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Symmetries, exact solutions, and nonlocal conservation laws

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The objective of the talk is to give an overview of my results – obtained under the supervision of Oleg I. Morozov – concerning geometrical structures associated to nonlinear partial differential equations (PDEs). On the example of the Gibbons-Tsarev equation it will be showed how to use a Lie group of local symmetries of a PDE to find its exact solutions. The procedure is a classical tool in the theory of applications of Lie groups to differential equations. The Khokhlov-Zabolotskaya (KhZ) equation was previously subjected to this procedure. In the talk it will be illustrated on the example of the KhZ equation how the method can still yield new solutions, if coupled with a Miura-type transformation.

A distinguishing feature of integrable PDEs is that they admit rich symmetry structures, but this can be often revealed only after examining them in nonlocal setting. The framework of differential coverings is particularly useful in this context. Within this framework, a Lie algebra of nonlocal symmetries of the second heavenly equation will be discussed. Another example of the strength of this framework will be presented in a review of the results concerning nonlocal conservation laws of several PDEs, related to each other via Bäcklund transformations. The presented results formed the core of my Ph.D. thesis.