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# THE PARAMETRIZED $SR$ ALGORITHM FOR HAMILTONIAN MATRICES*

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**Abstract.** The heart of the implicitly restarted symplectic Lanczos method for Hamiltonian matrices consists of the $SR$ algorithm, a structure-preserving algorithm for computing the spectrum of Hamiltonian matrices. The symplectic Lanczos method projects the large, sparse $2n \times 2n$ Hamiltonian matrix $H$ onto a small, dense $2k \times 2k$ Hamiltonian $J$-Hessenberg matrix $\widetilde{H}$, $k \ll n$. This $2k \times 2k$ Hamiltonian matrix is uniquely determined by $4k - 1$ parameters. Using these $4k - 1$ parameters, one step of the $SR$ algorithm can be carried out in $\mathcal{O}(k)$ arithmetic operations (compared to $\mathcal{O}(k^3)$ arithmetic operations when working on the actual Hamiltonian matrix). As in the context of the implicitly restarted symplectic Lanczos method the usual assumption, that the Hamiltonian eigenproblem to be solved is stable, does not hold, the case of purely imaginary eigenvalues in the $SR$ algorithm is treated here.

**Key words.** Hamiltonian matrix, eigenvalue problem, $SR$ algorithm

**AMS subject classifications.** 65F15

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