

Contents

Acknowledgement	i
Abstract	ii
1 Introduction	1
1.1 Quantum spin liquids	1
1.2 Honeycomb Kitaev model	3
1.3 Experimental proposals	5
1.4 Purpose of this thesis	8
1.5 Organization of this thesis	8
2 Model and Method	9
2.1 Multi-orbital Hubbard model	9
2.2 Kramers doublet	10
2.2.1 Low-spin d^5 case	10
2.2.2 High-spin d^7 case	13
2.3 Hopping Hamiltonian	17
2.4 Second-order perturbation	18
3 Result	21
3.1 Effective spin model	21
3.2 High-spin d^7 case	22
3.2.1 Effective Hamiltonian	22
3.2.2 Ground-state phase diagram	24
3.3 Low-spin d^5 case	24
3.3.1 Effective model	24
3.3.2 Ground-state phase diagram	25
4 Discussion	27
5 Summary	31

A	Intermediate states for the d^7 case	33
A.1	$t_{2g}-t_{2g}$ processes	33
A.2	$t_{2g}-e_g$ processes	36
B	Intermediate states for the d^5 case	40
B.1	$t_{2g}-t_{2g}$ processes	40
B.2	$t_{2g}-e_g$ processes	41