論文の内容の要旨

論文題目　Quantum inverse scattering method for higher spin systems
（高次スピン系に対する量子逆散乱法）

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The integrable spin systems and the quantum field theories are studied. Integrable systems are of interest since they allow us to calculate exact expressions of physical quantities. Although only the massless case is considered in the thesis, the method used here is applicable to the massive regime, where the conformal field theory is unavailable.

As a starting point, we computed correlation functions of the higher-spin Heisenberg XXZ chain are derived for the massless regime. In the computation, we use the algebraic Bethe Ansatz, which recently made a big progress in the derivation of asymptotic behavior of long-distance two-point functions for the spin-1/2 case. The calculation of correlation functions can be done purely by the algebraic relations arisen from the Yang-Baxter equation, as a result of integrability.

Local spin operators in the correlation functions are expressed in terms of elements of the monodromy matrix by making use of the quantum inverse scattering method. In the extension to the higher-spin systems, we wrote local spin operators of higher-spin representations in terms of tensor products of spin-1/2 representations by utilizing the projection operator. Correlation functions of the

higher-spin system are obtained in multiple-integral expressions, which we expect will give asymptotic behavior of long-distance correlation functions, also for the higher-spin case, in the future. The result is compared with the spacial cases, such as the isotropic case and the spin-1/2 case.

The boundary effect in the integrable system is also studied. As an example of the integrable system with non-periodic boundary conditions, the supersymmetric sine-Gordon model with Dirichlet boundary conditions, which corresponds to the spin-1 XXZ model with boundary magnetic fields, are considered. The supersymmetric sine-Gordon model is the low-energy effective field theory of the spin-1 XXZ model. At the same time, the theory can be considered on the light-cone, as it is relativestic. The notion of discretization of the light cone was introduced, which made it possible to treat the system by the algebraic Bethe Ansatz. The Heisenberg spin-1 XXZ chain with inhomogeneity parameter gives the supersymmetric sine-Gordon model in the scaling limit.

The nonlinear integral equations are derived for arbitrary excited states and the constraints on the numbers of holes and roots are obtained. Unlike the sine-Gordon case, the counting functions are unclear in the supersymmetric case. Therefore, we used the auxiliary functions, which are defined in the context of the T-Q relation.

As a crucial effect of boundary conditions, it was known that boundary bound states appear when the boundary magnetic fields exceed the threshold. Also in the quantum field theory, boundary bound states were discussed in the reflection matrix point of view. By comparing the boundary terms of nonlinear integral equations with the integral expression of the reflection matrix, the boundary excitation is also discussed in the repulsive regime, whose energy coincides with the known result from the bootstrap approach.