Mengqiao Di

Interaction between light and rare-earth doped crystals

Are you curious about why you feel hot after lying outside for a while under the sunshine? When you work at night with the light on, do you wonder how the light bulb emits light? What's more, have you seen the beautiful aurora in the north of Sweden? All of these happen due to the light-matter interaction!

People are familiar with light, no matter whether it is natural light, e.g., the aurora or artificial light, e.g., LED light. When light meets different matters, different romantic stories (interaction) happen. This project tells a story between light and a crystal doped by rare-earth ions. However, the story only happens when light meets the matter under the right condition in a similar way as you cannot see aurora frequently.

When light with a frequency close to the transition of rare-earth ions goes through the crystal, it will be absorbed. Then the rare-earth doped crystal acts as a band-pass filter which can have a variable narrow passband for the incident light. But how does it work? It will absorb the incident light but let the light with the same frequency as the passband go through. Hence, the crystals select the same frequency as its passband. How is this passband created? In brief, a passband is created inside a praseodymium (Pr) doped Y_2SiO_5 crystal with light which has the same frequency as the passband we want to create. The light is used to burn away the ions in the passband. Thus, when itis irradiated by the light at the same frequency, there are no longer any ions absorbing it (no story will happen). Moreover, this type of special filter will create another story, which is called "slow light effect". To make the story short, it is a time delay of the light like the way electrical pulses delayed in a band-pass filter in electrical circuits.

Why do we need such filters? Well, our filter can slow down the light by 4 to 5 orders of magnitude! The slowed down light can be widely used in quantum memories, laser stabilization, and deep tissue imaging, etc.

Supervisor: **Prof. Stefan Kröll**

Degree Project 30 credits in Physics 2018

Atomic Physics, Department of Physics, Lund University