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Geometrically representing spin correlations IAN G. WHITE, ANTHONY MIRASOLA, JACOB HOLLINGSWORTH, RICK MUKHERJEE, KADEN R. A. HAZZARD, Rice University — We develop a general method to visualize spin correlations, and we demonstrate its usefulness in ultracold matter from fermions in lattices to trapped ions and ultracold molecules. Correlations are of fundamental interest in many-body physics: they characterize phases in condensed matter and AMO, and are required for quantum sensing and computing. However, it is often difficult to understand even the simplest correlations – for example between two spin-1/2's – directly from the components $C^{ab} = \langle S_1^a S_2^b \rangle - \langle S_1^a \rangle \langle S_2^b \rangle$ for $\{a, b\} \in \{x, y, z\}$. Not only are the nine independent C^{ab} unwieldy, but considering the components also obscures the natural geometric structure. For example, simple spin rotations lead to complex transformations among the nine C^{ab}. We provide a one-to-one map between the spin correlations and certain three-dimensional objects, analogous to the map between single spins and Bloch vectors. This object makes the geometric structure of the correlations manifest. Moreover, much as one can reason geometrically about dynamics using a Bloch vector – e.g. a magnetic field causes it to precess and dephasing causes it to shrink – we show that analogous reasoning holds for our visualization method.

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