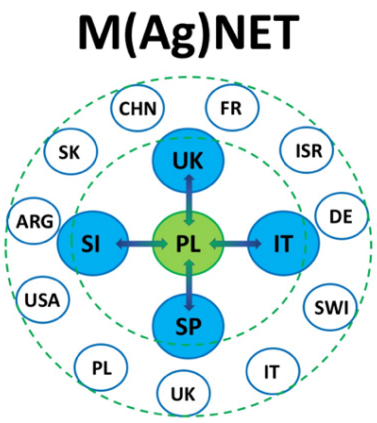
M(Ag)NET: *Novel quantum magnets and precursors of superconducting materials based on divalent silver* – popular-scientific abstract

Magnets are all around us: look at the earliest navigation system humans had, a compass, at different electromagnetic devices, at an electric motor, at a classical magnetic tape sound and image recording systems, at your computers magnetic hard drive, at magnetic resonance imaging in hospitals, and more. Magnetic devices are even more fancy and very small these days with the dawn of the new era of spintronics and of molecular machines. To exhibit "strong" magnetic features, a system should have some unpaired electrons (1, 2, 3, etc.) in an atomic center. In this project we will explore chemical compounds based on silver 2+, or divalent silver as chemists call it, which has 1 unpaired electron hence it fulfills this key criterion. This is a silver atom from which two electrons were removed, a positive-charge species, a cation – as scientists call it.

Why this research topic? Recently we have showed that compounds of silver 2+ show the strongest magnetic interactions among all materials known to men. And now we would like to push these boundaries even more! It is not just of curiosity that we want to learn how strong these interactions could be, but this could also have many practical and daily life applications. We would like also to find out examples of so called "exotic" magnetism in these systems, and by "exotic" we mean that they are so rare or weird that they surprise even the scientists. Based on our recent calculations, which give us good hint about the most promising directions, we expect to push the limits in materials, which show zero- (like a molecule), one- (like a wire) and two-dimensional (like a sheet of paper) features. In addition, we hope to achieve breakthrough in the field of so-called superconductivity by demonstrating that it is possible to achieve it in silver compounds.



How will we do it? We are planning to prepare novel chemical compounds which contain silver 2+ and explore their properties in depth. We will use both experiments and theory to understand their behavior. To prepare them we will use the most reactive element known, called fluorine, which is known as T-Rex of the Periodic Table. We will use not only the ambient temperature and pressure conditions but we will also squeeze some samples to huge pressures to see how they would behave. We will even do some explosions to see whether we can enforce some stubborn chemical reactions or at least prepare good quality samples. Explosions are fun! Finally, we will employ many cutting-edge methods to study our samples. We will skip their acronyms here as even scientists sometimes mess them up…!

To do this research and achieve our ambitious goals a lot of diverse expertise and resources are needed. This is why M(Ag)NET is an international network vortexed in Warsaw. The four key collaborators will come from UK, Spain, Italy and Slovenia, with an over dozen more auxiliary partners worldwide. All are either physicists or chemists. A lot of research time will be spent in huge (inter)national facilities in France, Germany, UK, and Switzerland, which are financed by their governments with some international support, thus reducing financial burden of the Polish NCN. Your scientists will be trained in the-state-of-the-art modern science and will disseminate their knowledge to other scientists and also popularize it in our societies.

It is impossible, impractical and not so clever trying to mix all 118 elements from the Periodic Table in different combinations and see what will happen. Infinite time and money would be needed for this! Therefore, we will save a lot of time, money, and human resources by employing the artificial intelligence. We will perform AI-supported calculations using supercomputers to guide us further and deeper into the most promising systems without the need to prepare all of them in the lab.