# The Gaia Object Generator (GOG)

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## Abstract

Gaia, a cornerstone ESA mission, will produce a three-dimensional map of our Galaxy. It was launched in December 2013, and it is expected to provide an important improvement in our understanding of the structure, composition and evolution of the Galaxy.

The preparation for the acquisition of the data was essential as Gaia will provide astrometry, radial velocities and multi-colour photometry for over one billion objects in the sky. The Gaia Data Processing and Analysis Consortium (DPAC), has prepared a simulator called the Gaia Object Generator (GOG), which simulates the end of mission catalogue, including observational errors. The GOG catalogue has provided useful information about the contents of the expected Gaia catalogue and moreover, is actively used to produce the tools that will validate, manipulate and visualize the real data before publication.

## GOG Simulator

During its five years of data collection, Gaia is expected to transmit to Earth some 150 terabytes of raw data, producing a catalogue of some 109 individual objects. After on-ground processing the full catalogue is expected to be in the range of one to two petabytes of data[1]. Preparation for the explotation of this huge amount of data is essential, and work is being undertaken to model the expected output of Gaia in order to predict the content of the Gaia catalogue and to facilitate the production of tools required to effectively analyse the data.

Therefore, the Gaia Data Processing and Analysis Consortium (DPAC) has developed a set of simulators, including a simulator called the Gaia Object Generator (GOG), which simulates the end of mission and the epoch transit catalogues, including observational errors. Simulation of many aspects of the Gaia mission are carried out by the CU2, belonging to DPAC, in order to test and improve instrument design, data reduction algorithms and tools for the use of final Gaia catalogue data.

## Error models

In GOG we have taken the recommendations from the various CUs in order to include the most complete picture of Gaia performance as possible. The following error models have been implemented into GOG:

- Astrometric epoch error model (error associated to a single transit)
- Astrometric end of mission error model
- Photometric epoch error model (error associated to a single transit)
- Photometric end of mission error model
- RVS parameters
- Astrophysical parameters
- XP and RVS spectra epoch error model (error associated to a single transit)
- XP and RVS end of mission model

## Graphical User Interface

An graphical user interface is available in order to produce GOG simulations. Its goal is to enhance the efficiency and use for the underlying logical design of GOG. The GOG users will interact with GOG by manipulating the interface, making the with simulations easier.

By using this interface, users can generate:

- A catalogue from the Universe model
- A catalogue from the Universe model, but as observed by Gaia (including epoch and/or end of mission errors)
- A external list of sources, which to compute Gaia outputs (data affected by errors).

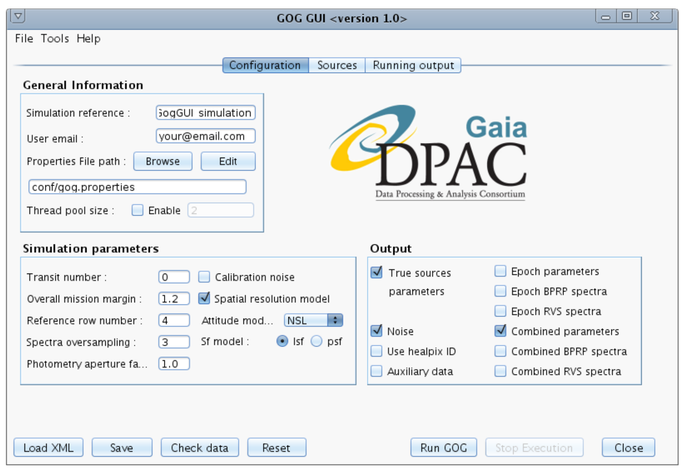


Figure 1. Initial window of the Graphical User Interface of GOG

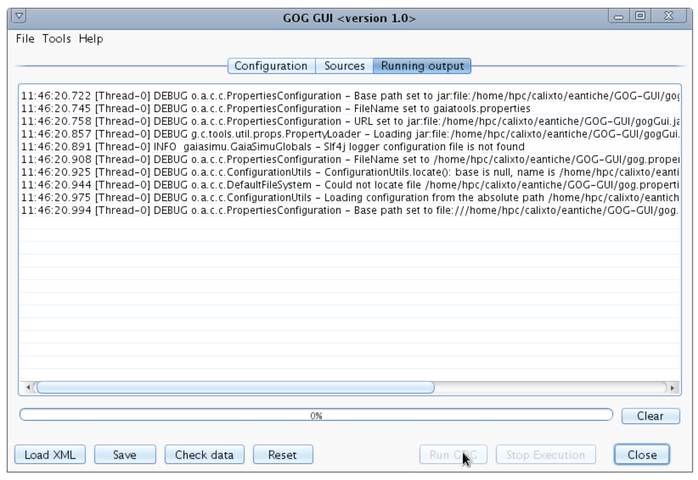


Figure 2. Running output seeing from the Graphical User Interface of GOG

## CU9 and future perspective

The DPAC CU9 is responsible for providing access to the Gaia data to the scientific community through the Gaia archive. CU9 will ensure the scientific correctness of the archive content by performing a thorough validation of the Gaia products before their publication. GOG has a direct impact in the Gaia real catalogue production, as the simulated Gaia data should be used for development, testing and validation of software. GOG dataset will be used to detect false-positives and a biased data set to validate that problems can been found.

