

**Zeitschrift:** Archives des sciences [1948-1980]  
**Herausgeber:** Société de Physique et d'Histoire Naturelle de Genève  
**Band:** 13 (1960)  
**Heft:** 9: Colloque Ampère

**Artikel:** On impurity effects in the infra-red and at ultra-high radio frequencies in solids  
**Autor:** Szigeti, B.  
**DOI:** <https://doi.org/10.5169/seals-738531>

### **Nutzungsbedingungen**

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

### **Conditions d'utilisation**

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

### **Terms of use**

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

**Download PDF:** 03.04.2026

**ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>**

## **On impurity effects in the infra-red and at ultra-high radio frequencies in solids**

*(Summary of paper to be presented at the Ampere  
Conference at Pisa, September, 1960).*

by B. SZIGETI

Department of Theoretical Physics, University of Liverpool

---

In recent years a number of papers dealt with various impurity effects connected with the vibrations of solids. Some of these are summarized in the review articles by Lifšic (1956) and Montroll et al. (1958). The present paper describes the first stage of a theoretical investigation on the effect of small amounts of impurities on the vibrational absorption spectrum of unpolar crystals. This is of interest, for instance, in connection with diamond, silicon and germanium. In the presence of small amounts of impurities (less than 1%) these materials exhibit characteristic absorption in the region of the lattice frequencies while in the pure state they show no absorption in that region. The results obtained, however, are not limited to these materials but are of interest in connection with all types of vibrational absorption due to impurities in solids. This type of absorption is usually in the infra-red, but in some cases it is at ultra-high radio frequencies.

At the first stage of this investigation, using the results of a previous paper by the author (1952), exact solutions have been obtained for the absorption due to a single impurity atom in a linear chain of uncharged atoms. It is found that the impurity atom takes part in almost all the modes of vibration of the chain, and to a larger or smaller degree, makes them all active in the absorption spectrum. The quantitative solution shows that the absorption due to this effect has a well pronounced maximum at a frequency which depends upon the nature of the impurity but is always lower than  $\nu_{max}$  the highest vibrational frequency of the chain.

Under certain conditions, if mass and force constant of the impurity atom are favourable, there is also a further absorption line at a frequency

higher than  $\nu_{max}$ . This line arises from a vibration where only the impurity atom and its immediate neighbours vibrate.

The result allows certain conclusions concerning impurity effects in a 3-dimensional solid. It also indicates that by the admixture of impurities it is possible to make such modes of vibration appear in the absorption which, in the pure state, are not active either in the absorption or in the Raman spectrum.

#### REFERENCES

- SZIGETI, B. (1952), *Proc. Phys. Soc., B*, 65, p. 19.  
LIFŠIC, M. (1956), *Il Nuovo Cimento*, Ser. X, Vol. 3, Suppl., p. 716.  
MARADUDIN, A. A., P. MAZUR, E. W. MONTROLL and G. H. WEISS (1958), *Rev. Mod. Phys.*, 30, p. 175.

#### DISCUSSION

*M. Palma.* — I should like to ask whether a temperature-dependence, down to a few absolute degrees, of the impurities spectrum is expected and (if this is the case) if it might be related to anharmonic phonon-scattering processes by impurities.

*M. Szigeti.* — The impurities are bound in the lattice essentially by harmonic forces; hence their most important effect is to alter the harmonic part of the lattice vibrations, and the absorption due to this effect should be independent of temperature.

---