Conservative numerical methods and their applications

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Many models in science and engineering are described by differential equations. Often these equations have geometric invariants or conserved quantities, which are important for understanding their long term dynamics. Classic examples of conserved quantities include mass, momentum and energy. However, traditional numerical methods do not preserve such quantities in general, which can lead to large deviations in long-term simulations and predictions. In this talk, I will introduce a new class of numerical methods called "Discrete Multiplier Method". In contrast to traditional numerical methods, this approach can preserve multiple conserved quantities of arbitrary forms, up to machine precision. I will also survey its recent applications in classical mechanics, molecular dynamics, biological systems, fluid mechanics, nonsmooth systems, geodesic flow, computational statistics and machine learning.

This is joint work with past and current students, postdoc and collaborators: Alexander Bihlo (MUN), Cem Gormezano (Oxford), Anil Hirani (UIUC), Geoffrey McGregor (UNBC), Jean-Christophe Nave (McGill), Erick Schulz (ETH Zürich) and Nikolas Wojtalewicz (UIUC).

The talk is intended to be largely accessible for a wide audience in science and engineering. Undergraduate and graduate students are especially welcomed!

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