Our knowledge about mineralogy and physical conditions on airless planetary bodies in the Solar system is based mainly on remotely captured reflectance spectra. However, reflectance spectra are influenced by many effects, a major one is the space weathering.

The term space weathering refers to a set of processes, also called space weathering agents, mainly the solar wind irradiation and micrometeoroid impacts, which on long timescales darken the surfaces and alter reflectance spectra of airless bodies. Here, I focused on finding the difference between the effect of the two, above-mentioned, space weathering agents on reflectance spectra of silicate-rich airless planetary bodies.

Firstly, I studied areas of magnetic anomalies on the Moon, so-called lunar swirls. The swirls' spectra are influenced mostly by micrometeoroid impacts. I compared these spectra to spectra of surrounding areas, influenced by both the space weathering agents. The results suggested that there is a difference in the effect of micrometeoroid impacts and the combination of the two space weathering agents. There are also additional effects that contribute to the evolution of spectra on the Moon, such as the position with respect to the near and far side, which relates to the shape of Earth's magnetotail and an increased shielding of the solar wind ions.

During the laboratory experiments, I, with the help of colleagues, irradiated pellets made of silicates typically found on airless planetary bodies, i.e. olivine and pyroxene. To simulate the effect of solar wind, I used ions of H, He, and Ar. To simulate micrometeoroid bombardment, I used individual femtosecond laser pulses. The main conclusions were that the difference between the two space weathering agents can be seen mainly in the longer near-infrared (NIR) wavelengths (around 2 µm). Micrometeoroid impacts cause greater changes there, resulting in smaller spectral slope changes. Otherwise, the original mineralogy seemed to influence the way the weathering proceeds more significantly, which agrees with previous studies and also with observations of A-type asteroids or asteroids (4) Vesta and (433) Eros.

The differences in irradiated samples were then analysed on micro-scale using electron microscopy. Ion irradiation caused only mild blistering on the surface while laser irradiation caused extended melting with associated melt splashes. The subsurface changes were also different. Ion irradiations induced vesiculation in partially amorphised topmost layers of the samples. Laser irradiation induced creation of the nanophase iron ($npFe^0$) particles in the olivine sample, but not in the pyroxene sample. Changes in ion-irradiated samples caused alterations in the visible spectral slope, while $npFe^0$ particles in laser-irradiated olivine also altered the NIR spectral slope. The pyroxene sample irradiated by laser showed only a significant amorphous layer full of large vesicles. The spectral slope did not change as a result, the sample only showed alteration of the absorption bands. This analysis highlighted the significance of wavelength-sized structures on the resulting reflectance spectra.

Based on these results, I gained an insight into the evolution of the spectra and subsurface structures. Nevertheless, more simulations on different minerals are needed to gain a complete understanding of the space weathering mechanism.