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Abstract for an Invited Paper
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Bond bipolarons and high temperature superconductivity.[1]

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Polarons originating from phonon displacement modulated hopping have relatively light masses and, thus, are of significant current interest as candidates for bipolaron mechanism of high-temperature superconductivity. We observe that the bond model, when the dominant coupling comes from atomic vibrations on lattice bonds, can be solved by efficient sign-free Monte Carlo methods based on the path-integral formulation of the particle sector. We introduce the corresponding algorithms and provide results for singlet bipolarons in two dimensions. Estimates for the superconducting temperature are exceeding predictions based on the Eliashberg theory and suggest that the route towards high transition temperature in the multiparametric space of the model lies between the Scylla of large size of moderately light bipolarons and Charybdis of large mass of compact bipolarons. As a result, on-site repulsion and relatively narrow electronic bands are helping s-wave superconductivity in sharp contrast with existing expectations.

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