INTRODUCTION

The problem of classification magnetic equilibrium states for spin \( s = 1 \) systems in the presence of the vector and tensor order parameters has been considered. This problem is carried out on the basis of the quasiaverages conception [1]. The proposed approach does not use any kind of model of free energy as a functional of the order parameter and does not require temperatures close to the phase transition point [2]. For this approach it is significantly assumption of the residual (unbroken) symmetry of the degenerate state of equilibrium [3], and the presence of certain transformation properties of the order parameter[4].

MACROSSOPHIC APPROACH

In degenerate states, the magnetic degrees of freedom consist of the \( \hat{g} \) and \( \hat{a} \). The first of this matrix is the generator of the SU(3) symmetry, and second is the order parameter of degenerate states.

Without loss of generality, we can represent these matrices as follows:

\[
\begin{align*}
\hat{g}_{\alpha\beta} &= q_{\alpha\beta} - i e_{\alpha\beta\gamma} s_{\gamma} / 2 \\
\hat{a}_{\alpha\beta} &= m_{\alpha\beta} - i e_{\alpha\beta\gamma} n_{\gamma} / 2
\end{align*}
\]

Energy model

\[
e_{\text{symm}} = \frac{1}{2} J_{0} (\hat{S}_{\alpha\beta} \hat{S}_{\alpha\beta}^0) + \frac{1}{2} J_{0} (\hat{P}_{\alpha\beta} \hat{P}_{\alpha\beta}^0)
\]

Dynamic equation

\[
\dot{\hat{g}} = -i J [\hat{g}, \Delta \hat{g}] - i J [\hat{a}, \Delta \hat{a}] = -i e_{\alpha\beta\gamma} \frac{\partial f}{\partial (\hat{S}_{\alpha\beta} \hat{S}_{\alpha\beta}^0)} \left[ \hat{a}, \hat{g} \right] - i J [\hat{a}, \Delta \hat{g}]
\]

For simplicity, we consider equilibrium values in the following form:

\[
\begin{align*}
\hat{g}_{\alpha\beta} &= q_{\alpha\beta} \left( e_{\alpha\beta\gamma} p_{\gamma} - \delta_{\alpha\beta} \gamma / 3 \right) - i e_{\alpha\beta\gamma} n_{\gamma} / 2 \\
\hat{a}_{\alpha\beta} &= m_{\alpha\beta} \left( e_{\alpha\beta\gamma} p_{\gamma} - \delta_{\alpha\beta} \gamma / 3 \right) - i e_{\alpha\beta\gamma} n_{\gamma} / 2
\end{align*}
\]

1. Ferro-quadrupol states \( \hat{g}_{0} \neq 0 \)

Spectra: \( \omega = \pm J K^2 s_{\gamma}, \) \( \omega = \pm \left( s_{\gamma} + 2 q_{0} \right) J K^2 / 2 \)

2. Antiferro-nematic states \( \hat{g}_{0} = 0 \)

Problems of phenomenological approach: Model dependence of the energy and order parameter; The smallness of the order parameter (temperature the proximity to the phase transition point); Attempts to link phenomenological parameters of the free energy with the parameters of intermolecular interactions are faced with considerable difficulty; The extremum of the energy functional is not related to the residual symmetry of the equilibrium state.

MICROSSOPHIC APPROACH

Gibbs operator –

\[
\hat{W} = \exp \left( \Omega - Y \hat{g} \right)
\]

Additive integrals of motion -

\[
\hat{J}_{\mu}, \hat{S}_{\mu}, \hat{N}, \hat{S}, \hat{Q}
\]

SU(3) magnetic symmetry of exchange interaction

\[
\hat{W}, \hat{S}, \hat{N}, \hat{S}, \hat{Q}
\]

Magnetic order parameter:

\[
\hat{S}_{\mu}(x) = -i e_{\alpha\beta\gamma} (x) \hat{a}_{\alpha\beta}(x) / 2
\]

Spin nematic order parameter:

\[
\hat{S}_{\mu}(x) = -i e_{\alpha\beta\gamma}(x) / 2
\]

Antiferromagnet order parameter

SPONTaneous BREAKING of SU(3) SYMMETRY

Equations of classification

Nontrivial solutions for \( \Delta_{\alpha} \) and \( \Delta_{\beta} \) exist for parameters \( b, c \).

General case: \( b \neq 0 \),

\[
\begin{align*}
d_{\alpha\beta} & = d_{\alpha\beta}^{(0)} + d_{\alpha\beta}^{(1)} \\
\Delta & = h_{A} \Delta_{M} + h_{B} \Delta_{A} + h_{C} \Delta_{B} \\
\Delta_{\alpha} & = \Delta_{\alpha}(b_{\mu}, b_{\nu}, \Delta_{\alpha}(b_{\mu}, b_{\nu})) \neq 0.
\end{align*}
\]


