数学与系统科学研究院

计算数学所系列学术报告

报告人：Prof. Ernst Hairer

（ ***University of Geneva, Switzerland*** ）

报告题目：

Geometric Numerical Integration

邀请人： 唐贻发 研究员

报告时间：

2019 年 9 月 14 日（周六）上午 9:00-11:00
2019 年 9 月 16 日（周一）上午 9:00-11:00
2019 年 9 月 17 日（周二）上午 9:00-11:00

报告地点： 数学院南楼七层

702 教室

Abstract:

The lectures give an introduction to numerical methods that preserve geometric properties of the flow of a differential equation: symplectic integrators for Hamiltonian systems, symmetric integrators for reversible systems, methods preserving first integrals, etc. The main issue is long-time integration, which can be understood with the help of backward error analysis for ordinary differential equations, and with modulated Fourier expansions for problems with highly oscillatory solutions.

First lecture. The ideas of “geometric numerical integration” are presented. Main emphasis is put on symplectic methods applied to Hamiltonian differential equations. In particular, symplectic Runge–Kutta methods, splitting methods, and variational integrators are discussed.

Second lecture. The long-time behaviour of numerical integrators is explained by using backward error analysis. This is done by considering a modified differential equation and a modified Hamiltonian (for symplectic methods). A recent application of backward error analysis provides insight into the near-preservation of energy for the Boris algorithm in charged particle dynamics.

Third lecture. For problems, where high oscillations originate from a linear part in the differential equation (e.g., Fermi-Pasta-Ulam-type problems), trigonometric time integrators are considered. Besides the energy, which is exactly conserved, the oscillatory energy is nearly conserved (adiabatic invariant). Concerning the long-time behaviour, the technique of modulated Fourier expansions gives much insight.

Most of the material for these lectures are taken from the monograph "Geometric Numerical Integration" (see below). Further references are:

K. Feng, M.-Z. Qin. Symplectic geometric algorithms for Hamiltonian systems. Zhejiang Science and Technology Publishing House, Hangzhou, 2010. Translated and revised from the Chinese original.

E. Hairer, C. Lubich, G. Wanner, Geometric Numerical Integration. Structure-Preserving Algorithms for Ordinary Differential Equations. 2nd edition. Springer Series in Comput. Math., vol. 31, 2006.

B. Leimkuhler, S. Reich, Simulating Hamiltonian Dynamics. Cambridge Monographs on Applied and Computational Mathematics, vol. 14, 2004.

J.M. Sanz-Serna, M.P. Calvo, Numerical Hamiltonian Problems. Chapman & Hall, Appl. Math. and Math. Comput., vol. 7, 1994.

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