# THE SAGA OF $BACO_2(ASO_4)_2$

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A honeycomb compound BaCo2(AsO4)2 has been studied since 1970s, where using inelastic neutron scattering it was shown to exhibit a spiral state [1]. Recently, BaCo2(AsO4)2 was also put in spotlight due to recent interest in cobalt-based honeycomb materials [2]. They were proposed to host Kitaev exchange model [3], an exactly solvable model that has Majorana excitations with topological properties [4]. Recent INS also showed that BaCo2(AsO4)2 has unique double-zigzag ground state [5] and a plateau in the magnetization process [1,2].

We have performed an extensive search through a eight-parameter phase space of the Kitaev-Heisenberg model and showed that third-neighbor anisotropic Kitaev-type interaction is the one necessary for stabilization of double-zigzag, which we also confirmed by DMRG calculations [6]. We have also calculated field phase diagram for the minimal model that stabilizes double-zigzag ground state and establish a parameter regime where experiementally observed sequence of magnetic phase transitions is realized [7].

## References

[1] L.-P. Regnault, P. Burlet, J. Rossat-Mignod, *Magnetic ordering in a planar X-Y model: BaCo2(AsO4)2*, Physica B+C **86–88**, 660 (1977).

[2] R. Zhong, T. Gao, N. P. Ong, R. J. Cava, *Weak-field induced nonmagnetic state in a Co-based honeycomb*, Sci. Adv. **6**, eaay6953 (2020).

[3] H. Liu, J.Chaloupka, and G. Khaliullin, *Kitaev Spin Liquid in 3d Transition Metal Compounds*, Phys. Rev. Lett. **125**, 047201 (2020).

[4] A. Kitaev, *Anyons in an exactly solved model and beyond*, Annals of Physics **321**, 2 (2006).

[5] L.-P. Regnault, C. Boullier, J.E. Lorenzo, P*olarized-neutron investigation of magnetic ordering and spin dynamics in BaCo2(AsO4)2 frustrated honeycomb-lattice magnet,* Heliyon **4**, e00507 (2018).

[6] P.A. Maksimov, A.V. Ushakov, Z.V. Pchelkina, Y. Li, S.M. Winter, and S.V. Streltsov, *Ab initio guided minimal model for the "Kitaev" material BaCo2(AsO4)2: Importance of direct hopping, third-neighbor exchange, and quantum fluctuations*, Phys. Rev. B **106**, 165131 (2022).