

Localized Excitations in Solids

Edited by R. F. WALLIS

U. S. Naval Research Laboratory
Washington, D. C.

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Localized Excitations in Solids,
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FOREWORD

The first International Conference on Localized Excitations in Solids was held at the Irvine campus of the University of California on September 18-22, 1967. The Conference was supported by the International Union of Pure and Applied Physics, the U. S. National Science Foundation, the U. S. Office of Naval Research, the U. S. Army Research Office, the University of Southern California, and the University of California, Irvine.

The initial idea for an International Conference on Localized Excitations in Solids was conceived in discussions between Professors Maradudin, Burstein, and Krumhansl. It was felt that such a Conference would render a valuable service in bringing together scientists actively engaged in the study of localized excitations to survey the work to date, describe current research, and point out areas for future exploration. It was also felt that the very rapid increase in research on the subjects of interest made such a Conference particularly desirable at this time. Furthermore, an opportunity would be provided for close interaction between workers in diverse areas of solid state physics such as lattice dynamics, magnetism, and electronic structure.

The localized excitations which formed the subject matter of the Conference are localized phonons, localized magnons, localized plasmons, and localized excitons. These subjects possess the unifying feature that the theory is substantially the same for each. The papers presented covered such topics as the fundamental characteristics of localized excitations, the interactions of localized excitations, and the effects of localized excitations on observable physical properties.

Approximately 120 scientists attended the Conference. Countries represented among the participants were Canada, Denmark, England, France, Germany, Israel, Italy, Japan, New Zealand, Scotland, the Soviet Union, Sweden, and the United States. A particular honor was the presence of Professor I. Waller, one of the founders of the field of lattice dynamics, and Professor E. W. Montroll, one of the first to investigate localized phonons.

The success of the first International Conference on Localized Excitations in Solids was due in large measure to the efforts of Professor A. A. Maradudin of the University of California, Irvine. He provided not only the initiative, but also the insight, effort, and attention to detail that were required to insure that the Conference would be a memorable and valuable experience for the participants. To Professor Maradudin, many thanks for a job well done. Appreciation must also be expressed to Professor Elias Burstein and the other members of the Program Committee for the outstanding program which they arranged. Special thanks are due Mr. Rodney Rose, Business Manager of the Department of Physics, University of California, Irvine, who very capably handled many details associated with the smooth operation of the Conference, the comfortable living arrangements, and the social and recreational events. Thanks are also due Mrs. Sandy Mills and Mrs. Peg Maradudin who were co-chairmen of the ladies program and Mrs. Marty Pelke of the Conference Staff who provided much help in many ways. Finally, deep appreciation must be expressed for the splendid hospitality shown the Conference and its participants by the University of California, Irvine.

R. F. Wallis

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PART A. INTRODUCTORY PAPERS

LOCALIZED, GAP, AND RESONANCE MODES

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I. Introduction

It is only seven years since the first experimental discovery of localized vibration modes in crystals,⁽¹⁾ but in those seven years more studies, both theoretical and experimental, of exceptional vibration modes have been carried out than in the first eighteen years following their theoretical discovery by I.M. Lifshitz.⁽²⁾ It seemed appropriate, therefore, at a Conference devoted to localized excitations in solids to survey the studies of localized vibrations in solids, which have been carried out in the past few years. Since a great deal of the existing work has been surveyed elsewhere recently⁽³⁾, I will restrict my remarks here largely to the results of very recent investigations.

II. Localized Modes

High frequency localized modes were the first kind of impurity induced exceptional vibration modes to be observed experimentally. They have been observed by various experimental techniques in ionic crystals, in polar and homopolar semi-conductors, and in metals.

In the cases of ionic crystals and polar semi-conductors the most widely studied impurities which give rise to localized vibration modes occupy sites of cubic symmetry. They are charged impurities, and the localized modes to which they give rise therefore have a non-zero dipole moment associated with them which can couple

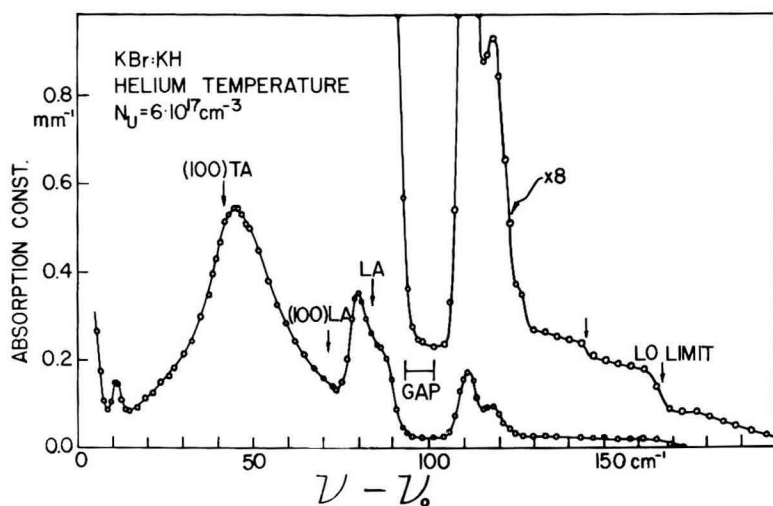


Fig. 1. The high frequency sideband to the localized mode peak due to H^-U -centers in KBr.

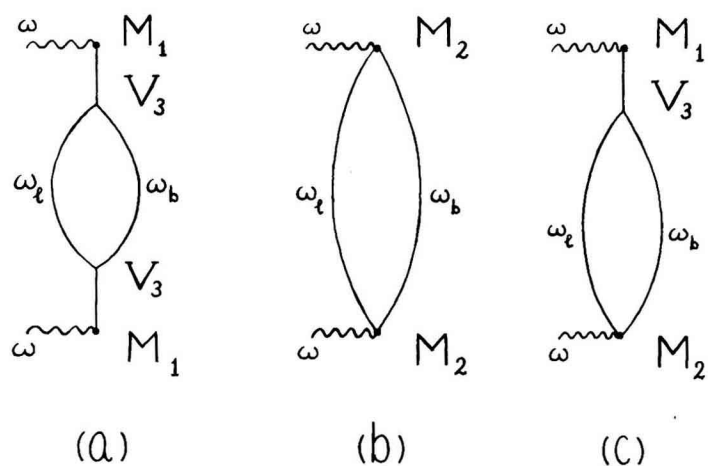


Fig. 2. The three dominant mechanisms which give rise to sidebands to localized mode peaks.