Solving cubic matrix equations arising in conservative dynamics

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In this paper we consider the spatial semi-discretization of conservative PDEs. Such finite dimensional approximations of infinite dimensional dynamical systems can be described as flows in suitable matrix spaces, which in turn leads to the need to solve polynomial matrix equations, a classical and important topic both in theoretical and in applied mathematics. Solving numerically these equations is challenging due to the presence of several conservation laws which our finite models incorporate and which must be retained while integrating the equations of motion. In the last thirty years, the theory of geometric integration has provided a variety of techniques to tackle this problem. These numerical methods require to solve both direct and inverse problems in matrix spaces. We present two algorithms to solve a cubic matrix equation arising in the geometric integration of isospectral flows. This type of ODEs includes finite models of ideal hydrodynamics, plasma dynamics, and spin particles, which we use as test problems for our algorithms.

Joint work with M. Benzi

References

[1] M. Benzi and M. Viviani, *Solving cubic matrix equations arising in conservative dynamics*, arXiv, (2021), https://arxiv.org/abs/2111.12373.