Contribution ID: **7** Type: **not specified**

# The $\varphi(A)$bulous matri$\otimes$ functions in exponential integrators for problems with Kronecker structure

*Tuesday, 26 September 2023 09:45 (45 minutes)*

In this talk, we consider two efficient ways to approximate actions of $\varphi$-functions for matrices $A$ with a $d$-dimensional Kronecker sum structure, that is $A = A_d \oplus \cdots \oplus A_1$. The first one is based on the approximation of the integral representation of the $\varphi$-functions by Gaussian quadrature formulas combined with a scaling and squaring technique. The resulting algorithm evaluates the required exponential actions using Tucker operators, which are realized in a $\mu$-mode fashion by exploiting the high performance level 3 BLAS. The whole procedure involves exponentials of the *small sized* matrices $A_\mu$, does not require forming the *large sized* matrix $A$, and allows for the computation of linear combinations of actions of $\varphi$-functions, too. The second one is based on a direction splitting and it is suitable for approximating actions of $\varphi$-functions for well-established exponential integrators. The desired actions are realized in an efficient way again in a $\mu$-mode fashion by using few Tucker operators. The two approaches have been successfully tested on Riccati differential equations and on 2D and 3D semidiscretized partial differential equations, with various exponential integrators, showing consistent speedups with respect to state-of-the-art techniques to approximate (linear combinations of) actions of $\varphi$-functions.

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**Session Classification:** Invited talks