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Soliton equations in $2 + 1$ dimensions: deformations of dispersionless limits

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We classify scalar third order soliton equations in $2 + 1$ dimensions which generalize the examples of Kadomtsev-Petviashvili, Veselov-Novikov and Harry Dym equations. Our approach is based on the observation that dispersionless limits of integrable systems in $2 + 1$ dimensions possess an infinity of multi-phase solutions coming from the so-called hydrodynamic reductions. proves to be an efficient classification criterion. In this paper we adopt a novel perturbative approach to the classification problem: based on the method of hydrodynamic reductions, we first classify integrable quasilinear systems which may (potentially) occur as dispersionless limits of soliton equations in $2 + 1$ dimensions. To reconstruct dispersive corrections, we require that all hydrodynamic reductions of the dispersionless limit are inherited by the corresponding dispersive counterpart. This procedure leads to a complete list of integrable third order equations, some of which are apparently new.

MSC: 35L40, 35Q51, 35Q58, 37K10, 37K55.

Keywords: dispersionless equations, hydrodynamic reductions, dispersive corrections, integrability.