

PHOTOLUMINESCENCE STUDIES OF THE YELLOW SERIES
FREE EXCITON IN CUPROUS OXIDE USING PULSED
AND CONTINUOUS WAVE TUNABLE DYE LASERS

by

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INTRODUCTION

In 1931, J. I. Frenkel proposed the concept of the exciton for explaining absorption in solids that was not accompanied by photoconductivity.¹ This electrically neutral quasi-particle, consisting of an electron and hole bound through a Coulomb interaction, has the interesting property of being able to migrate through a crystal. The exciton can probably best be described in terms of two different limiting approximations, one due to Frenkel and the other due to Wannier and Mott. The Frenkel model considers the exciton tightly bound so that the electron and the hole are usually on the same atom in the lattice although they may migrate from atom to atom. In the Wannier model, the exciton is weakly bound so that the electron-hole separation may extend over many lattice constants. The particular model that is appropriate depends upon the state of the exciton and the properties of the insulator or semiconductor in which it is formed. A discussion of these two models is given in Knox's Theory of Excitons.²

Following Frenkel's fundamental work, the exciton hypothesis was used to explain various crystal phenomena. However, it was not until the early 1950's that systematic optical absorption experiments were performed by independent groups that confirmed the existence of excitons. Although nearly all semiconductors show exciton effects, cuprous oxide (Cu_2O) has a particularly rich optical spectrum and was therefore an important crystal in these early experiments. The first observations of exciton spectra were made by Hayashi.³ Similar observations were made by Gross and Karryev a few months later and reported in 1952.⁴ Gross had begun a study of the