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# Note: Fatal error in the May and Partridge general order kinetics equation.

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***Abstract:***

*In this paper an analysis has been attempted of the theoretical aspect of the general order kinetic equation mostly employed in the analysis of thermoluminescence and optically stimulated luminescence is analysed. From the analysis it is found that the general order kinetics equation of May and Partridge is theoretically invalid and destroys the very foundation of physics.*

***Keyword: Thermoluminescence, general order kinetics, OSL***

## 1. Introduction:

Thermoluminescence/ Optically Stimulated Luminescence (TL/OSL) is the emission of the stored energy of a material due to thermal/optical excitation. TL/OSL analysis provides information about the trap structure and previous exposure to ionizing radiation. The TL/OSL analysis is mostly performed using the Order of Kinetics Model which includes the first order kinetics (FOK) [1], second order kinetics (SOK) [2] and general order kinetics (GOK) [3] equations.

In the order of kinetics model there are three modes of transition, as follows:

a. The electron from a trap and goes directly to the recombination center via the conduction band. This is the Randall and Wilkins [1] first order kinetics.
b. The electron once excited from the trap to the conduction band has equal probability of either going to the recombination center or being retrapped again at the empty trap. This is the Garlick and Gibson [2] second order kinetics.
c. The transition in between the first order and the second order kinetics is known as the general order kinetics of May and Partridge [3].

The general order of kinetics of May and Partridge [3] is purely empirical in the sense that the equation cannot be derived mathematically. Despite this however, it is the most widely used expression in the analysis of TL/OSL curves. Some researchers [4-6] have even gone so far as to compare this empirical equation with the differential equation formalism without even considering the parameters involved.

Recently Lovedy [7], using the probability theory proved that the General Order Kinetics is mathematically wrong. However, it being necessary to test the theoretical validity of the May and Partridge [3] equation too, a theoretical analysis of the equation has been performed in this paper.

## 2. Theoretical Analysis:

As per Lovedy [7], a TL/OSL equation should be in the form of:

$$I(t)=-\frac{dn}{dt}=nP(T)P(R) \qquad (1)$$

where $n$ is the number of electron involved in the process, $P(T)$ is the thermal/optical excitation probability and $P(R)$ is the recombination probability.

The FOK of Randall and Willkins [1] is given by:

$$I(t)=-\frac{dn}{dt}=nse^{-E/k\theta} \qquad (2)$$

The SOK of Garlick and Gibson [2] by:

$$I(t)=-\frac{dn}{dt}=\frac{n^2se^{-E/k\theta}}{N} \qquad (3)$$

And the GOK of May and Partridge [3] by:

$$I(t)=-\frac{dn}{dt}=n^{b}s''e^{-E/k\theta} \qquad (4)$$

Where $E(eV)$ is the activation energy, $\theta(^{\circ}K)$ is the temperature, $b$ is the Order of kinetics, $s$ is the frequency factor, $N$ is the number of traps and $s''$ is the pre exponential factor.

Decomposing eqn (2), (3) and (4) in the eqn (1) format gives:

$$I(t)=-\frac{dn}{dt}=nP(T)\left(\frac{n}{n}\right) \qquad (5)$$

$$I(t)=-\frac{dn}{dt}=nP(T)\left(\frac{n}{N}\right) \qquad (6)$$

$$I(t)=-\frac{dn}{dt}=nP(T)\left(\frac{n^{b-1}}{Z}\right) \qquad (7)$$

where $P(T)=se^{-E/k\theta}$ and $Z$ is some unknown parameter such that $s''=s/Z$ .

If we consider $b=1.5$ and $n=5$ such that $n^{b-1}=5^{1/2}=2.236$ (approximated to three places of decimal) then eqn (5), (6) and (7) can be interpreted as:

a. as per eqn no (5) and (6) it is seen that all the 5 electrons take part in the recombination process.
b. as per eqn no (7) it is seen that out of 5 electrons only 2.236 (approximated to three places of decimal) electron takes part in the recombination process.

From the above argument it is seen that fractional electron take part in the recombination process for May and Partridge [3] general order kinetics. However, physics states emphatically that electrons being elementary particle, can't be divided further. It may thus be argued that the May and Partridge [3] prediction seeks to destroy the very foundation of physics and hence, is invalid. It thus follows that the May and Partridge [3] general order equation is mathematically and theoretically invalid.

**Conclusion:**

From the above discussion it is seen that the May and Partridge general order kinetics equation is theoretically and mathematically invalid and destroys the very foundation of physics which states emphatically that electrons are indivisible particle.

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