Think of materials: imagine a block of wood, a metallic beam, or glass panels that make up windows. They all possess different properties - wood is quite light and strong, metal is heavy and feels cold to the hand, and glass is fragile and transparent. When two identical materials are are assembled together, they do not become much different: two windows glued together are still transparent, metallic rods are still cold and opaque, and an assembly of two blocks of wood remains light and strong. In other words, the properties of materials remain the same when put together, and this is true for all most common materials.

It is very different when the materials become extremely thin – so thin that they are made of only one single atom along the thickness, like a sheet of paper, but 200 000 times thinner! When two extremely thin materials are put together, their *collective* properties can change in a completely surprising manner. It is as if the two blocks of wood from above would become transparent, or if the metallic rods would suddenly become insulating and could not conduct electricity anymore.

Scientists still don't really understand why this happens. For now, it is very difficult to predict what happens when two atom-tick materials are assembled together - but one day, when physicists and chemists agree on how this works, engineers will make use of this incredible phenomenon in the real world – for example, to make computers use almost no electricity to operate, or to exchange information even faster than it is possible today.

In this research project, we will try to answer the question: "why do properties of super thin materials change so strongly when they are put together?". We think that we have an idea, and the answer might be in the "moiré superlattices", also known as "moiré patterns". The moiré patterns are a phenomenon also visible in the daily life when two meshes are superposed together. In the image below, on the left, when two meshes are superposed they create a totally new shape called the moiré superlattice. The same thing happens when two atom-thick materials are brought together and twisted with one another. In the image on the right, "Sheet 1" in black is superposed with "Sheet 2" in red. At first, no moiré superlattice is visible, but when Sheet 2 is twisted, a moiré pattern appears. It is the moiré superlattice itself that is responsible for the new properties: for example, if the two sheets conduct electricity poorly, they now conduct the electricity extremely well when they are assembled together. In this research, we will put together different super thin materials, and every time we will measure their properties and use mathematical models to understand the reason behind this extremely strange phenomenon.