Multi-product expansion of solving Hamiltonian equations: Theory and Application in Levitron Problems

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This talk is about our recent research to develop time-integrators for symmetric rigid bodies. The ideas are to apply second order Poisson integrators and generalize to higher order schemes via multi-product expansion. First we present the underlying model-problems based on a magnetic top in an axisymmetric magnetic fields (Levitron problem). Next we discuss the time-integrator based on the Poisson integrators with the time-stepping operator $\exp h(A+B)$ and its products of $\exp hA$ and $\exp hB$. In the context of solving Hamiltonian dynamics, see [1], we discuss an alternative approach to higher order schemes based on Suzuki's forward-time derivative. Structure preserving ideas are given with respect to momentum preserving of the underlying Poisson integrator and its extensions. We discuss the convergence analysis and a generalization of the extrapolation method, see [2]. Numerical experiments are given with test and benchmark algorithms and real-life stability discussions for a Levitron problem, see [3].

References

[1] J. Geiser and S. Chin. *Multi-product operator splitting as a general method of solving autonomous and non-autonomous equations.* IMA Journal of Numerical Analysis, accepted, June 2010.

[2] J. Geiser. *Multi-product expansion with Suzukis method: Generalzation.* Numerical Mathematics: Theory, Methods and Applications, accepted, March 2010.

[3] J. Geiser and K. F. Lüskow. *Splitting methods for Levitron Problems*. Preprint in arXiv, 2012.