A new method to calculate transition lines near the Ashkin-Teller multicritical point

NOMURA, Kiyohide
Department of Physics, Kyushu University

MORIYA, Shunji
HIRUKAWA METAL Inc.

A new method to calculate transition lines
near the Ashkin-Teller multicritical point

Kiyohide NOMURA[1] and Shunji MORIYA[2]

[1] *Department of Physics, Kyushu University, JAPAN.*
[2] *HIRUKAWA METAL Inc., JAPAN*

A point where several critical lines intersect is called a multicritical point. Near such a point, multiple critical phenomena interfere each other, and finite-size corrections become very complicate. Ashkin-Teller model [1], which is composed with the two 2D Ising models, shows such a multicritical behavior: there are two 2D Ising type critical lines and one Gaussian critical line. Ashkin-Teller model can be mapped to the quantum S=1/2 XXZ spin chain with bond-alternation[2]

$$H = \sum_{j}(1 + \delta(-1)^{j})(S_{j}^{x}S_{j+1}^{x} + S_{j}^{x}S_{j+1}^{x} + \Delta S_{j}^{z}S_{j+1}^{z}).$$ (1)

Although there is the Bethe-Ansatz solution on the self-dual line($\delta = 0$), it is not known exact solutions for other regions, thus we must use numerical method. However, it was very difficult to treat numerically this model around the Ashkin-Teller multicritical point.

We have proposed a new method [3] to numerically calculate transition lines near the Ashkin-Teller multicritical point, by using twisted boundary conditions and the duality(see Fig. 1). And we apply our method for other non-solvable models.
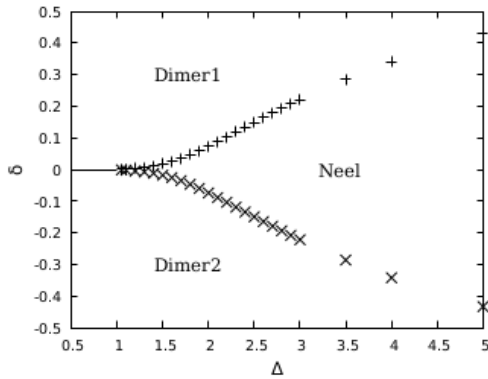

Figure 1: Ashkin-Teller multicritical behavior

References

[1] J. Ashkin and E. Teller, Phys. Rev. 64, 178 (1943).

[2] M.Kohmoto, M. den Nijs, and L. P. Kadanoff, Phys. Rev. B **24**, 5229 (1981).

[3] S. Moriya and K. Nomura, J. Phys. Soc. Jpn. **89**, 093001 (2020).