or quantum-mechanical, have so far been complicated by the fact that the {220}{113}{004} and {331} secondary groups are unexpectedly incomplete. *All* the theories, given suitable initial hypotheses, predict spots in geometrically identical positions, and in the case of the {111} planes these spots are found; but they also all predict spots associated with other planes some of which have not been found.

Full details of our experimental work await publication.

[1] C. V. Raman and P. Nilakantan, Phys. Rev. **60**, 63 (1941).

[2] K. Lonsdale and H. Smith, Nature **148**, 112 (1941).

[3] K. Lonsdale and H. Smith, Nature **148**, 257 (1941).

[4] K. Lonsdale and H. Smith, Proc. Roy. Soc. London **A179**, 8 (1941) [with 28 plates].

[5] R. Robertson, J. J. Fox and A. E. Martin, Phil. Trans. Roy. Soc. London **A232**, 463 (1934).

[6] C. V. Raman and P. Nilakantan, Proc. Ind. Acad. Sci. **A11**, 389 (1940); Curr. Sci. **10**, 242 (1941).