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A special class of integrable Lotka-Volterra systems and their Kahan discretization

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Abstract

We present a family of integrable systems associated with a special set of polynomials $z_i^{(n)}$. The quadratic vector fields associated with $z_3^{(n)}$ are closely related to a class of Lotka-Volterra systems. We prove that they are superintegrable when n is odd and non-commutative integrable (of rank 2) when n is even. We also apply the Kahan-Hirota-Kimura discretization (a special Runge-Kutta method) to these quadratic vector fields, restricted to a subspace, and show that Liouville integrability and superintegrability are preserved. In the more general case of full, non-restricted, quadratic vector fields, numerical computations indicate integrability as well and therefore generate new questions for further investigation.

Key words: Integrable systems, Kahan-Hirota-Kimura discretization