# Solution of f(A)x = b with Krylov subspace information

#### 11.1 Introduction

In this chapter, I expand on an idea for exploiting Krylov subspace information obtained for the matrix A and the vector b. This subspace information can be used for the approximate solution of a linear system f(A)x = b, where f is some analytic function,  $A \in \mathbb{R}^{n \times n}$ , and  $b \in \mathbb{R}^n$ . I will make suggestions on how to use this for the case where f is the matrix sign function. The matrix sign function plays an important role in QCD computations, see for instance [147].

In [197] an approach was suggested for the use of a Krylov subspace for the computation of approximate solutions of linear systems

f(A)x = b.

The approach was motivated by the function  $f(A) = A^2$ , which plays a role in the solution of some biharmonic systems. The approach is easily generalized for nonsymmetric complex matrices, but we may have to pay more attention to the evaluation of f for the reduced system, associated with the Krylov subspace.

In particular, I will discuss some possible approaches in which the Krylov subspace is used for the computation of sign(A)p for given vectors p. With the evaluation of the matrix sign function we have to be extremely careful. A popular approach, based on a Newton iteration, converges fast, but is sensitive for rounding errors, especially when A is ill-conditioned. We will briefly discuss a computational method that was suggested (and analysed) by Bai and Demmel [15]. This approach can also be combined, in principle, with the subspace reduction technique.

# **Iterative Krylov Methods For Large Linear Systems**

O García

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