The Gaia Simulator: Design and Results

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Abstract Simulation of the data generated during the 5 year observations is one of the most relevant aspects of the Gaia mission preparation. The simulations allow the development and test of the reduction algorithms to be used during the mission.

A complex software named Gaia Simulator has been developed in order to perform the simulation. It includes three different data generators: Gibis, to produce pixel level images; Gass, to provide telemetry data stream; and Gog, designed to generate the final data mission or data at an intermediate state of the reduction process. The three data generators share several libraries, including the universe and instrument models.

1 The Gaia Mission

Gaia is a Cornerstone mission of the ESA, devoted to space astrometry. The main goal of the mission is to produce a set of homogeneous and accurate data needed to perform the most deep study of the structure, origin, formation and evolution of our Galaxy. As there is not input catalogue, the final data will be unbiased.

At the end of the mission Gaia will provide:

- 10^9 objects (1% of the Milky Way)
- complete upto G=10
- position, velocity and parallax
- nominal accuracy: 20 μas at G=15
- spectrophotometry upto G=20
- radial velocity spectrometry upto G=18

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2 Design of the Gaia Simulator

2.1 Overview

The Gaia Simulator is composed of three data generators (Gibis, Gass and Gog) that share a common library (GaiaSimu), a set of parameters (GaiaParam) and a toolbox (GaiaTools). The data generated by these three data generators are needed for:

- improvement of the mission's concept
- the dessign of the instruments
- the preparation and validation of the reduction algorithms

2.2 GaiaSimu

GaiaSimu is the basic simulation library. It contains the models for the universe and instrument, as well as the needed tools to perform the simulations.

2.3 Gibis: Gaia Instrument and Basic Image Simulator

The aim of Gibis is to simulated the Gaia observations at pixel level, using very detailed models of the instrumental response and astronomical objects to generate very realistic images.

2.4 Gass: GAia System Simulator

The aim of Gass is to simulate the Gaia telemetry stream. Given the very big amount of telemetry data, Gass uses simplified models of the instruments and astronomical objects, in order to allow a fast execution.

2.5 Gog: Gaia Object Generator

Gog is designed to simulate data at any intermediate stage of the reduction process, including the final results. A part from the models of instrument and universe, Gog needs an accurate error model of the reduction algorithms, in order to generate the data with a realistic error in astrometric, photometric and spectroscopic parameters.

3 Results

Both Gass and Gog run on the Marenostrum supercomputer at Barcelona Supercomputer Center (BSC).

From 2006, every six months we run the different data generators in order to provide data to the different teams working in the preparation of the Gaia mission. These campaigns fits the cycles division of the preparation phase of the mission. In particular for the last cycles (3 and 4) the follow datasets were generated:

3.1 Cycle 3

About 4TB of data were generated in 140,000 CPU hours:

- 2 datasets corresponding to 5 years of observations with the sky density scaled to 2 millions objects (Gass).
- 5 years of observations with the sky density scaled to 6 millions objects (Gass).
- 7 days of observations of 1000 millions stars (Gass).
- Intermediate and final data for extrasolar planets (Gog).
- Final mission data of RVS spectral observations (Gog).
- Several sets of images including multiple system and solar system objects (Gibis)

Fig. 1 Screen capture of the Gibis web interface

3.2 Cycle 4

About 8TB of data were generated in 400,000 CPU hours:

- 6 hours of observations of 1000 milions stars (G<20) (Gass).
- 5 years of observations with the sky density scaled to 10 millions objects (G<17.5) (Gass).
- 5 years of observation of solar system objects (Gass).
- Several datasets corresponding to 3 months of obervations of stars upto G< 17 plus a subset of stars upto G<20 (Gass).
- Intermediate data for several types of variable stars (Cepheids, RR Lyrae,) upto G<12 (Gog).
- Final mission BP/RP and RVS spectra (Gog).

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