Interplay of spin-orbit coupling and altermagnetism in two-dimensional altermagnets

Marko Milivojević*,[1,2] Marko Orozović,[3] Timon Moško,[4] Silvia Picozzi,[5] Martin Gmitra,[4,6] and Srdjan Stavrić[3]

[1] Institute of Informatics, Slovak Academy of Sciences, Bratislava, Slovakia; [2]Faculty of Physics, University of Belgrade, Belgrade, Serbia; [3]Vinča Institute of Nuclear Sciences, University of Belgrade, Belgrade, Serbia; [4]Institute of Physics, Pavol Jozef Šafárik University in Košice, Košice, Slovakia; [5]Department of Materials Science, University Milan-Bicocca, Milan, Italy; [6]Institute of Experimental Physics, Slovak Academy of Sciences, Košice, Slovakia;
marko.milivojevic@savba.sk

Receiving increasing interest in the field of spintronics are a type of magnets known as altermagnets[1,2], which exhibit zero net magnetization and feature spin-split electronic bands. Using the combination of the density functional theory and symmetry analysis we show that RuF_4 monolayer is a two-dimensional d-wave altermagnet[3]. Furthermore, we show that spin-orbit coupling has a pronounced effect on the splitting of the electronic bands of RuF_4, giving rise to pronounced spin splitting of the electronic bands at the Γ point by ∼100 meV and turning this material into a weak ferromagnet. We explain the appearance of weak ferromagnetism and the spin splitting at the Γ point using the group theory and extend our analysis to other two-dimensional altermagnets (VF_4 and OsF_4) recently discovered[4,5]. Finally, we argue that the canted weak ferromagnetism in two-dimensional altermagnets gives rise to the Rashba-Edelstein effect which could be easily detected in charge-spin conversion experiments[6].

References

1. Yuan, L. D.; Wang, Z.; Luo, J.-W.; Rashba, E. I.; Zunger, A. *Physical Review B*, **2020**, 102, 014422.
2. Šmejkal, L.; Sinova, J.; Jungwirth, T. *Physical Review X*, **2022**, 12, 031042.
3. Milivojević, M.; Orozović, M.; Picozzi, S.; Gmitra, M.; Stavrić, S. *2D Materials*, **2024**, 11, 035025.
4. Sødequist, J.; Olsen, T. Applied Physics Letters, **2024**, 124, 182409.
5. Orozović, M.; Moško, T.; Milivojević, M.; Gmitra, M.; Stavrić, S. *in preparation.*
6. Ghiasi, T. S.; Kaverzin, A. A.; Blah, P. J.; van Wees, B. J. *Nano Letters*, **2019**, 19, 5959–5966.