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RATE OF EQUATION IN RESPECT OF ABSORPTION BY THE TWO LEVELS ATOM

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Abstract: In this topic, we have attempted to carry out this program to obtain the T-operator for the system and get the solutions of the problem using similarity transformation of physical observables in contrast to Lamb's and Fleck's treatments for finding out the elements of the density operator and the probability coefficient for the system respectively.

Index Terms **- Lamb's and Fleck's treatment.**

I. INTRODUCTION

In this topic was we have tried to develop the quantized approach to the problem where using the T- matrix formation, we have very elegantly solved the problem. Further exact equilibrium solutions have been obtained along the lines by introducing phenomenological loss mechanism in the system. Instead of the conventional approach of adding the unperturbable Hamiltonian of the complex system itself which results in complex energy eigen-value. The state vector for the complex system of states, constructed form a product of photon states in the representation and products of Pauli spin Eigen's describing all combinations of atoms in the lower and upper energy levels. As a matter of fact, that an apparently distinctive approach to the problem is the set-up rate equation taking population of different status and the transition probabilities governing them and solve them for the problem.

II. THEORY

Geometrical interpretation of the process of emission or absorption by the two levels atoms easily follows from the nature of the T-operator. The elements directly give the probability amplitudes for the two status of the system and are seen to be just the Cayley-Klein parameters characterizing rigid body rotations. Corresponding Eulerian angles of rotations can be obtained in terms of the characteristics of the system and the radiation. Since the matrices involving Euler angles represent definite spatial rotational matrices such an analysis of the interaction matrices in the present problem provides as with a geometrical picture of the interaction matrices in the present problem provides as with a geometrical picture of the process undergoing in a Cartesian co-ordinate system and hence a deeper physical understanding of the process. Transformation form a given Cartesian co-ordinate system to another in rigid body rotation can be carried out by means of three successive rotations performed in a definite sequence. It has already been observed that the rotations for the two-level problems in spin space are special cases of general rotational transformation matrices in terms of Euler angles and which are involve in rigid body rotations.

We observed that a single two-level system confirms to the formalism of a spin 1\2 particles. Methods of a single particles can easily be extended to the cases of an assembly of two level non-interacting particles couple by a common radiation field. The system is characterized by a common radiation field. The system is characterized by equispaced levels. The Hamiltonian, the density matrix, and the T-operator of interaction for the system is obtained from the respective and the T-operator of interaction for the system is obtained from the respective expressions for a single tow level atom all the relevant operations for the system are seen to be functions of general angular momentum operators. The considerations of a two- level system when extended to the case of N two level systems lead to the finding that the general state function for the system is a function of 3N co-ordinates. Thus, the wave must be regarded as propagating in a 3N dimensional configuration space. The energy spacing for any of the constituent atom will be AE=hu. But for the highest and lowest Eigen states are degenerate and there are in all (N+1) different Eigen states characterizing the system.

Since the atoms are indistinguishable and each has same energy Eigen states, it is simply the distribution of the atoms between these two states which determines the Eigen-states for the co-related atoms forming the gas. The Eigen value problem for the gas the unitary system can then be written as

$$H0\ \Psi m = Em\ \Psi m = 1/2h\omega 0\ m\Psi m \quad (1)$$

Where Ψ`s are the normalized Eigen function H1 the unperturbed Hamiltonian for system and

$$m = (Na - Nb) \quad (2)$$

is always an integer and Na and Nb being respectively the number of atom in the upper and lower energy states. Therefore, each Eigen is characterized by a given value of m defined by the above equation (1). Referring to the diagonal representation for

unperturbed Hamiltonian for a single two-level atom, the total unperturbed Hamiltonian for the gas as a whole in a similar is given by

$$H0 = \sum 1/2\hbar\omega 0\ \sigma j3 = 1/2\hbar\omega 0 \sum \sigma\ j3 \quad (3)$$

Where the summation extend over all the atoms and the index J denotes the Jth atoms.

In terms of the macroscopic operators, we may express the unperturbed Hamiltonian Hi for the system

$$H0 = \hbar\omega 0\ R3 \quad (4)$$

where, $Rj3 = 1/2 \sum \sigma\ j3$

Thus equation (1) allows us to write the Eigen value problem as

$$R3|m> = 1/2\ m|n> \quad (5)$$

Thus, we find that the Eigen value of operator R3 (=dR3 /dt) i.e., R3 given the rate equation for the problem. As a matter of fact, an apparently distinctive approach to the problem is to set up rate equation taking population of different states and the transition probabilities governing them and solve them for the problem. It is quite clear that the Eigen states of the system are obtain from the population of the two states and hence from the population difference. Hence, we see from equation (5) and the above states fact that the two approaches toward the problem are interconnected.

III. Discussion and Result:

This work shows that the interaction problem between radiation and single two-level systems has been seemed to confirm to the formalism of spin-1/2 particle. In the semi-classical treatment, the formalism has been easily extended to treat the problem when a number of such two levels non-interacting systems coupled by a common radiation field take part in the interaction. It is found that the relevant operators for the system viz the Hamiltonian, the density operator, the T-operator of interaction etc, are expressed in terms of angular momentum operators such as R_1, R_2, and R_3 defined as

$$R_1 = 1/2 \sum\sigma_{j1},\ R_2 = 1/2 \sum\sigma_{j2},\ R_3 = 1/2 \sum\sigma_{j3} \quad (6)$$

Obeying the commutation relations.

$$[R_1 . R_2] = iR_3,\ [R_2 . R_3] = iR_1,\ [R_3 . R_1 = iR_2] \text{ and } [R_2 . R_1] = 0 \quad (7)$$

where $R^2 = R_1^2 + R_3^2$

The method has been used to treat the problem of corelated emission and photon echoes. The T-operator technique is not only an elegant method to solve the dynamical problem, but it provides at the same time a possible geometrical picture of the process undergoing. We have seen that the determination of the T-operator lies in eventuating the integral

$$T(t) = \exp(-1/h \int H\ dt) \quad (8)$$

This is facilitated only when the Hamiltonian H can be expressed in a simple linear form and is a constant of time in same or other frame of reference. For two level system the same has been possible in the space of the basic spin matrices σ_1 , σ_2 , σ_3 for ($j=1/2$) which are 2×2 matrices.

The present work shows that the perturbed and unperturbed Hamiltonians for the two-level problem connecting with the transitions of quantum mechanical system between an isolated pair of level can be written in terms of Pauli-matrices as follow.

$$H_0 = 1/2\ \hbar\omega_0\sigma_3 \text{ and } H = 1/2\hbar(\omega_1\sigma_1 + \omega_2\sigma_2 + \omega_3\sigma_3) \quad (9)$$

Where ω_1, ω_2 and ω_3 introducing, the perturbation are frequencies introduce by Feynman. In fact, the operation ½ ($\sigma_1 + i\sigma_2$) and ½ ($\sigma_1 - \sigma_2$) are seen to be excitation and de-excitation operators. This gives an elegant method of treating the dynamics of the atom.

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