From Linear to Nonlinear Integrable PDEs via the Riemann-Hilbert Formalism

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We show that by deforming the Riemann-Hilbert (RH) formalism associated with certain *linear* PDEs and using the so-called dressing method, it is possible to derive in an *algorithmic* way *nonlinear integrable* versions of these equations.

In the usual Dressing Method, one first *postulates* a matrix RH problem and then constructs dressing operators. Here we present an *algorithmic* construction of matrix Riemann-Hilbert (RH) problems appropriate for the dressing method as opposed to *postulating* them *ad hoc*. Furthermore, we introduce two mechanisms for the construction of the relevant dressing operators: The first uses operators with the same dispersive part, but with different decay at infinity, while the second uses pairs of operators corresponding to different Lax pairs of the same linear equation. As an application of our approach, we derive the NLS, derivative NLS, KdV, modified KdV and sine-Gordon equations.