THE ATTITUDE OF THE GAIA SATELLITE

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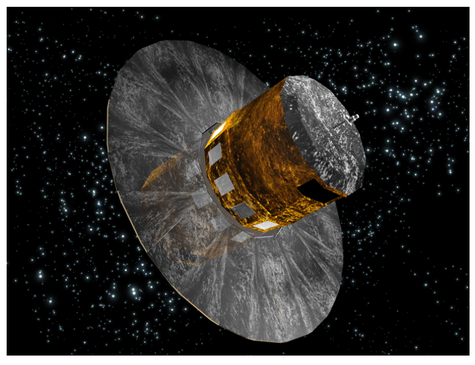
The Gaia Attitude Model (GAM) is a simulation software package that is being developed to achieve a detailed understanding of the Gaia's attitude. It takes into account external physical effects and will consider internal hardware controlling the satellite. The main goal of Gaia is to obtain extremely accurate astrometry. This implies to have a good knowledge of Gaia's behavior as a spinning rigid solid body under the influence of various disturbances, and the understanding of CCD caveats because Gaia's scientific results will be self-calibrated.

What is the Gaia mission?

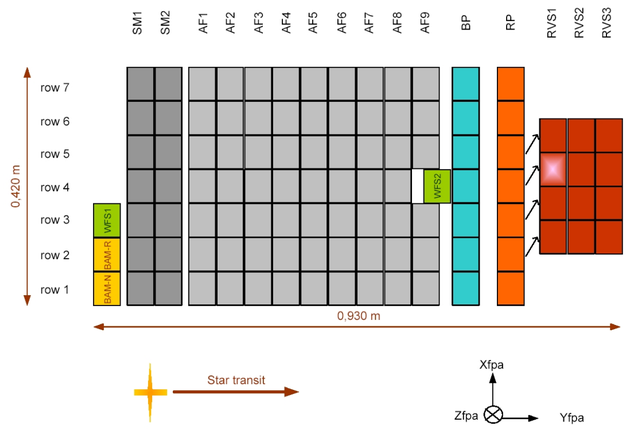
High-accuracy astrometry will allow Gaia to exactly pinpoint the position of a star and to measure its movement across the sky, whilst spectroscopic measurements will allow the radial velocity to be determined. Gaia will also gather photometric data using dispersive prisms. This array of data will reveal a moving, three-dimensional Milky Way map of unprecedented scope and precision, as well as providing profiles of the physical properties of each star, including luminosity, surface gravity, temperature and elemental composition.

Gaia's payload features two telescopes sharing a common focal plane. Optical CCD detectors comprise a total of nearly one billion pixels (a 'gigapixel'). The focal plane is shared by the astrometric, photometric and spectroscopic instruments. As the spacecraft slowly rotates, the light from the celestial object (that is, the image of the object) passes across the focal plane. In this way, Gaia steadily scans the whole sky as the satellite spins and gradually precesses, with each part being observed around 70 times in the course of the operational lifetime.

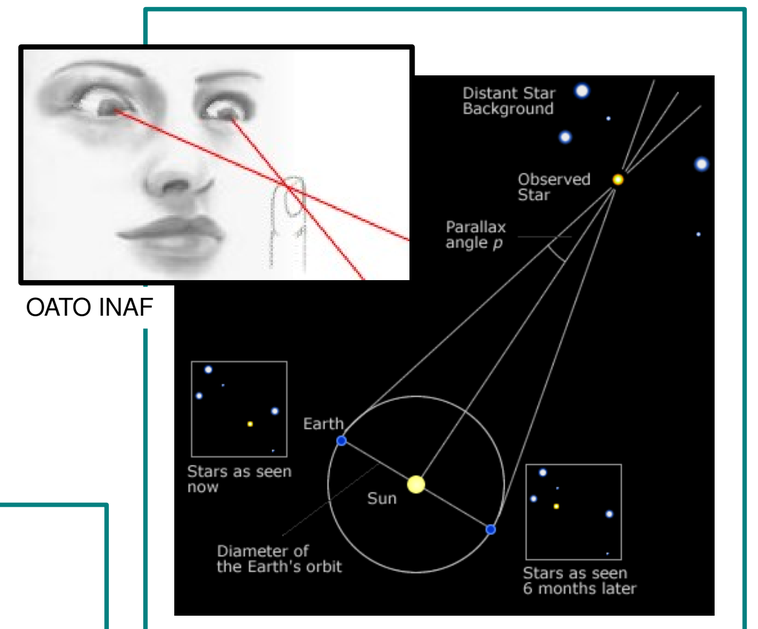
Gaia will be able of measure the position of 10^9 stars with a precision up to 7 micro-arcsec (equivalent to 1 cm on the Moon's surface, as seen from the Earth).



Artistic image of Gaia. Credits: ESA.



