

Crystallizing the Spinon Basis

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Abstract: The quasi-particle structure of the higher spin XXZ model is studied. We obtained a new description of crystals associated with the level k integrable highest weight $U_q(\widehat{sl_2})$ modules in terms of the creation operators at $q = 0$ (the crystalline spinon basis). The fermionic character formulas and the Yangian structure of those integrable modules naturally follow from this description. We have also derived the conjectural formulas for the multi quasi-particle states at $q = 0$.

0. Introduction

In this paper, we consider the integrable XXZ spin chain with spin $k/2$ of sl_2 . The space of states is the infinite tensor product (the space of local fields)

$$\mathcal{W} = \dots \otimes \mathbf{C}^{k+1} \otimes \mathbf{C}^{k+1} \otimes \mathbf{C}^{k+1} \otimes \mathbf{C}^{k+1} \otimes \dots$$

In remarkable papers [7, 25], using the Bethe Ansatz, Faddeev and Takhtajan discovered that the one-particle excitation in the anti-ferromagnetic regime of XXX chain is always (a kink of) spin 1/2. According to this picture, one can expect another description of space of states [7, 23] such as (the space of asymptotic particles)

$$\mathcal{F} = \sum_{n=0}^{\infty} \left[\sum_{p \in \text{path}} \mathbf{C}((z_1, \dots, z_n)) \otimes [\otimes^n \mathbf{C}^2]_p \right]^{\text{Symm}},$$

where Symm is the symmetrization with respect to the S -matrix. On the other hand, stimulated by the deep results by Smirnov [24], the third description of the space of states in terms of the representations of $U_q(\widehat{sl_2})$ (the space of non-local symmetries) was proposed [5, 10]

$$\mathcal{H} = \sum_{i,j=0}^k V(\lambda_i) \hat{\otimes} V(\lambda_j)^*.$$

Here $V(\lambda_i)$ is the integrable highest weight representation of $U_q(\widehat{sl_2})$ and $\hat{\otimes}$ means some extended tensor product. The particle picture is recovered using the q -vertex operators acting among them.