that the *photographic* luminosity of the collapsed star should be roughly three magnitudes fainter than its pre-nova value. Put differently, since such a large bolometric reduction results from the change of temperature, we conclude that the observed equality of pre- and post-nova stars requires that the end product be three magnitudes brighter bolometrically than before outburst. To the writer, at least, this appears to be a *reductio ad absurdum*. More details are given in a paper now in press in *Popular Astronomy*.

It is, of course, possible to object that the assumption of equal bolometric luminosities is incorrect. This is granted as a likely possibility. It is, therefore, of interest to determine in which direction it may be expected to fail. Appealing to observation, we see that while main sequence stars in general fit the mass-luminosity relation, the white dwarf companion of Sirius is too faint for its mass. This is just opposite to the direction of failure which would be required to account for the equality of the pre- and post-nova photographic luminosities on the hypothesis of collapse.

We must, of course, admit the existence of a remote possibility that a star could collapse, with radical changes of all its physical parameters except mass, and vary the energy distribution in its spectrum so as to keep the photographic radiation the same. This would imply almost a diabolical intent to deceive the observer! And, as one of my colleagues has remarked, it would take a pretty "cagey" star to do the trick.

The above remarks apply only to the common novae, and are not meant to include the supernovae. There are reasons for believing that the latter originate in a different way from the former, and because the energy liberated in these greater explosions is of the order of magnitude to be expected from stellar collapse, it appears quite possible that the theory of neutrino emission would apply there. The pre-outburst state of supernovae is entirely unknown, and the preceding arguments, therefore, cannot be applied to them.

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Classical and Quantum Reflections of X-Rays

C. V. Raman and P. Nilakantan
Department of Physics, Indian Institute of Science, Bangalore, India
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In a series of papers[1] published in April and May, 1940, we presented evidence proving conclusively that the lattice planes in a crystal give a second kind of geometric reflection of x-rays which we designated as the modified or quantum reflection, to distinguish it from the unmodified or classical reflection discovered by Laue and his collaborators in 1912. The process which results in the modified reflection was clearly established by the experimental results in the specific cases studied by us. In the language of classical optics, a modified reflection by the lattice planes results from the dynamic variation of their structure amplitude consequent on an oscillation, relative to each other, of the interpenetrating lattices in the structure of the crystal. In the act of such reflection, the primary x-ray frequency is altered by the addition or subtraction of one or another of the characteristic infra-red frequencies of the crystal. In the language of quantum mechanics, the modified reflection represents an inelastic collision of the photon with the crystal in which the two exchange energy. The probability of such transition, and therefore also the intensity of reflection, is determined by the principles of quantum mechanics and not by classical dynamics. The theory of the effect has been discussed in further papers.[2]

The view has been put forward in some recent papers[3–5] that the phenomenon dealt with by us may be explained as "diffuse maxima in the scattering of x-rays by elastic waves of thermal origin." We desire energetically to contradict this suggestion. The theory of the thermal scattering of x-rays has been fully discussed by Laue[6] in 1926. It is therefore possible to anticipate the results to be expected on the basis of such scattering. It may be stated at once that they are quite incapable of explaining the phenomena actually observed by us.

In the first place, the intensity of the scattering of x-rays by elastic waves of thermal origin comes out proportional to N, the number of scattering atoms in the crystal, and not to N^2. The absolute intensity of scattering is therefore very small, and the effects due to it would be perceptible only when large volumes of the crystal are operative. The present effect, on the other hand, though decidedly feebler than the classical reflections, can be recorded under precisely the same experimental conditions as the latter, that is to say, with fine x-ray beams and the thinnest crystal plates.

The so-called maxima in scattering arise from the presence of a factor in the expression for its intensity proportional to the square of the wave-length of the elastic waves which are effective. However, it is only when the direction of scattering coincides exactly with that of the classical reflection, and is therefore unobservable, that this multiplying factor becomes important. For other settings of the crystal, the "peak" disappears and is replaced by broad humps of relatively small intensity in the curve of intensity of scattering. These cannot explain the discrete reflections actually observed over a wide range of settings of the crystal. The (111) reflection by a crystal of diamond, for example, is remarkably sharp and may be readily photographed with crystal settings, in which it appears displaced by as much as 10° on either side of the Laue spot. No significant changes are observable either in its size or in its definition over the whole of this range.