Moreover, GOG simulations will be used also to test the software which will maintain and preserve all the versions of the catalogue, and to become familiar with working with such a large and rich dataset.

## GOG end of mission catalogue

The Data Simulations coordination unit (CU2) has the responsability to cover the simulation needs for the work of other CUs, ensuring that reliable data simulations are available for the various stages of the data processing development. CU2 has delivered this year a GOG end of mission catalogue, containing the potential single star observable population (with G 〈 20mag) using the Gaia Universe Model[2] and the scanning law, showing the effect of the observational errors , with detailed information about parallax, proper motions, radial velocities, photometry in the four Gaia bands and astrophysical parameters[1]. The simulation was performed on the MareNostrum super computer at the Barcelona Supercomputing Centre (Centre Nacional de Supercomputació), and it took 400 thousand CPU hours.

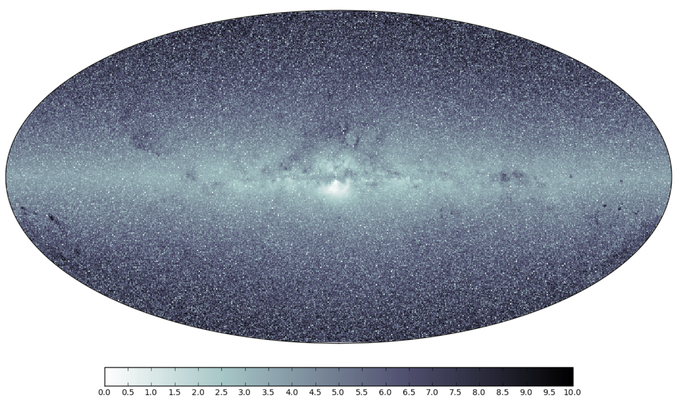

Figure 3. Skymap of the total integrated flux over the whole sky[1]

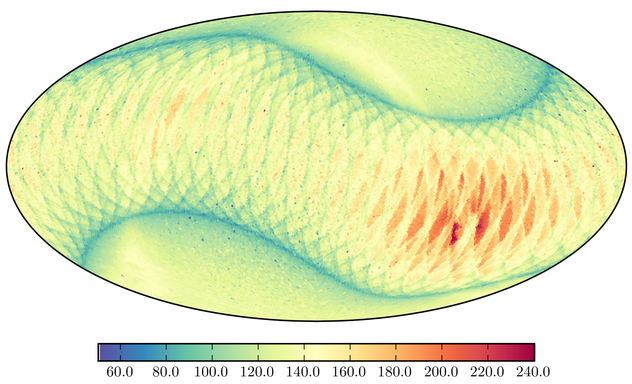

Figure 4. Skymap of the mean parallax error over the whole sky[1]

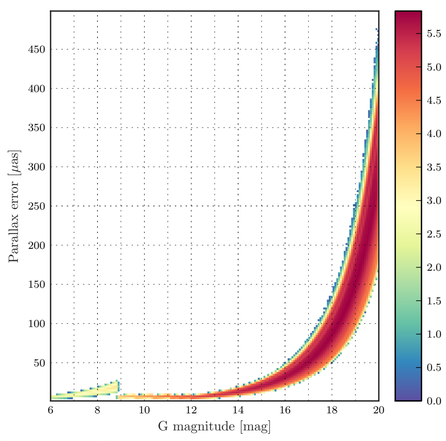


Figure 5. Parallax error in function of G magnitude[1]

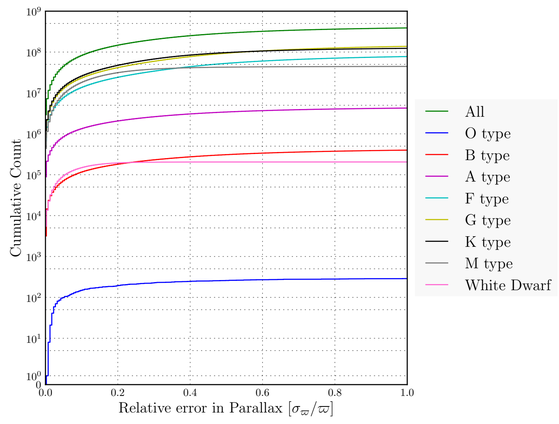


Figure 6. Relative parallax error for the different spectral type[1]

1: Luri et. al., A&A 566, A119, 2014

2: Robin et. al., A&A 543, A100, 2012