Pardeep Kumar Tanwar @ Paul Scherrer Institute (PSI), Switzerland

Kitaev magnets have attracted much attention because they are expected to host a variety of low-energy-exotic spin excitations. They can also find applications in future quantum information technology. Generally, these excitations are chargeless, which precludes their probing by electrical transport. Additionally, in transition metal oxides Kitaev material, Na_2IrO_3, and Cu_2IrO_3, Ir is a strong neutron absorber that makes inelastic neutron scattering (INS) experiments quite challenging. On the other hand, since heat is also carried by charge-neutral excitations, their signature can be seen in thermal conductivity measurements.

Kitaev candidate materials are highly magnetically frustrated which leads to many exotic quantum phenomena like gapless quantum spin liquid state as ground state, in which no magnetic order is seen down to zero Kelvin temperature due to the presence of quantum fluctuations. The ground state has been predicted to have long-range entanglement. An external magnetic field can drive this gapless ground state into a gapped topologically nontrivial spin liquid, which may host chiral Majorana edge modes. The signature of such modes can be seen in the quantum thermal Hall effect as fractionalized values of the thermal Hall conductivity. From both a fundamental and technological perspective, it can be fascinating to study Majorana fermions and their response to external heat stimuli.

During this one-month-research visit to PSI under the supervisor of Dr. Ekaterina Pomjakushina, synthesis of two Kitaev materials (Na_2IrO_3 and Cu_2IrO_3) was carried out. Firstly, the polycrystalline form of Na_2IrO_3 was prepared using a solid-state reaction. Later, this polycrystalline sample was used to prepare the single crystalline form and Cu_2IrO_3 crystals. The crystals were characterized using various state-of-the-art techniques like X-ray diffraction (XRD) to confirm the phase purity.

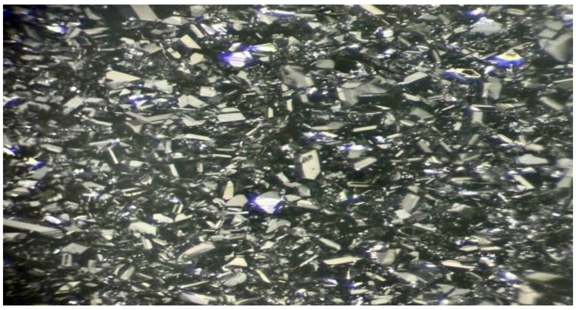

Figure 1: Optical images of crystals. Plate-like single crystals (left)) are found on top of semi-melted pellet, and needle-like crystals (right) on the wall of the alumina crucible

During my time in the chemical lab, I became more independent in my work. I gained experience in operating glove boxes, fume-hood, and different types of box furnaces. Additionally, I had a chance to establish a future collaboration for my ongoing PhD research on the thermal conductivity of NdAISi. We discuss the possibility of performing inelastic neutron spectroscopy to understand the thermal conductivity data in depth.

Finally thanks to the Erasmus+ program which provided me the mobility without any financial constraint and an opportunity to interact with experts in the field of crystal growth.