result proves to be also true for the mica, it may enable us to investigate the nature of the surface distribution apart from the bulk distribution.

A more detailed account of the work to date will be published later.

[1] J. Joly, Proc. Roy. Soc. **A102**, 682 (1923).
[2] J. Joly and E. Rutherford, Phil. Mag. **25**, 644 (1913).
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Infra-Red Color Center Bands in the Alkali Halides

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New color center bands in the near infra-red have been observed in alkali halides irradiated with x-rays from a beryllium window tube with a tungsten target[1] and subsequently irradiated with white light. In agreement with the results of earlier investigators, the *F*- and *M*-bands formed by relatively small x-ray exposures (10^6 roentgens/cm^2) are completely bleached without appreciable *R*-band formation. However, after greater x-ray exposures (10^8 roentgens/cm^2) the *F*- and *M*-bands are only partially bleached by irradiation with white light. Under these conditions there is appreciable *R*-band formation and, in addition, new bands are observed in the near infra-red beyond the *M*-bands. Additional prolonged irradiation with white light produced relatively little effect on the appearance of the various bands. Visual examination of the partially bleached specimens showed that the residual color was located in a thin section at the surface of the crystal entered by the x-rays. At liquid nitrogen temperatures the various bands narrowed, shifted to shorter wave-lengths, and showed additional structure. The various color center bands are shown in Fig. 1 for KCl after a dosage of 600×10^6 roentgens/cm^2 and subsequently irradiation with white light. Preliminary measurements on additively colored crystals of KCl which were exposed to white light revealed that the new bands are also present in these crystals. Similar results were obtained for KBr and NaCl.[2]

The nature of the new near infra-red bands ("*N*-bands") and the factors leading to their formation are being investigated further. At present, it may be supposed that the *N*-bands correspond either to electrons trapped at specific clusters of vacancies in a manner analogous to that suggested by Seitz for the *R*- and

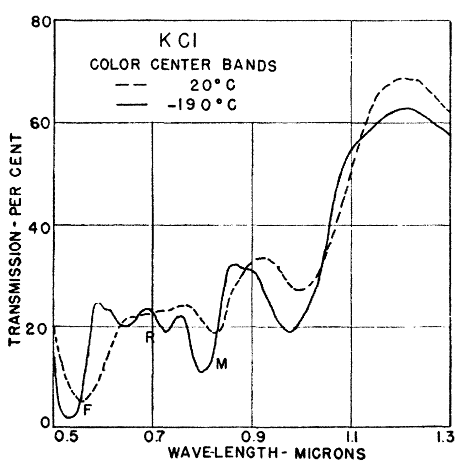

Fig. 1. Various color center bands for KCl after a dosage of 600×10^6 roentgens/cm^2.

M-bands[3] or to two-dimensional aggregates of *F*-centers as suggested by Mitchell for the color center bands in the silver halides.[4] The inability to bleach the color center bands indicates that the positive holes formed during irradiation have diffused away from the surface regions of the crystal. A loss of atomic halogen from the surface of the crystal during *x*-irradiation is highly probable and may, in fact, account for part of the decrease in density observed in KCl on prolonged *x*-irradiation.[5] Regardless of the exact mechanism for the decrease in density, it is reasonable to assume that the *x*-irradiated crystal contains a larger concentration of vacancies than is normally present. Partial bleaching increases the concentration of negative ion vacancies still further so that conditions are favorable for the aggregation of vacancies or *F*-centers. Measurements are being carried out on the changes in ionic conductivity and dielectric loss to obtain further information about the mechanism of vacancy formation during *x*-irradiation.

[1] A Machlett AEG-50A tube operated at 50 kv and 20 ma was used in this work.
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The *S*-Matrix for Meson-Nucleon Interactions

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Dyson[1] has given a set of simple rules for writing down the integrals for the matrix elements for transitions in electrodynamics. These rules have since been extended to cover the more general meson-nucleon interactions which may include differentials.[2] With the use of his rules Dyson[3] has proved that the consistant renormalization of mass and charge will remove all the divergences from the *S*-matrix for scattering processes in electrodynamics. Dyson starts by proving that there are only four types of primitive divergents in the theory. One of these—the scattering of light by light, to be referred to as a "square" part—is then shown by arguments of gauge invariance to introduce, in fact, no new divergences. For (pseudo-)scalar meson scalar-interactions with nucleons the primitive divergents are the same as in electrodynamics, but the attempt to obtain a finite *S*-matrix fails because genuine divergences arise from square parts.[4] In all the other meson-nucleon interactions the occurrence of extra differentials allows for an infinite number of primitive divergents and Dyson's method appears to fail completely. However, the (pseudo-)vector meson vector-interactions are peculiar in that the differentials occur in the commutation relations, not in the interactions. It will be shown below that in the single case of the neutral vector meson vector-interaction the differentials do not contribute to the matrix elements and a finite *S*-matrix can be obtained by Dyson's method.

The vector meson field $\varphi_\mu(x)$ with positive definite energy can be expressed in terms of two subsidiary fields,[5] a vector field $A_\mu(x)$ and a scalar field $B(x)$, where

$$\varphi_\mu(x)=A_\mu(x)+(1/\kappa)(\partial B/\partial x_\mu). \tag{1}$$

The wave function satisfies the subsidiary condition

$$(\partial A_\mu/\partial x_\mu+\kappa B)\Psi=0. \tag{2}$$

The Hamiltonian for the vector-interaction in the interaction representation is[6]

$$H(x)=(1/c)j_\mu(x)(A_\mu(x)+(1/\kappa)\partial B/\partial x_\mu)+(1/2c^2\kappa^2)(j_\mu(x)n_\mu)^2, \tag{3}$$

where n_μ is the normal to the general space-like surface. The components of $A_\mu(x)$ and $B(x)$ commute like independent scalar fields so that the differentials in the commutation relations of $\phi_\mu(x)$ arise from the differential of $B(x)$ in the definition of $\phi_\mu(x)$.