Thirdly, exact measurements of the position of the (111) reflection by diamond over a wide range of settings have been made. They fit perfectly into the Raman-Nath formula, the inclination of the phase waves to the lattice planes coming out as half the tetrahedral valence angle. On the other hand, considered over the whole of this range, the Faxén formula is not even a rough approximation to the truth.

Finally, a crucial test is provided by the low temperature results with the (111) reflections by diamond. As

Laue has shown, a change of frequency occurs also in the scattering by elastic waves. According to the "scattering" theory, the intensity maxima correspond to elastic waves of maximum wave-length and minimum frequency. In such a case, therefore, the transition probabilities should be given correctly by the classical dynamics. The intensity maxima should fall off in proportion to the absolute temperature, the more exactly, the nearer the "scattering" maximum is to the Laue spot. Actual observations show, however, that the intensity is practically unaffected by cooling the crystal down to liquid-air temperatures, and this is true irrespective of the setting of the crystal. The observations thus clearly show that the transitions involved correspond to the high frequency infra-red levels and not to the low frequency acoustic ones. They also prove that the modified reflection is a quantum-mechanical effect.

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Proceedings of the Ohio Section of the American Physical Society

THE fourth meeting of the Ohio Section of the American Physical Society was held at Muskingum College, New Concord, Ohio, on March 29, 1941. About fifty-five members and guests were present at the luncheon. Fourteen papers were scheduled for presentation, though weather conditions curtailed the programme; abstracts of five are appended.

The fifth meeting of the Ohio Section was held at Cleveland, in the buildings of the Case School of Applied Science and the Western Reserve University, on May 10, 1941; it was a joint meeting with the Ohio Academy of Science. One hundred members and guests were present. Nineteen papers were scheduled for presentation; of these the abstracts of five are appended. It was voted to cooperate with the Ohio Academy in sponsoring the programme of the Junior Academy for the creation of further interest in science in secondary schools, and five members (J. Albright, F. L. Berger, H. J. Kersten, H. P. Knauss, H. H. Roseberry) were chosen to collaborate in the various parts of the state. A symposium on "Light and Lighting" is planned for the meeting intended to be held in Cleveland in October 1941.

Newly elected officers of the Section for the season 1941–42 are the following: Chairman, W. E. Forsythe; Vice Chairman, P. B. Taylor; Secretary-Treasurer, R. H. Howe.

RICHARD H. HOWE, *Secretary*
Denison University, Granville, Ohio

ABSTRACTS OF PAPERS PRESENTED AT THE MUSKINGUM MEETING

1. The Vibrational Spectrum of the Potassium Chloride Crystal Lattice. L. L. FOLDY, *Case School of Applied Science.* (Introduced by R. S. Shankland.)—The methods of Born, v. Kármán, and Blackman for the investigation of the thermal vibrations of crystal lattices are applied in detail to an atomic model representative of a potassium chloride crystal. The potential interaction between ions, assumed of equal mass, is represented as a Coulomb interaction for any ion and its eighty nearest neighbors, a van der Waals attractive interaction varying as the inverse sixth power of the distance between nearest neighbors, and an exponential repulsive interaction also between nearest neighbors. Explicit solutions of the secular equation for the frequencies, which is of the third order, are obtained for waves traveling in certain directions in the crystal. The calculated principal restrahlen frequency was found to be about 10 percent lower than the observed value. The dispersion for short longitudinal waves traveling normal to the 111 planes of the crystal was found to be so great that the frequency increases with wave-length for wave-lengths less than about four and one-half times the distance between nearest neighbors. This extreme behavior was not manifested for transverse waves traveling normal to the 111 planes or for any waves traveling normal to the 110 and 100 planes.

2. The Harmonic Analysis of Geiger Counter Pulses. ROBERT S. SHANKLAND AND RICHARD H. BLYTHE, *Case School of Applied Science.*—The discharge of a Geiger-Müller counter results in a sudden drop in the potential of the wire electrode, followed by a more gradual return of this potential to its normal value. The time variation of potential constitutes a voltage pulse of which the shape and duration depend on both the discharge mechanism in the counter itself and upon the values of the electrical elements that compose the counter circuit. Thus the voltage