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Spin Liquid Induced By Ring Exchange in κ-(BEDT-TTF)$_2$X and Et$_n$Me$_{4-n}Pn$[Pd(dmit)$_2$]$_2$

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We model the Mott insulating phases of quasi-two dimensional organic charge-transfer salts κ-(BEDT-TTF)$_2$X and Et$_n$Me$_{4-n}Pn$[Pd(dmit)$_2$]$_2$ by a modified Heisenberg model on the anisotropic triangular lattice which include both Heisenberg exchange and ring exchange. Using the semi-classical spin wave approximation, we study the interplay of magnetic frustration and ring exchange on the ground state properties and excitation spectra. Surprisingly, we find that ring exchange strongly suppresses the long-range antiferromagnetic order and induces a large region of the phase diagram without long-range order due to strong quantum fluctuations. In addition, we find general conditions for the behaviour of the spin-excitation spectrum in the quantum critical regime. For the pure Heisenberg model, the spin-excitation spectrum softens and the spin-velocity vanishes. When ring-exchange is included in the model, an instability in the spin excitation-spectrum develops and results in the ordered phase undergoing a first order transition to a spin-liquid phase. Combined with recent electronic structure calculations [1] the results obained provide constraints on whether antiferromagnetic long-range order or a spin-liquid will be observed experimentally in these materials.

[1] E. P. Scriven and B. J. Powell, Phys. Rev . Lett. **109**, 097206 (2012).