Low temperature properties of the spin-1 Heisenberg antiferromagnet with nearest and next-nearest neighbour couplings and single ion anisotropy on the honeycomb lattice

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Possible existence of quantum spin liquid states in the spin-1 Heisenberg model with Single Ion Anisotropy (SIA) on the honeycomb lattice has motivated recent studies of its low temperature properties (Xu et al [PRL 108, 087204 (2012)], Chen et al (CHR) [PRL 109, 016402 (2012)]). Here we derive a low temperature theory of the model built over the paramagnetic phase using the the Green's function equations of motion in the Standard Basis Operator (SBO) formalism within the RPA approximation. For the 3-d case, our results are in broad agreement with those of CHR suggesting the low temperature putative spin liquid properties of the model can be explained through proximity of the system to the paramagnet-spin spiral quantum phase transition. In 2-d, however, we obtain a region of parameters where the system does not attain conventional magnetic ordering, suggesting the possibility of more exotic ordering.