Efficient Numerical Schemes for Highly Oscillatory Klein-Gordon and Dirac type Equations

Patrick Krämer (KIT Karlsruhe), Katharina Schratz

Klein–Gordon and Dirac equations physically describe the motion of relativistic particles. The construction of efficient numerical time integration schemes for solving these equations in the nonrelativistic limit regime, i.e. when the speed of light c formally tends to infinity, is numerically very delicate, as the solution becomes highly-oscillatory in time. In order to resolve the oscillations, standard time integrations schemes require severe restrictions on the time step $\tau \sim c^{-2}$ depending on the small parameter c^{-2} which leads to high computational costs.

In my talk, I will present numerical techniques based on [1] for efficiently solving these highly oscillatory systems without any time step restriction by exploiting their inherent time-oscillatory structure. We carry out the construction of these schemes by filtering out the highly oscillatory phases (in time) explicitly, which allows us to break down the numerical task to solving slowly oscillatory Schrödinger-type systems.

References

[1] S. Baumstark, E. Faou and K. Schratz, Uniformly accurate exponential-type integrators for Klein-Gordon equations with asymptotic convergence to the classical NLS splitting, *Math. Comp.* **87**(2018), pp. 1227–1254.