PASSAGE OF POLARIZED NEUTRONS THROUGH MAGNETIC MEDIA

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Consider a neutron passing a path along a direction s through a magnetic media with a velocity V. The recursion equation

$$\begin{pmatrix} u_x(s-\frac{\Delta s}{2}) \\ u_y(s-\frac{\Delta s}{2}) \\ u_z(s-\frac{\Delta s}{2}) \\ u_0(s-\frac{\Delta s}{2}) \end{pmatrix} = \begin{pmatrix} v_0(s) & v_z(s) & -v_y(s) & v_x(s) \\ -v_z(s) & v_0(s) & v_x(s) & v_y(s) \\ v_y(s) & -v_x(s) & v_0(s) & v_z(s) \\ -v_x(s) & -v_y(s) & -v_z(s) & v_0(s) \end{pmatrix} \begin{pmatrix} u_x(s+\frac{\Delta s}{2}) \\ u_y(s+\frac{\Delta s}{2}) \\ u_z(s+\frac{\Delta s}{2}) \\ u_0(s+\frac{\Delta s}{2}) \end{pmatrix}$$

describes the behaviour of the neutron spin interacting with the magnetic field of the medium /1/. The initial condition is $u_x(0)=u_y(O)=u_z(0)=0$ $u_0(0)=1$. The matrix components are

$$v_x = h_x \sin\frac{\xi}{2}, \quad v_y = h_y = \sin\frac{\xi}{2}, \quad v_z = h_z \sin\frac{\xi}{2}, \quad v_0 = \cos\frac{\xi}{2} .$$

Here $h_x=H_x/H$, $h_y=H_y/H$, and $h_z=H_z/H$ are components of the unit vector h indicating the direction of the magnetic field H. The precession angle $\xi=(\varepsilon_\bullet/h)\Delta t$ is proportional to the time $\Delta t=\Delta s/V$ while the spin is affected by the magnetic field H and to the value of the Zeeman splitting $\varepsilon_\bullet=2\mu_n H$ of the neutron full energy in the magnetic field. Here $\mu_n=g_n he/(2m_n c)$ is the value of the neutron magnetic moment, m_n is the neutron mass, and $g_n=-1.913$ is the neutron gyromagnetic ratio.

In order to find the components of the polarization vector $P=(P_x,P_y,P_z)$ the rotation of which is described by the matrix representation R of the group SO(3) it is necessary to represent the matrix R in terms of components $u_x(t)$, $u_y(t)$, $u_z(t)$, $u_o(t)$:

$$R = \begin{pmatrix} (u_0^2+u_x^2)-(u_y^2+u_z^2) & 2(u_xu_y-u_0u_z) & 2(u_xu_z+u_0u_y) \\ 2(u_xu_y+u_0u_z) & (u_0^2+u_y^2)-(u_x^2+u_z^2) & 2(u_yu_z-u_0u_x) \\ 2(u_xu_z-u_0u_y) & 2(u_yu_z+u_0u_x) & (u_0^2+u_z^2)-(u_x^2+u_y^2) \end{pmatrix} .$$

The transformation $P(t)=R\,P(0)$ gives the components $P_x(t)$, $P_y(t)$, $P_z(t)$ of the measured polarization vector on the detector.

A most expedient application of the matrix approach based on the fundamental representation of the group SU(2) is the Monte-Carlo method in the treatment of experimental data.

REFERENCES:

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