Neutron Scattering in Condensed Matter Physics II

ETHZ 402-0544-00L, FS 2010

Dr. V. Pomjakushin and Prof. Dr. A. Zheludev

Series 3 - Representation analysis of Magnetic Structures

For the centrosymmetric and orthorhombic space group $Pbnm$ (D_{2h}^{16}) one finds eight different one-dimensional representations for a magnetic structure associated with the wave vector $\boldsymbol{k} = 0$.

	e	2_x	2_y	2_z	$\bar{1}$	$2_x\bar{1}$	$2_y\bar{1}$	$2_z\bar{1}$
$\Gamma_1=\Gamma_{1g}$	1	1	1	1	1	1	1	1
$\Gamma_2=\Gamma_{2g}$	1	1	−1	−1	1	1	−1	−1
$\Gamma_3=\Gamma_{3g}$	1	−1	1	−1	1	−1	1	−1
$\Gamma_4=\Gamma_{4g}$	1	−1	−1	1	1	−1	−1	1
$\Gamma_5=\Gamma_{1u}$	1	1	1	1	−1	−1	−1	−1
$\Gamma_6=\Gamma_{2u}$	1	1	−1	−1	−1	−1	1	1
$\Gamma_7=\Gamma_{3u}$	1	−1	1	−1	−1	1	−1	1
$\Gamma_8=\Gamma_{4u}$	1	−1	−1	1	−1	1	1	−1

Assume four spins S_j ($j = 1-4$) at the four equivalent centres of symmetry (0 0 0), (0 0 1/2), (1/2 1/2 1/2) and (1/2 1/2 0). The $3 \cdot 4 = 12$ dimensional vector space can be decomposed using the irreducible representations Γ_j ($j = 1-4$):

$$\Gamma^{12D} = 3\Gamma_1 + 3\Gamma_2 + 3\Gamma_3 + 3\Gamma_4.$$

Applying a projection operation along the x direction one obtains the following basis functions:

$$A_x = S_{1x} - S_{2x} - S_{3x} + S_{4x}$$
$$F_x = S_{1x} + S_{2x} + S_{3x} + S_{4x}$$
$$C_x = S_{1x} + S_{2x} - S_{3x} - S_{4x}$$
$$G_x = S_{1x} - S_{2x} + S_{3x} - S_{4x}$$

Find for each basis function the corresponding irreducible representation. Proceed as shown in the example during the lecture.