Exponentially Fitted Methods that Preserve Conservation Laws

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The solutions of PDEs modelling physical phenomena, typically satisfy a set of conservation laws. Conservation laws usually refer to some quantity with a precise physical meaning such as mass, momentum, energy or charge. They state that the change in the quantity within an arbitrary small region of the spatial domain, is given by the net amount of quantity that flows in or out of the volume.
From a mathematical point of view, conservation laws are among the most important geometric properties of a PDE and preserving them in the discrete setting confers local constraints on the behaviour of the numerical solutions and yields better accuracy over long integration times [3, 4].
When the solution has an oscillatory behaviour, it is well-known that exponentially fitted numerical methods perform much better than standard ones [1, 2]. In this talk we shall discuss a new technique to find exponentially fitted methods that preserve conservation laws. Numerical tests showing the effectiveness and conservative properties of the new methods will be presented.

References

[1] Calvo, M.P. Franco, J.M. Montijano, J.I. and Rández L. 2008 *Structure preservation of exponentially fitted Runge–Kutta methods.* J. Comput. Appl. Math. 218, 421–434.

[2] Cardone, A. D'Ambrosio, R. and Paternoster, B. 2017 *Exponentially fitted IMEX methods for advection–diffusion problems.* J. Comput. Appl. Math. 316, 100–108.

[3] Frasca-Caccia, G. and Hydon, P. E. 2020 *Simple bespoke preservation of two conservation laws.* IMA J. Numer. Anal. 40, 1294–1329.

[4] Frasca-Caccia, G. and Hydon, P. E. 2021 *A new technique for preserving conservation laws.* Found. Comput. Math. `https://doi.org/10.1007/s10208-021-09511-1`.