



DEPARTMENT OF APPLIED MATHEMATICS

應 用 數 學 系

**The Hong Kong Polytechnic University
Department of Applied Mathematics
Colloquium**

On splitting methods for the Dirac equation in the nonrelativistic limit regime

By

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Abstract

We establish error bounds of the Lie-Trotter splitting and Strang splitting for the Dirac equation in the nonrelativistic limit regime in the absence of external magnetic potentials. In this regime, the solution admits high frequency waves in time. Surprisingly, we find out that the splitting methods exhibit super-resolutions, i.e. the methods can capture the solutions accurately even if the time step size is much larger than the sampled wavelength. Lie splitting shows half order uniform convergence w.r.t temporal wave length. Moreover, if the time step size is non-resonant, Lie splitting would yield an improved uniform first order uniform error bound. In addition, we show Strang splitting is uniformly convergent with half order rate for general time step size and uniformly convergent with three half order rate for non-resonant time step size. We also discuss the case with external magnetic potentials, and splitting schemes also show superior performance among the commonly used numerical methods.

Bibliography

Prof. Cai Yongyong obtained his Bachelor and Master degrees from Peking University, and obtained his PhD from National University of Singapore in 2012. He was a postdoctoral researcher at the University of Wisconsin Madison, University of Maryland Park, and Purdue University. From 2016 to 2019, he was a distinguished researcher at Beijing Computational Science Research Center. Currently, he is a full professor at Beijing Normal University. Prof. Cai obtained Thousand Talents Plan in 2016 and NSFC grants later. He was the plenary speaker of many international conferences, including SciCADE 2019 held in Austria, which is one of the main conferences in the computational mathematics society. Prof. Cai's main research interest is the numerical computation and analysis of partial differential equations and their applications in the fields of quantum dynamics.

Date: 26 January 2022 (Wednesday)

Time: 15:30-16:30 (Hong Kong Standard Time GMT +8)

Venue: Online Talk via Zoom (Meeting ID: 932 3666 8259)

Speaker: Prof. Yongyong Cai, Beijing Normal University

Host: Dr. Buyang Li, The Hong Kong Polytechnic University

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