In the focal plane the are 106 optical CCDs, 4500x1966 pixels each one, working in TDI mode (Time Delayed Integration). There are CCDs dedicated to astrometry (soft gray), photometry (blue and orange), and spectrometry (red). The field of view is 0.7°x0.7°. Credits: EADS Astrium.



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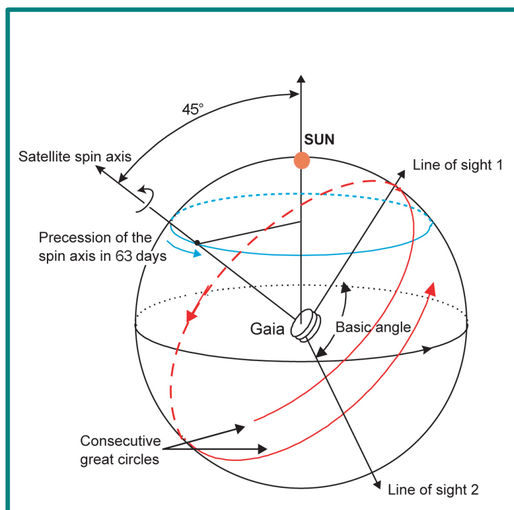
The main goal of the Gaia mission is to measure the distance to the stars. Gaia will use the parallax method: the position of a star apparently shifts with respect to background stars during the Earth orbital period (one year). It is the same effect that we observe when we extend one arm and look one of our fingers using only one eye. The apparent position of the finger with respect to distant objects depends on which eye is open. Courtesy C.J. Hepburn.

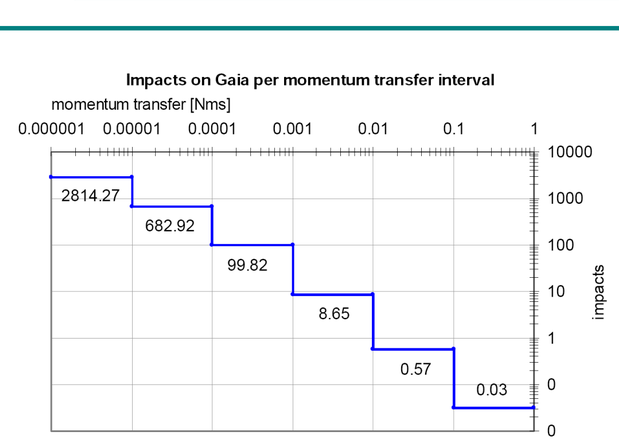
What is this work about?

The Gaia Attitude Model (GAM) is a simulation software package that is being developed to achieve a detailed understanding of the satellite's attitude. It takes into account external physical effects and internal hardware controlling the satellite.

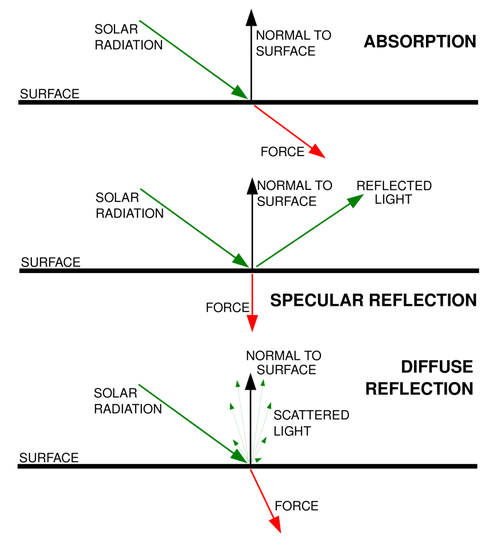
The main goal of Gaia is to obtain extremely accurate astrometry, and this implies to have a good knowledge of Gaia's behavior as a spinning rigid solid body under the influence of various disturbances, like the solar radiation pressure, the impact of micro-meteoroids, and the noise due to the thruster firings. The main simulation loop is currently being developed, it calculates angular rates and positions as a function of time.



Gaia's scanning law. This is the behavior of the requested attitude. The two field of views of the telescopes swept the sky through the red line. The final movement of Gaia is the result of adding up the spinning period (6 hours), the precession around the Sun direction (63 days), and the one year orbital period around the Sun. Credits: ESA.



Expected number of micro-meteoroid impacts per year, as a function of their momentum transfer. The biggest expected impacts (1 Nms) are due to dust particles with a mass of 50 micro-grams flying at 20 km/s. Credits: R. Ernst.



The solar radiation (optical photons in this case) impacts with the surface of Gaia. These photons may be absorbed or reflected, and the final force depends on it. The expected torque is of the order of magnitude of 10^{-4} Nm, equivalent to the torque due to a mosquito in the border of the Gaia's sun-shield.

Acknowledgments:

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