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Identification of self-similar characteristics in multiscale flows using low-rank approximation methods

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Low-rank multilevel approximation methods are often suited to attack high-dimensional problems successfully and they allow very compact representations of large data sets. Specifically, hierarchical tensor product decomposition methods, e.g., the Tree-Tucker format, [1], and the Tensor Train format, [2], emerge as a promising approach for application to big data that are concerned with cascade-of-scales problems as, e.g., in turbulent fluid dynamics. Beyond multilinear mathematics, those tensor formats are also successfully applied in e.g., physics or chemistry, where they are used in many body problems and quantum states.

Here, we focus on two particular objectives, that is representing turbulent data in an appropriate compact form and, secondly and as a long-term goal, finding self-similar structures in multiscale problems. In the first case, we test the reconstruction capabilities of a tensor product decomposition based approximation method using 3D turbulent channel flow data, and we test whether tensor decomposition methods are suitable for the development of compact storage schemes [3]. In the latter case, we aim at quantitative characterisations of self-similar and intermittent turbulence structures based on advanced data analysis techniques. The question here is whether those methods can support the development of improved understanding of the multiscale behavior.

REFERENCES

[1] W. Hackbusch and S. Kühn, A new scheme for the tensor representation, *J. Fourier Anal. Appl.*, Vol. **15**, pp. 706–722, 2009.

[2] I.V. Oseledets and E.E. Tyrtyshnikov, Breaking the curse of dimensionality, or how to use SVD in many dimensions, *SIAM J. Sci. Comput.*, Vol. **3**, pp. 3744–3759, 2009.

[3] Th. von Larcher and R. Klein, On identification of self-similar characteristics using the Tensor Train decomposition method with application to channel turbulence flow, *arXiv:1708.07780 [physics.flu-dyn]*, 2017.