Proceedings of the Conference

Lattice Effects in High-T_c Superconductors

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PREFACE

The "Lattice Effects" conference was motivated by the rapidly expanding experimental results and theoretical predictions that lattice anomalies are important in high temperature superconductors.

Most of the effort in the theory of High-T, superconductivity has been driven by suggestions that antiferromagnetism may be responsible for superconductivity. Such theories have as yet not provided definitive predictions which establish their relevance to the Cu-O based class of high-T_c materials. Experimental evidence linking magnetism and superconductivity remains circumstantial.

Experimental evidence for very large coupling of electron and lattice dynamics, has grown from indirect tests to direct measures. A variety of subtle structural transitions have been found to occur in the relevant region of the phase diagram.1 Infrared absorption and Raman scattering[2,3] show strong coupling between lattice and carrier dynamics. A signal of very large lattice relaxations is found in photo-induced absorption.[4,5] The most direct experiments have been ion-channeling cross-section changes as a function of T near T_c,[6,7] neutron radial-distribution-function measurements showing direct evidence for dynamic correlations which change at T_c,[8] EXAFS showing oxygen atoms tunneling between sites separated by 0.13Å,[9] and Mössbauer experiments showing anomalous nuclear dynamics.[10]

These experiments suggest that in High-T_c materials there are anomalous atomic dynamics which are orders of magnitude larger than in conventional superconductors. Furthermore, the nuclei change their dynamics through T_c as indicated by channeling, neutron scattering, EXAFS and Mössbauer probes.

One early experiment, the absence of an isotope shift,[11] suggested that nuclear motions are not important for superconductivity. Theoretical discussions indicate this conclusion may not follow. Moreover, recent experiments have shown the isotope shift changes substantially with doping.'*

Several theories of superconductivity may be consistent with lattice fluctuations and structural correlations: enhanced electron-phonon theory,[13] large bipolaron theory,[14] electron phase separation theory,[15] nonlinear electron-phonon coupling theory,[16] Jahn-Teller theory,[17] and negative-U based two-component theory.[18]

The workshop was designed to provide an opportunity for experimentalists and theorists with a diversity of techniques and approaches to discuss the large variety of structural anomalies and the importance of structural effects in superconductivity. Particular emphasis was placed on the rapid development of direct measures of lattice fluctuations and structural coherence.

The conference was held in Santa-Fe on January 3-5, 1992. In order to reach the conference site the attendees braved a snow storm that closed roads in many parts of New Mexico - but not the roads to Santa-Fe. It was attended by approximately 150 participants and was an ***intense*** three days of stimulating presentations and discussions. We wish to thank the speakers who introduced the conference: Kay Adams, Director of the Exploratory Research and Development Center at Los Alamos National Laboratory and Don Parkin, Director of the Center for Materials Science at Los Alamos National

Laboratory. We also thank sessions chairs for their efforts: James L. Smith, Heroshi Katayama-Yoshida, Dragoljub Mihailović, Stewart K. Kurtz, James E. Schirber, Masashi Tachiki, Joseph I. Budnick, Heinz-Bernd Schüttler, Yoshiteru Maeno. We wish to express our gratitude to Jean Stark and her staff at the protocol office of Los Alamos for their work prior to and during the conference to ensure the comfort of all the attendees and a smooth program. The conference would not have been possible without the generous sponsorship of the Department of Energy, Office of Basic Sciences, and the Exploratory Research and Development Center at Los Alamos National Laboratory, and the Center for Materials Science at Los Alamos National Laboratory.

We expect that lattice effects will continue to be an important topic leading to a wide variety of experimental and theoretical investigations important both for superconductivity and for our understanding of novel properties of these interesting materials.

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