MW-Gaia STSM

Galactic evolution from Gaia data. Applications to simulations for future missions

Dr. Annie Robin from Observatoire de Besançon (France) spent one week (12-18/02/2023) at the University of Barcelona STSM grant to collaborate with Dr. Fancesca Figueras and her collaborators. The main goal of the visit was to discuss, launch and test the code BGMFast developed by Roger Mor during his thesis for adjusting star formation history and initial mass function, among other galactic structure parameters by comparing Besancon Galaxy Model simulations to Gaia data.

Now that DR3 is published the same work can be done but with more accurate data and also an improved model as a striating point (Robin+2022). During the visit In Barcelona we succeeded to run the test with simplified number of fitted parameters, locally first. Then the code has been launched on virtual machines on the Google Cloud, as planned in the OCRE project, with a small subsample of Gaia data. The code is now validated and can be prepared to be launched with a larger number of parameters and with a larger Gaia sample. We discussed in detail the plan to validate the process of testing and how to pursue the project by considering larger number of data (tests have been made using a small sample of about 40,000 stars) to be able to constrain the evolution parameters. We tried to estimate how the time of processing will increase as a function of the size of the sample and of the number of fitted parameters. This point needs more tests that the master student Marc Del Alcazar will produce in the coming weeks.

Concerning the study of Gaia-NIR project, we discussed the new extinction map to used, which is also the one planned for the new GOG simulation. Solutions have been found in order to implement at the same time Lallement+2022 maps together with Marshall+2006 for large distances towards the Galactic bulge. The computation will be conducted by Eduard Masana in a few days.

**Description of the STSM main achievements and planned follow-up activities**

The visit allowed to successfully test the BGMFast code under Python 3 on local machine with 12 parameters, then on Google cloud. The student Marc Del Alcazar will continue testing whether the result will be the same using Python2.7 and Python3. Then he will test if the program achieves fitting using 22 parameters (the one of Mor+2019) and using the same data sample as in this published study. A step further will be to use incrementally larger sets of Gaia data, with fainter apparent G magnitude limits, to see how it improves the reliability and accuracy of the results, especially on the stellar mass function and the star formation history. Since data will be more accurate and will go deeper than Mor+2019 study, we expect to be able to also determine the star formation history of the thick disc of the Milky Way, an important point for the understanding of the Milky Way formation.

On the point of view of the initial model simulations, a first set have already been done and is ready for inclusion in BGMFast process. A new one will be prepared after revision of the tracks of low mass stars (Baraffe+2015) which are under testing.

Further discussions with be needed, and performed during regular teleconf in this collaboration. They will concern the Gaia sample to consider, discussions about the fitted parameters and their interpretation, that should be the object of at least one publication.

About extinction maps for GOG simulations, both for gaia-DR4 and Gaia-NIR, tests have to be planned to assert the reliability and the continuity at the limit of the 2 maps. This will be discussed during future teleconference between Eduard Masana, Francesca Figueras and myself in the coming weeks.

The collaboration between Besançon Observatory (Institute UTINAM) and University of Barcelona (Institute of Cosmos Sciences) is continuing, with the aim to reach a better Galaxy model and to add constraints on the star formation history of the Milky Way and the stellar mass distribution. We also hope to learn more about the global dynamics and to better understand the distribution of the dark matter.
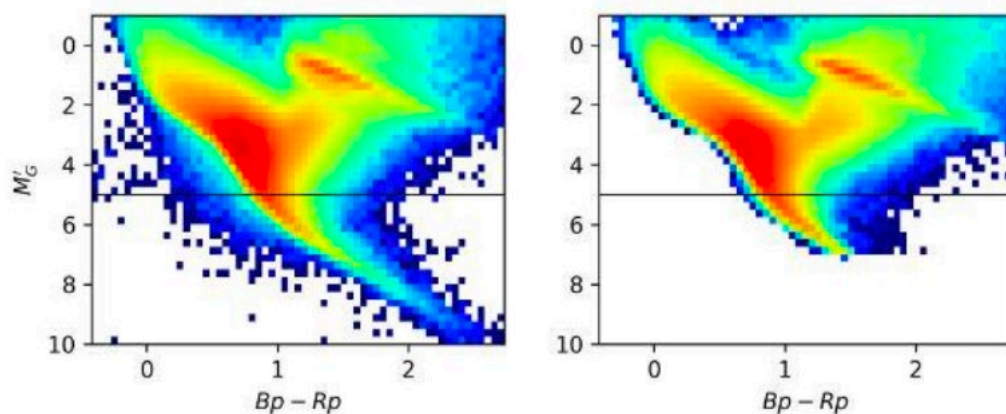
Hess diagram: comparison of stars in colour and absolute magnitude between Gaia data (left) and model after fitting SFH and IMF (right).