Quantum Dance of Electrons and Spins: Unraveling the Intricate Interplay in Magnetic Systems

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Welcome aboard on this thrilling journey through the realm of quantum mechanics with this bachelor's thesis! We're setting sail into a model system, a microcosm brimming with various and competing magnetic interactions. Think of this system as a magnetic playhouse where two localized magnetic moments, or "spins", and a single itinerant electron—that hops between two orbitals—put on a captivating show.

These magnetic actors aren't merely two-dimensional characters; they're full of complexities, and it's these complexities that we aim to explore. Picture our spins as actors donning different costumes, sometimes fully quantum, sometimes hybrid quantum-classical, and other times fully classical. Their performances change with each role, and this system is their stage. The spins engage in a dramatic interplay via Heisenberg exchange and Dzyaloshinskii-Moriya interaction (DMI), while the itinerant electron, always quantum-mechanically treated, binds to the spins through s-d (Kondo-like) coupling.

But what's a play without a twist? Our plot revolves around comparing the results from these three distinct approaches to treating the spins. The burning question is: which approach best captures the magnetic dance taking place on our stage? As the curtain rises, our initial findings suggest that coherence between the different methods improves when the DMI term plays a smaller role than the others. Moreover, slow perturbations in the plot seem to enhance the agreement between the solutions.

There's no cut-and-dry ending to this quantum tale. The hybrid quantum-classical solutions often align more closely with the full quantum solution than the fully classical ones. However, discrepancies arising may be due to quantum plot twists and entanglement. What's next in this magnetic drama? Further research might continue this saga by thoroughly exploring the parameter space to pinpoint under what conditions mixed quantum-classical methods perform best.

So fasten your seatbelts, folks! Join us on this exhilarating journey as we delve deeper into the magnetic universe, pushing the boundaries of our understanding of quantum mechanics and magnetic systems. There's plenty to learn and lots to ponder, so let's set the stage and watch the magnetic dance unfold!