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**Variational ground states of 2D antiferromagnets in the valence-bond basis**[1] JIE LOU, ANDERS SANDVIK, Boston University — We use a variational method to study two-dimensional $S = \frac{1}{2}$ Heisenberg antiferromagnets in the valence bond basis. The wave function is of the form

$$| \psi\rangle = \prod h(x_{ij}, y_{ij})(i, j),$$

where $(i, j)$ represents a singlet formed by the spins at sites $i$ and $j$;

$$(i, j) = \frac{1}{\sqrt{2}}(\uparrow_i\downarrow_j - \downarrow_i\uparrow_j),$$

and $h(x_{ij}, y_{ij})$ is the amplitude corresponding to a bond coneenting two spins with seperation $(x_{ij}, y_{ij})$. The form $h \sim \frac{1}{r^p}$, where $r$ is the distance, was studied prevously. The best variational energy was obtained for $p = 4$. Now we optimize all $h(x, y)$by combining a standard Newton method and a conjugate gradient method. For systems with up to $16 \times 16$ spins, the energy of the optimized wave function deviates by less than 0.1% from the exact ground state energy. The spin-spin correlations are also very well reproduced. The exponent $p = 3$ in agreement with recent Monte Carlo simulations. We also investigates this class of wave functions for a quantum-critical bilayer model.

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