

# On Block-Krylov Subspace Iterations and the AMP Eigensolver Software

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This talk is concerned with the efficient computation of the smallest eigenvalues and the corresponding invariant subspace of an FE-discretized self-adjoint and elliptic partial differential operator. We demonstrate an implementation of block-Krylov subspace iterations in the AMP Eigensolver software (<http://www.math.uni-rostock.de/ampe>) which combines adaptive mesh refinement with preconditioned iterations for matrix eigenproblems. Further, we report on recent results [5] on the convergence analysis of block-Krylov subspace iterations. Therein an estimate by Saad [1] is improved by changing the underlying auxiliary vectors, and an estimate by Knyazev [2] is generalized based on our previous results on blockwise gradient iterations [3] and restarted Krylov subspace iterations [4].

## References:

- [1] Y. Saad, *On the rates of convergence of the Lanczos and the block-Lanczos methods*, SIAM J. Numer. Anal. 1980, 17(5): 687–706.
- [2] A.V. Knyazev, *Convergence rate estimates for iterative methods for a mesh symmetric eigenvalue problem*, Russian J. Numer. Anal. Math. Modelling 1987; 2(5): 371–396.
- [3] K. Neymeyr and M. Zhou, *Iterative minimization of the Rayleigh quotient by block steepest descent iterations*, Numer. Linear Algebra Appl. 2014; 21(5): 604–617.
- [4] K. Neymeyr and M. Zhou, *Convergence analysis of restarted Krylov subspace eigensolvers*, SIAM J. Matrix Anal. Appl. 2016; 37(3): 955–975.
- [5] M. Zhou, *Convergence estimates of nonrestarted and restarted block-Lanczos methods*, Numer. Linear Algebra Appl. 2018; e2182, <https://doi.org/10.1002/nla.2182>.

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