

Franck Condon Principle

In 1925, before the development of the Schrödinger equation, Franck put forward qualitative arguments to explain the various types of intensity distributions found in vibronic transitions. His conclusions were based on the fact that an electronic transition in a molecule takes place much more rapidly than a vibrational motion of the nuclei that the instantaneous internuclear distance and the velocity of the nuclei can be considered remains unchanged during the electronic transition (later used as Born-Oppenheimer Approximation). This means in the diagrams showing the potential energy curve of the two electronic states of the molecule, the transition must be represented by the vertical lines, i.e. the most probable or most intense transition will be those represented by the vertical lines.

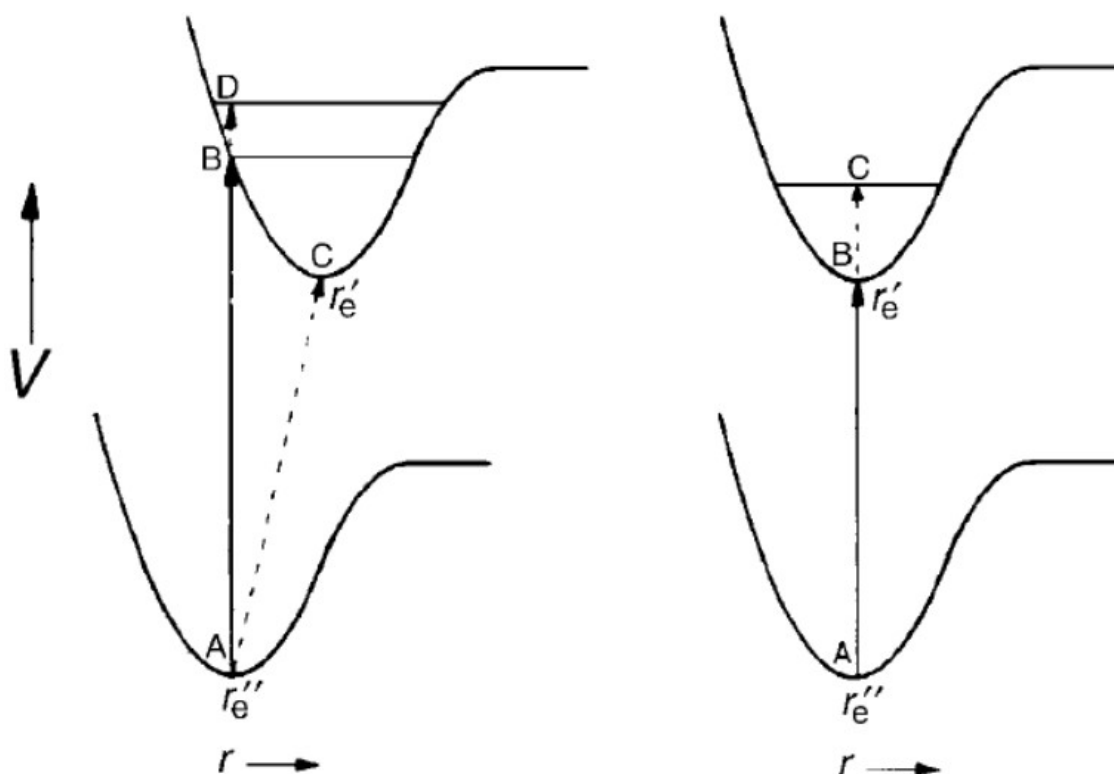


Figure demonstrating the Franck principle: for $r_e' > r_e''$ (left) and $r_e' = r_e''$ (right). The vibronic transition $A \rightarrow B$ is the most probable in both cases. Another important factor to be considered is the distributions of the probability density $|\psi_n|^2$ in various vibrational level of each electronic states. The greater the values of $|\psi_n|^2$ at particular values of inter nuclear distance r in a vibrational level, the greater the probability of the nuclei to be found at that distance apart. It is evident that $|\psi_n|^2$ is a maximum at the mid-point of the $v = 0$ level and near the turning points of the higher energy levels. Accordingly, the Franck-Condon Principle

is stated as “The most probable vibrational transitions are those in which one of the two turning points of a vibrational level of one electronic state lies at approximately the same inter nuclear distance as one of the two turning points of the level of other electronic state, except in case of $v = 0$ level for which the mid-point rather than the turning point must be substituted”.

