



MW-Gaia STSM

Massive classification of new hot subdwarf binary systems with Gaia DR3

Carlos Viscasillas Vázquez, PhD student at the Vilnius University spent a week (29/05-02/06/2023) at the Universidad de Vigo thanks to a GP4 STSM grant to collaborate with Dr. Ana Ulla.

An analysis of the sample hot subdwarfs (hot sds) of Solano et al. (2022) has been carried out, which includes a comparison with the new Gaia DR3 available data, as well as the normalization and subsequent treatment of the BP/RP spectra for their posterior analysis with artificial intelligence (AI) techniques. Several AI techniques are to be applied, including SOM (Self Organised Maps) and using software available in the collaboration group. This collaboration is inserted within the GGG, Galician Group for the Gaia satellite, integrated by researchers from the universities of A Coruña (UDC) and Vigo (UVIGO), and linked to the DPAC (<https://www.cosmos.esa.int/web/gaia/dpac/consortium>) consortium.

So far, a new classification method for hot subdwarfs in binary systems based on supervised ML techniques has been explored, performing the subsequent calculation of binary probabilities distribution. Training samples from Solano et al. (2022) and from Drilling et al. (2013) were selected and applied the technique to a larger sample, of about 39.000 blue candidates, in Geier et al. (2019). The results are to be compared with the outcome from SOM techniques, to be conducted by UDC colleagues, and that from Virtual Observatory (VO) techniques, as those explored in Solano et al. (2022).

Although only very preliminary conclusions can be handled after this 5-day in person working meeting, it has been positive, useful and fruitful in setting a sound base for the application of AI techniques to this massive discovery and classification line of research, to build up on the VO approach already proposed and exploited. In fact, an interesting outcome from the continuation of the present collaboration in the near future is foreseen.

Main achievements

The scientific visit was very positive and the treatment of the Gaia DR3 BP/RP spectra obtained for the sample in Solano et al. (2022) was possible, and have it ready and in optimal conditions for its next treatment with an adaptive visualization tool for unsupervised classification of astronomical objects in a Big Data context. All the parameters of the aforementioned sample have been updated with the new data of Gaia DR3. New techniques of supervised learning methods used for classification based on Support vector machines (SVMs) have been successfully tested. And they have been applied to the sample of binaries by Solano et al. (2022) obtaining preliminary but promising results. In particular, only a probabilistic colour-magnitude approach on Geier et al (2019) catalogue is already revealing in terms of its discovery potential

During the visit Carlos Viscasillas was able to interact with other members of the GGG at UDC, as well as with Enrique Solano from the Spanish Virtual Observatory. The following steps include further treatment of the spectra and the data, as well as the use of the Gaia Utility for the Analysis of self-organizing maps (GUASOM) analysis tool. Inter-comparability of various ML techniques on the collaboration data sets will also be

performed. So, the scientific visit was crucial to start a formal collaboration and to continue a promising project.

In the short term, the collaboration presented the preliminary results in a talk at the European Astronomical Annual meeting (<https://eas.unige.ch/EAS2023/>), held in Krakow from July 10 to 14, and in a poster to the Final Conference "The Milky Way Revealed by Gaia: The Next Frontier" that took place in Barcelona from 5 to 7 September 2023. And, by the end on 2023, a draft paper on the topic is expected. For sure, this collaboration will continue in the future.