Exact solution for the spin-chain model of alternating Ising and Heisenberg spins in arbitrary magnetic field

J. Strečka[a], M. Hagiwara[b], Y. Han[b], T. Kida[b], Z. Honda[c]

[a] *Department of Physics, Faculty of Science, P. J. Šafárik University, Park Angelinum 9, 040 01 Košice, Slovakia*
[b] *KYOKUGEN (Center for Quantum Science and Technology under Extreme Conditions), Osaka University, 1-3 Machikaneyama, Toyonaka, Osaka 560-8531, Japan*
[c] *Graduate School of Science and Engineering, Saitama University, 255 Simookubo Saitama, Saitama 338-8570, Japan*

The spin-chain model of alternating Ising and Heisenberg spins in arbitrary magnetic field is exactly solved by making use of the transfer-matrix method. The proposed model brings a deeper insight into the ferrimagnetism of bimetallic spin chains, which constitute two different but regularly alternating magnetic ions with unequal Landé factors. It is demonstrated that the low-temperature magnetization process depends basically on a spatial orientantion of the applied magnetic field with respect to the easy-axis direction of the Ising spins. The sharp stepwise magnetization curve, which is characteristic for the magnetic field applied along the easy-axis direction of the Ising spins, becomes gradually smoother if the external field is tilted from the easy-axis direction of the Ising spins. The angular dependence of the low-temperature magnetization curve of a single-crystal sample is investigated in particular. In addition, the low-temperature magnetization curve for a polycrystalline sample is also exactly calculated by performing the powder averaging of the derived magnetization formulae. The presented theoretical results shed light on the high-field magnetization curve of 3d-4f bimetallic chain $[Dy(NO_3)(DMSO)_2Cu(opba)(DMSO)_2]$, which can be regarded as the experimental representative of the spin-chain model of alternating Ising and Heisenberg spins formed by the highly anisotropic dysprosium(3+) and almost isotropic copper(2+) ions.

Acknowledgment: This work was partially supported under the grant VEGA 1/0234/12.