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# A new iteration method for a class of complex symmetric linear systems*

Teng Wang† Qingqing Zheng‡ Linzhang Lu§

**Abstract.** In this paper, a new iteration method is proposed for solving the complex symmetric linear systems. In theory, we show that the convergence factor or the upper bound of the spectral radius of the iteration matrix of the new method are smaller than that of the PMHSS method proposed by Bai, Benzi and Chen (Numer. Algor. (2011)56:297-317). Moreover, we analyze and compare the parameter-free versions and the spectrum distributions of the preconditioned matrix of the new method and the PMHSS method. Finally, we present some numerical experiments on a few model problems to illustrate the theoretical results and show the effectiveness of our new method.

**Key words.** complex symmetric linear system, PMHSS method, convergence theory, iterative methods, numerical experiment

**AMS subject classifications.** 15A24, 65F10

## 1 Introduction

In this paper, we consider the following system of linear equations:

$$Ax = (W + iT)x = b, \quad A \in C^{n\times n} \quad \text{and} \quad x, b \in C^n, \tag{1}$$

where A is a nonsingular complex symmetric matrix, W; T are real, symmetric and positive semidenite matrices. Here, we do not impose the restriction that at least one of W and T, e.g., W, is positive definite, as in [7].

The system such as (1) is important and arises in a variety of scientific and engineering applications. For example, diffuse optical tomography [1], FFT-based solution of certain time-dependent PDEs [16], molecular scattering [30], lattice quantum chromody-namics [24], quantum chemistry, and eddy current problem [4]. For more examples, we refer to [2, 6, 8, 12, 13, 18–21, 26, 27, 33–36, 39] and the references therein.

To solve efficiently the complex symmetric linear system (1), one approach is to deal with some $2n \times 2n$ equivalent real formulations to avoid solving the complex linear system [2,3,15], and the other is to tackle the $n\times n$ linear system (1) directly, such as conjugate

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