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Symplectic properties of a hierarchy of the Riemann type hydrodynamic systems

The nonlinear Whitham-Riemann type hydrodynamic type system [1] can be written in the compact form (thanks to Darryll Holm for this observation)

$$D_t^2 u = 0, \quad (1)$$

where the flow operator $D_t = \partial_t + u\partial_x$ is well known in fluid dynamics [3]. Indeed, the aforementioned equation can be written as two related to each other equations of the first order

$$D_t u = z, D_t z = 0, \quad (2)$$

which is nothing else but exactly (1). Thus, an obvious generalization of (1) for an N -component case is written as

$$D_t^N u = 0, \quad (3)$$

where $N \in Z_+$ is arbitrary. In the report we discuss the symplectic properties of the above hydrodynamical system subject to its bi-Hamiltonian [2] Lax type integrability. Special results are obtained for $N = 3$. The corresponding Poissonian structures are constructed in exact form.

- [1] Bogolubov N.(jr.), Prykarpatsky A., Gucwa I. and Golenia J. Analytical properties of an Ostrovsky-Whitham type dynamical system for a relaxing medium with spatial memory and its integrable regularization. Preprint ICTP-IC/2007/109, Trieste, Italy. (available at: <http://publications.ictp.it>)
 - [2] Prykarpatsky A. and Mykytyuk I. Algebraic Integrability of nonlinear dynamical systems on manifolds: classical and quantum aspects. Kluwer Academic Publishers, the Netherlands, 1998, 553p.
 - [3] J. Marsden and R. Chorin. Mathematical theory of hydrodynamics.
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