# Bespoke finite difference methods that preserve two local conservation laws of the modified KdV equation.

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Conservation laws are among the most fundamental geometric properties of a given partial differential equation. However, standard finite difference approximations rarely preserve more than a single conservation law.

A novel symbolic-numerical approach, introduced in [1], exploits the fact that divergences belong to the kernel of the Euler operator to construct schemes that preserve multiple conservation laws. However, this approach is limited by the complexity of the symbolic computations, whose cost is high even when the nonlinearity in the PDE is only quadratic.

Some key simplifications, making the symbolic computations tractable, have been introduced in [2]. We apply this simplified strategy to the modified Korteweg-de Vries equation, having a cubic nonlinearity, to construct new bespoke finite-difference schemes that preserve the local conservation laws of the mass and of the energy.

[1] Grant, T. J., Hydon, P. E., 2013, Characteristics of conservation laws for difference equations. *Found. Comput. Math.* **13**: 667–692.

[2] Frasca-Caccia, G., Hydon, P. E., 2018, Simple bespoke preservation of two conservation laws. Preprint *arXiv:1805.03181v2*.