Near-UV stellar spectroscopy: uncovering the past and building the future

dr hab. Rodolfo Smiljanic
CAMK/PAN

This project is focused on exploring the near-ultraviolet region of the stellar spectra, from ~ 3000 to 4500 Å, to study different astrophysical problems. This spectral region is of great interest because of the large number of atomic and molecular lines that are present in the spectra of F-, G-, and K-type stars.

The first part of the project concentrates on old metal-poor stars of the Galactic halo. The study of these old stars offer a unique window to look at and understand the past conditions of the Galaxy. Recent results have found that the halo is strongly dominated by stars formed in an external system that has merged with our Galaxy. Our plan is to study two samples of halo stars, one made of those stars formed locally and other made of those stars of extra-galactic origin. We will use near-UV spectral lines to determine abundances of the light element beryllium and of heavy elements produced by the rapid neutron-capture process.

Beryllium is only produced by cosmic-ray spallation in the interstellar medium, from the break up of heavier nuclei (carbon, nitrogen, and oxygen). Because of this peculiar origin, it has been suggested that Be abundances are a good tracer of time and can be used to separate stars formed in different environments. We plan to use stellar Be abundances to study the past conditions of star formation in the systems that formed the Galactic halo and confirm its usefulness as a discriminator of stellar populations.

Regarding the heavy elements (with atomic weight above 85), one important open question is what are the astrophysical events where they are produced. It has recently been shown that neutron star mergers are one of such astrophysical sites, but observational evidence seems to show that additional sites are needed. We plan to study chemical elements like Y, Zr, Mo, Ru, Pd Pr, Sm, Eu, Gd, Tb, and Dy in the same stellar samples used for the Be study above. This study will provide new clues to understand the origin of these elements.

In a second part of the project, we are interested in the near-UV properties of globular cluster stars. Globular clusters are complex systems containing multiple stellar populations whose origin is still not clear. In particular, near-UV photometric colours of stars in globular cluster have revealed, in some cases, unexpected extended stellar sequences that are still not fully understood. Our aim here is to compute near-UV stellar spectral energy distributions to better understand the photometric data of globular cluster stars. We will investigate if changes in the abundances of C, N, and O (elements that are part of molecules with bands affecting the near-UV region) can explain the observed variations. In addition, we will also investigate the contribution of binaries with hot components or stars with emission lines to these photometric colours.

Finally, this project also has an eye on future developments in the near-UV spectroscopy. We are involved in a consortium (together with researchers from the UK, Germany, Italy, and Brazil) interested in developing a new instrument dedicated for near-UV spectroscopy that could be installed at ESO's VLT. In the context of this new instrument, our work on simulating near-UV stellar spectra is of great importance. Simulated spectra are needed for testing the performance of the instrument, studying possible science cases, and refining the instrument parameters. To be able to make a significant contribution to this project is very important to strengthen the Polish bond to the ESO community, to develop local expertise with cutting edge astronomical instrumentation, and to bring some financial return from the Polish contribution to ESO.