

Lax M. The Franck-Condon principle and its application to crystals.
J. Chem. Phys. 20:1752-60, 1952.
[Department of Physics, Syracuse University, NY]

When the electron-phonon interaction is linear in the lattice displacements, and the electric dipole moment is a constant, the spectrum for optical absorption at a localized center is calculated exactly and quantum mechanically. The Franck-Condon principle is found by a semiclassical approximation, and its accuracy evaluated. [The SCI® indicates that this paper has been cited in over 520 publications since 1955.]

Melvin Lax
Department of Physics
City College
New York, NY 10031

August 23, 1985

While my predoctoral research was in the area of acoustics, my PhD thesis (under Herman Peshbach) was in the area of meson physics. I continued work in meson physics for four years at Syracuse University. However, the experimental effort at Syracuse was much stronger in the solid-state physics area. In preparation for switching to solid-state physics, I taught a course in solid-state theory.

By coincidence, just as I had completed my teaching assignment at Syracuse, I learned that E. Burstein, then head of the Crystal Physics Branch at the Naval Research Laboratory, wanted

some support in solid-state theory and had a summer position available.

The most important problems being investigated in the Crystal Physics Branch at that time involved radiative and nonradiative transitions at impurities in solids. We decided that both problems could be considered simultaneously because they were closely related. The radiative problem involved phonon-assisted optical transitions. The nonradiative transitions made up the energy difference with phonons alone.

K. Huang and A. Rhys had just written a key paper on radiative and nonradiative transitions.¹ Their procedure was restricted to the case of optical phonons—namely, phonons all of whose energies were identical. Since acoustic phonons provide a continuum of frequencies (and optical phonons do too when the optical branch is not approximated as flat), a new technique had to be developed that relied on delta-function tricks. (Theorists do it with delta functions; experimentalists do it with mirrors.)

Aside from new technical procedures, the results shed light, after a semiclassical approximation, on the Franck-Condon principle in solids. For this reason, the paper was submitted to the *Journal of Chemical Physics*. The nonradiative transitions were discussed in later papers using the methods developed here.^{2,3}

It is amusing that my entry paper into solid-state theory became a *Citation Classic*, perhaps because of its innovative approach to a long-standing problem. Interest in this field continues.⁴

1. Huang K & Rhys A. Theory of light absorption and non-radiative transitions in F-centres.

Proc. Roy. Soc. London 204:406-23, 1950. (Cited 280 times since 1955.)

2. Lax M. The influence of lattice vibrations on electronic transitions in solids. (Breckenridge R G, Russell BR & Hahn E E, eds.) *Photoconductivity Conference*. New York: Wiley, 1956. p. 111-45.

3. Gummel H & Lax M. Thermal capture of electrons in silicon. *Phys. Rev.* 100:592-602, 1957.

4. Ranjani A, Mugnai D, Bacchi M, Viani G & Fontana M P. The optical properties of thallium-like impurities in alkali-halide crystals. *Advan. Phys.* 32:823-905, 1983.