

Christian Lubich: "Time integration of tree tensor networks"

Tuesday, January 17, 2023 11:30 AM (55 minutes)

First I report on recent numerical experiments with time-dependent tree tensor network algorithms for the approximation of quantum spin systems. I will then describe the basics in the design of time integration methods that are robust to the usual presence of small singular values, that have good structure-preserving properties (norm, energy conservation or dissipation), and that allow for rank (= bond dimension) adaptivity and also have some parallelism. This discussion of basic concepts will be done for the smallest possible type of tensor network differential equations, namely low-rank matrix differential equations. Once this simplest case is understood, there is a systematic path to the extension of the integrators and their favourable properties to general tree tensor networks.

This talk is based on joint work with many colleagues and former and present students, among which I wish to single out Othmar Koch for the first mathematical work on dynamical low-rank approximation (DLRA) in 2007, Ivan Oseledets for jointly finding the first robust DLRA integrator (the projector-splitting integrator) in 2014, Gianluca Ceruti for jointly finding the Basis Update & Galerkin (BUG) integrators in 2021, and him and Hanna Walach and Dominik Sulz for the recent systematic extension from low-rank matrices to general tree tensor networks.