Noncommutative (generalized) sine-Gordon/massive Thirring correspondence, integrability and solitons

Some properties of the correspondence between the non-commutative versions of the (generalized) sine-Gordon (NCGSG$_{1,2}$) and the massive Thirring (NCGMT$_{1,2}$) models are studied. Our method relies on the master Lagrangian approach to deal with dual theories. The master Lagrangians turn out to be the NC versions of the so-called affine Toda model coupled to matter fields (NCATM$_{1,2}$), in which the Toda field g belongs to certain subgroups of $GL(3)$, and the matter fields lie in the higher grading directions of an affine Lie algebra. Depending on the form of g one arrives at two different NC versions of the NCGSG$_{1,2}$/NCGMT$_{1,2}$ correspondence. In the NCGSG$_{1,2}$ sectors, through consistent reduction procedures, we find NC versions of some well-known models, such as the NC sine-Gordon (NCSG$_{1,2}$) (Lechtenfeld et al. and Grisaru-Penati proposals, respectively), NC (bosonized) Bukhvostov-Lipatov (NCbBL$_{1,2}$) and NC double sine-Gordon (NCDSG$_{1,2}$) models. The NCGMT$_{1,2}$ models correspond to Moyal product extension of the generalized massive Thirring model. The NCGMT$_{1,2}$ models posses constrained versions with relevant Lax pair formulations, and other sub-models such as the NC massive Thirring (NCMT$_{1,2}$), the NC Bukhvostov-Lipatov (NCBL$_{1,2}$) and constrained versions of the last models with Lax pair formulations. We have established that, except for the well known NCMT$_{1,2}$ zero-curvature formulations, generalizations ($n_{F} \ge 2$, $n_F=$number of flavors) of the massive Thirring model allow zero-curvature formulations only for constrained versions of the models and for each one of the various constrained sub-models defined for less than n_F flavors, in the both NCGMT$_{1,2}$ and ordinary space-time descriptions (GMT), respectively. The non-commutative solitons and kinks of the $GL(3)$ NCGSG$_{1,2}$ models are investigated.

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