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On Differential Equations Describing 3-Dimensional Hyperbolic Spaces

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Abstract: In this paper, we introduce the notion of a (2+1)-dimensional differential equation describing three-dimensional hyperbolic spaces (3-h.s.). The (2+1)-dimensional coupled nonlinear Schrödinger equation and its sister equation, the (2+1)-dimensional coupled derivative nonlinear Schrödinger equation, are shown to describe 3-h.s. The (2+1)-dimensional generalized HF model: $S_t=\{(1/2i)[S,S_y]+2i\sigma S\}_x$, $\sigma_x=-(1/4i)tr(SS_xS_y)$, in which $S\in[GL_C(2)]/[GL_C(1)\times GL_C(1)]$, provides another example of (2+1)-dimensional differential equations describing 3-h.s. As a direct consequence, the geometric construction of an infinite number of conservation laws of such equations is illustrated. Furthermore we display a new infinite number of conservation laws of the (2+1)-dimensional nonlinear Schrödinger equation and the (2+1)-dimensional derivative nonlinear Schrödinger equation by a geometric way.

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