times appear trivial or unimportant to other people. One gets paid for doing something one really likes and which one might even do if one wasn't paid (assuming one had enough money to live off) – I wonder how many people outside of science would say the same about their job! The freedom a scientist has after having received the necessary grants is certainly unique in our society. Even though doing science can be hard, a "real job" does involve many circumstances that scientists do not experience (as much). Being told what to do, doing boring repetitive "labor", not even mentioning physical work i.a..

But does this privilege of having one's hobby as a job come for free? In my view every scientist should be well aware of the enormous freedom given to him. If ever possible we should work on topics that benefit society (in one way or another). Additionally, passing on the knowledge we generate to both students as well as the general public should be part of our self-understanding and should not be seen as a waste of research time. Going even further, I would emphasize that as science is at the forefront of technical and intellectual progress, it needs to enter more into public discourse explaining current and future developments. Up to this day science is often hidden in institutes and laboratory spaces. It should be part of our definition as scientists that we actively contribute to the debate in society and that this is an important part of our scientific challenge. Then I would also have an easier time to convince my brother that being a scientist is not only a "real job", but also a very important one.

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Conducting a Quantum Orchestra

Sebastian Will studied physics at the Johannes Gutenberg-University, Mainz and the Massachusets Institute of Technology. He carried out his doctoral studies at the Johannes Gutenberg-University and the Ludwig Maximilians University, Munich and, afterwards, rejoined the Massachusetts Institute of Technology for postdoctoral studies. In his research he uses Bose-Einstein condensates and ultracold Fermi gases to study intriguing quantum phenomena, such as superfluidity and quantum magnetism.

A usual day in my lab starts by switching on numerous computers, power supplies, electronics boxes, and lasers. A remarkable number of devices have to play together in order to create what presumably is the coldest matter in the universe. Our experimental apparatus is capable to bring the movements of atoms almost to a halt, cooling them to the coldest possible temperature where only quantum mechanical zero point energy is left. The cooling of atoms happens in cycles. Every thirty seconds we create a sample of a few million ultracold atoms, that is subsequently manipulated, investigated and observed within less than a second. The process of observation heats the ultracold sample and it needs to be replaced by a new one. The continuous repetition of the cooling cycle is the heart beat of our lab.

I like to view a single cycle of the experiment as the performance of a piece of music. In an elaborate, computer-controlled, carefully timed sequence of experimental steps, first an oven creates a hot beam of atoms; laser beams are shone towards the atoms to slow them down and trap them. As a conductor of the apparatus, one has to control more than hundred switches. These switches trigger the individual instruments of the experiment with a precision of better than a microsecond, sending the signals to create magnetic fields, produce radio frequency pulses, or shine in laser beams exactly at the right time. The lab is filled with the humming of power supplies, the clicking of laser shutters, the flashing of laser beams. After the first cooling step in which lasers cool down the atoms to millikelvin temperatures, strong magnetic fields are applied to levitate and trap the atoms. To reach the desired quantum regime of atomic motion, further cooling is necessary, typically down to a few hundred nanokelvins. This is done by an ingeniously simple experimental twist, reminiscent of cooling a cup of coffee by blowing across it: Using radio frequency radiation we blow away the hottest atoms; only the coldest ones remain and exclusively occupy the lowest quantum levels of the trap. With these ultracold samples we set out to unravel, how nature rules the behavior of interacting many-particle systems in the quantum regime.

Developing and controlling the experimental sequence has indeed much in common with musical performance. The parameter space in which the experiment operates is infinite, just as the ways of how to perform a piece of music are. Yet, as in music, there are certain prerequisites that ensure that a high quality of execution is achieved. First, technical skills are indispensable. For our experiments we need to know, how optical systems work, how lasers operate, how to build electronics circuitry, how to write programs, or how to solve elementary quantum mechanical models, just to name a few examples. Second, care to the details. Often things that initially seem unimportant decide whether an experiment ultimately fails or works. Shifting the crucial details to the focus of attention is a key to success. Still, for the sake of efficiency, it remains an art to distinguish the crucial from the less important details. Third, scientific work never goes without endurance, repetitive attempts and successive improvements. All these skills help to conduct the experimental quantum orchestra in an exceptionally synchronized way. When a high degree of perfection is reached, magic can happen :. as in musical performances such moments are rare, but they can mark the achievement of a scientific breakthrough.

Besides the work with the experimental apparatus, I regard communication a key element in my scientific work. Be it with team members, colleagues from inside and guests from outside the institute, scientific work grows through open and honest discussions. We discuss science rather formally during seminars or talks, or, more informally, while sitting around a table, standing in front of a random white board or during lunch and coffee breaks. Here the quality, the originality, the impact of science is assessed, new strategies are devised.

Freewheeling discussions with little expectations and no taboos often lay the fertile grounds for scientific creativity, giving birth to new ideas – just like melodies that often leap into ones mind in the most unlikely situations. In most cases, new ideas are weak and fragile. They are not protected by an established framework: A single half-cooked comment can kill an idea; it can get lost before its full potential is explored. This is again similar to music, where a melody can carelessly get lost, although it might have had the substance to serve as a subject for a song or a symphony. The creation of an environment, in which new ideas can survive, live and make first steps into realization is an important challenge. In fact, I really like the thought that a relaxed cookie hour or an innocent coffee break can lay the grounds for a scientific breakthrough :.

Coming back to actual lab work, the experimentally most productive hours often start after the dinner break. The experiment has warmed up, the scientific goal for the day has materialized and the mood is set for new investigations. When it's a good day, the experiment runs until the early morning hours of the next day and we leave the institute in the light of the morning sun :.with a new song in our minds.

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