

Multi-Soliton Dynamics of Anti-Self-Dual Gauge Fields

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We study dynamics of multi-soliton solutions of anti-self-dual Yang-Mills equations for $G = GL(2, \mathbb{C})$ in four-dimensional spaces. The one-soliton solution can be interpreted as a codimension-one soliton in four-dimensional spaces because the principal peak of action density localizes on a three-dimensional hyperplane. We call it the soliton wall. We prove that in the asymptotic region, the n -soliton solution possesses n isolated localized lumps of action density, and interpret it as n intersecting soliton walls. More precisely, each action density lump is essentially the same as a soliton wall because it preserves its shape and “velocity” except for a position shift of principal peak in the scattering process. The position shift results from the nonlinear interactions of the multi-solitons and is called the phase shift. We calculate the phase shift factors explicitly and find that the action densities can be real-valued in three kind of signatures. Finally, we show that the gauge group can be $G = SU(2)$ in the Ultrahyperbolic space U (the split signature $(+, +, -, -)$). This implies that the intersecting soliton walls could be realized in all region in $N=2$ string theories. It is remarkable that quasideterminants dramatically simplify the calculations and proofs.

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