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**On convergence behavior of block GMRES and related methods**

**Abstract**

We focus on block Krylov subspace methods for non-Hermitian systems, in particular on block GMRES. While it is known that any non-increasing convergence curve is possible for standard GMRES with one right-hand side and a matrix with a given spectrum, no analog of this result is currently available for block methods, when multiple systems are solved at once. Using a recent framework for studying these methods as being a single linear system over a  $*$ -algebra of complex matrices, we show what convergence behavior is admissible for block GMRES and provide a full characterization of matrices and right-hand sides producing such behavior. At the end, we will also present some new results regarding convergence of block GMRES with restarts.