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Frustrated Orbital Exchange Models in p-band Mott Insulators

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We investigate the general structure of orbital exchange physics in Mott-insulating states of p-orbital systems. Orbital orders occur in both the triangular and kagome lattices. In contrast, orbital exchange in the honeycomb lattice is frustrated as described by a novel quantum 120° model. Its classical ground states are mapped into configurations of the fully packed loop model with an extra U(1) rotation degree of freedom. Quantum orbital fluctuations select a six-site plaquette ground state ordering pattern in the semiclassical limit from the "order from disorder" mechanism. This effect arises from the appearance of a zero energy flat band of orbital excitations.

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