

## Next-neighbour interactions in BCSOS surface model

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In present work was considered further than nearest interaction in BCSOS surface model. Transfer-matrix approach was utilized to supersede studying of BCSOS thermodynamic properties by investigation of appropriate one-dimensional quantum model ground state. All calculations was performed in one-flip approach that corresponds to low temperature regime.

BCSOS model with the nearest neighbour interactions can be mapped to spin- $\frac{1}{2}$  anisotropic Heisenberg chain. By neglecting the non-commutativity of cofactors in transfer-matrix was shown that more distant interactions leads to arising of new terms proportional to  $s_j^z s_{j+k}^z$  in the spin Hamiltonian.

Calculation with taking into account the non-commutativity in transfer-matrix was also performed. The transfer-matrix was constructed in form  $e^{\hat{X}} e^{t\hat{Y}} e^{\hat{X}}$  and rewritten in limit  $t \ll 1$  as series of commutators  $[\hat{X}, \dots [\hat{X}, \hat{Y}] \dots]$ . Explicit representation for commutators allows to sum up series and write down complex Hamiltonian with multi-spin exchange interactions. Shown, that even for just nearest neighbour interactions in quantum Hamiltonian 4-spin exchange interactions exists and should be accounted.