ERC success for University of Stuttgart: The European Research Council (ERC) awarded Dr. Tim Langen from the Institute of Physics (5) with one of the coveted ERC-Starting Grants. The 1.5 million euro prize supports outstanding young scientists for groundbreaking and visionary research. Tim Langen will use the ERC Starting Grant named NEWMAT (Supersolids and beyond: Exploring new states of matter with laser-cooled dipolar molecules) to research novel quantum mechanical superposition states of solid and superfluid, so-called supersolids.

In the microscopic world ruled by quantum mechanics, nature can behave in ways that are very different from our everyday experience. A particularly fascinating example is the superposition principle. Following this principle, atoms can be located in different places at the same time, and matter can behave both as a solid and as a liquid simultaneously. The latter case is the defining property of a supersolid, a recently discovered state of matter that combines the frictionless flow of a superfluid with the crystalline structure of a solid. Using his ERC Starting Grant, Dr. Tim Langen aims to study this exotic state of matter in unprecedented detail.

Whether such a supersolid can really exist had - until recently - been intensely debated for more than 60 years. Only in 2019, its very existence was finally proven by Langen and Tilman Pfau at the University of Stuttgart, and several other international teams, by experimentally studying the behavior of magnetic atoms at temperatures close to absolute zero. This first experimental proof initiated a completely new research field that now aims to understand the properties of supersolids in more detail.

However, the possibilities to do so using existing experimental approaches is very limited. In his ERC project, Langen will therefore establish a new experimental platform to study supersolids. Instead of magnetic atoms, he will be studying molecules in his experiments. As quantum objects, molecules are much more complex and can therefore provide completely novel insights into the properties of supersolids. Using high resolution imaging techniques, Langen plans to observe and control the relevant processes at the level of single molecules. „Until very recently the manipulation of molecules with this kind of precision was considered completely impossible. The ERC Starting Grant enables me to advance state-of-the-art laser cooling techniques to prepare the molecular supersolids for the first time,” Langen explains. He expects his experimental approach to provide a precise comparison between theory and experiment, as well as unprecedented insights into the nature of these and other exotic new states of matter.

About Tim Langen:
Dr. Tim Langen studied physics in Mainz, Marseille, Paris, and Vienna. Already during his PhD studies, he made important contributions to experimental quantum physics and received several international awards for his work. Subsequently, he was awarded a fellowship of the Alexander von Humboldt Foundation to work at JILA (Boulder, USA). He has been leading a research group at the University of Stuttgart since 2017.
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