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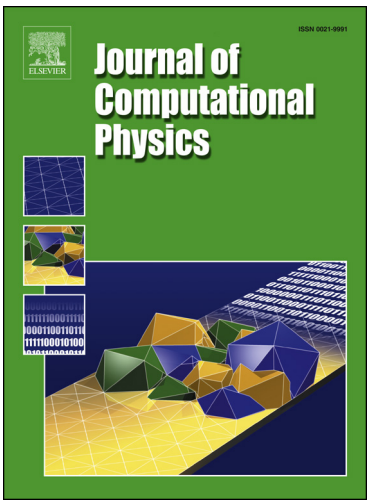

Anderson acceleration and application to the three-temperature energy equations

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Anderson acceleration and application to the three-temperature energy equations ⋆

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Abstract

The Anderson acceleration method is an algorithm for accelerating the convergence of fixed-point iterations, including the Picard method. Anderson acceleration was first proposed in 1965 and, for some years, has been used successfully to accelerate the convergence of self-consistent field iterations in electronic-structure computations. Recently, the method has attracted growing attention in other application areas and among numerical analysts.

Compared with a Newton-like method, an advantage of Anderson acceleration is that there is no need to form the Jacobian matrix. Thus the method is easy to implement. In this paper, an Anderson-accelerated Picard method is employed to solve the three-temperature energy equations, which are a type of strong nonlinear radiation-diffusion equations. Two strategies are used to improve the robustness of the Anderson acceleration method. One strategy is to adjust the iterates when necessary to satisfy the physical constraint. Another strategy is to monitor and, if necessary, reduce the matrix condition number of the least-squares problem in the Anderson-acceleration implementation so that numerical stability can be guaranteed. Numerical results show that the Anderson-accelerated Picard method can solve the three-temperature energy equations efficiently. Compared with the Picard method without acceleration, Anderson acceleration can reduce the number of iterations by at least half. A comparison between a Jacobian-free Newton-Krylov method, the Picard method, and the Anderson-accelerated Picard method is conducted in this paper.

Key words: Anderson acceleration, Picard method, fixed-point iteration, Jacobian-free Newton-Krylov, iteration acceleration, three-temperature energy equations