has higher energy than the corresponding ... the energy sequence is as follows :

$$E_{S_1} > E_{T_1} ; E_{S_2} > E_{T_2} ; E_{S_3} > E_{T_3} \text{ and so on.}$$

On absorption of light photon, the electron of the absorbing molecule may jump from S_0 to S_1, S_2 or S_3 singlet excited state depending upon the energy of the light photon absorbed, as shown in Jablonski diagram (Fig. 2). For each singlet excited state (S_1, S_2, S_3, etc.), there is a corresponding triplet excited state (T_1, T_2, T_3, etc.) The molecule, whether in singlet or triplet excited state, is said to be *activated*. Thus,

$$A_0 + h\nu \longrightarrow A^*$$

where A_0 is the molecule in the ground state and A^* is the molecule in the excited state.

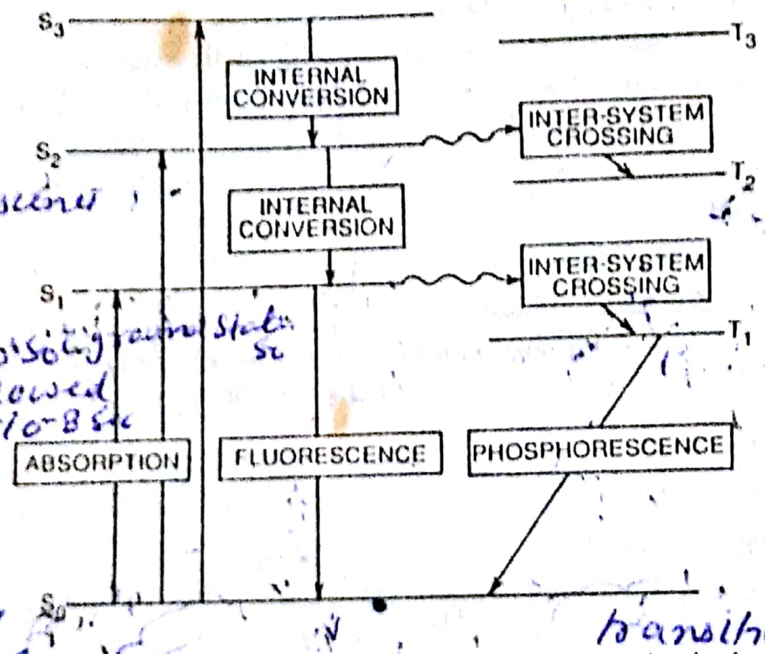

Fig. 2. The Jablonski diagram depicting various photophysical processes.

The activated molecule returns to the ground state by dissipating its energy through the following general types of processes :

1. Non-radiative Transitions. These transitions involve the return of the activated molecule from the higher excited states (S_3, S_2, or T_3, T_2) to the first excited state (S_1 or T_1). These transitions do not involve the emission of any radiations and are thus referred to as *non-radiative* or *radiationless* transitions. The energy of the activated molecule is dissipated in the form of heat through molecular collisions. The process is called **internal conversion (IC)** and occurs in less than about 10^{-11} second.

The molecule may also lose energy by another process called **intersystem crossing (ISC)**. This process involves transitions between *states* *of different spins, i.e.,* different multiplicity, as, for example, from S_2 to T_2 or S_1 to T_1. These transitions are also *non-radiative* or *radiationless*. Spectroscopically, such transitions are forbidden. However, *they do occur though at relatively slow rates.*

2. Radiative Transitions. These transitions involve the return of activated molecule from the singlet excited state S_1 and triplet excited state T_1 to the ground state S_0. Such transitions are accompanied by the emission of radiation. Spectroscopically, the transition from S_1 to S_0 state is an 'allowed' transition and occurs in about 10^{-8} second. The emission of radiation in this transition is called **fluorescence.**

The transition from the triplet excited state T_1 to the ground state S_0 is rather *slow* since it is a 'forbidden' transition, as already mentioned. The emission of radiation in this transition is called **phosphorescence.** The life times of phosphorescence are much longer being of the order of 10^{-3} sec or greater, since the transition involves spin inversion which needs time for its occurrence.

Both fluorescent and phosphorescent radiations are of shorter frequencies than the exciting light. This is obviously because some part of the light energy absorbed by the molecules is dissipated in the form of heat during the non-radiative transitions.

3. Chemical Reactions. The activated molecule may also lose energy by undergoing chemical reaction. Since the molecule in singlet excited state