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# Response of a two-level system to a sequence of N radiation pulses

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**Abstract.** A general expression has been obtained for the polarisation of an assembly of two-level systems irradiated by a sequence of N radiation pulses. The times and amplitudes of the echo-polarisation have been obtained. The method is an extension of the T-matrix method for the exact solution of the problem of interaction of radiation with two-level systems.
The number of polarisation echoes is $3^{N-1} - N$. The echo times are given by

$$t' = (1 + a)\, t_N + (b - a)\, t_{N-1} + (c - b)\, t_{N-2} + \cdots + (q - p)\, t_1$$

where $t_k$ are the pulse times and $a$, $b$, $c$ take on values 1, 0, − 1. From the general expression the amplitudes of echoes due to sequences of 2, 3 and 4 pulses are obtained as special cases. Distinct echo sequences determined by time relations among the incident pulses are discussed. The echo sequences exhibit interesting features which are of significance in the application of the phenomenon in holophony, etc.

**Keywords.** Photon echoes; superradiance; magnetic induction echoes; correlated emission; holophony

## . Introduction

'he dynamics of an atom (or an electron in a magnetic field) can be visualised s the motion of a vector $\boldsymbol{r}$ characterising the atom interacting with radiation Feynman *et al* 1957). The picture represents the action of radiation over a finite ıterval of time as the tipping of the vector $\boldsymbol{r}$ through an angle $\theta$ followed by the ·ee precessional motion of $\boldsymbol{r}$ with angular velocity $w_3 = \dot{\phi}$. If one introduces a ıseudo-angular momentum $\boldsymbol{m}$, a pseudo-electric moment $\mu$ and a pseudo-field ; by the following definitions (Venkatesh and Dixit 1971)

$$\boldsymbol{m} = \hbar \boldsymbol{r}, \quad \mu = \gamma \boldsymbol{r} = \frac{\gamma}{\hbar} \boldsymbol{m}, \quad \boldsymbol{E} = -\frac{\hbar \omega}{\gamma} \tag{1}$$

·here $\omega_0$ is the atomic transition frequency $\omega_0$ between the states $\psi_a$ and $\psi_b$. The ıther components $\omega_1$, $\omega_2$ are determined by the interaction potential $\hbar$ is Planck's onstant (divided by $2\pi$) and $\gamma = (\mu_1 + i\mu_2)_{ab}$, the gyroscopic equations can be ecast into the equations of magnetic resonance

$$\frac{d\boldsymbol{m}}{dt} = \mu \times \boldsymbol{E} \tag{2}$$

These *c*-number relations express precisely the parallelism between the electric and the magnetic case and enable one to treat photon and magnetic induction echoes on a uniform basis.