

# Construction of Instantons and Skyrmions in dimensions higher than four

分子科学専攻 量子物理学

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Instantons are solutions to a Yang-Mills model. The four-dimensional, one time and three spaces, Yang-Mills model is a gauge theory which describes the behavior of the fundamental interactions without the gravitation, namely the electromagnetic, weak and strong interactions. It is known that instantons play important roles in the study of non-perturbative effects in gauge theories. Of particular importance for the instantons is its systematic generation method of solutions, known as the Atiyah-Drinfeld-Hitchin-Manin (ADHM) construction. We usually need to solve partial differential equations (PDEs) to obtain the instantons, but when using the ADHM construction then we suffice to only solve algebraic equations instead of PDEs. Moreover it is known that the ADHM construction can algebraically construct all the instantons.

One of other important solutions in particle physics is known as a Skyrmon. The Skyrmons are solutions to a four-dimensional (static) Skyrme model which is a model for element particles in the low-energy effective theory of the strong interaction. However, no analytic solutions of Skyrmon have been found yet, the numerical solutions are only known. Finding proper solutions of Skyrmons is a long standing problem. There are several directions to construct solutions. For example, the rational map ansatz provides a good approximation to the Skyrmon solutions. Alternatively, there is another promising approach to Skyrmons known as an Atiyah-Manton construction. The Atiyah-Manton construction gives well approximated static Skyrmon solutions from the holonomy of the Yang-Mills instantons.

We sometimes consider extra dimensional models, for example the Kaluza-Klein theory, the brane world scenario, the M-theory and others, to solve some modern physics problems. Hence, it is natural that we consider instantons and Skyrmons in higher dimensions. Indeed, several kinds of higher-dimensional “instantons” were proposed, and these have been studied in various contexts. Similarly it is an interesting topic that we study generalization of construction methods of instantons and Skyrmons in higher dimensions. This paper treats mainly the higher-dimensional ADHM construction of self-dual type instantons and the Atiyah-Manton construction of higher-dimensional Skyrmons.