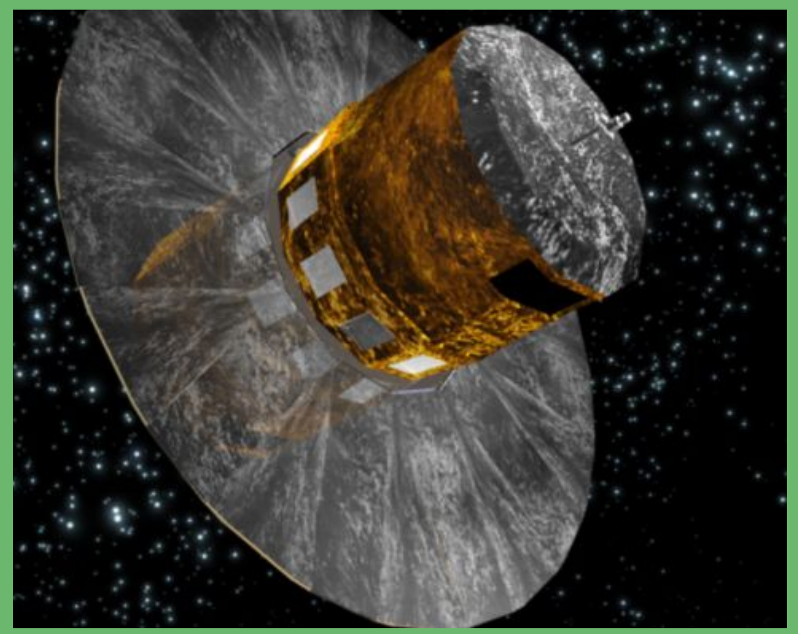

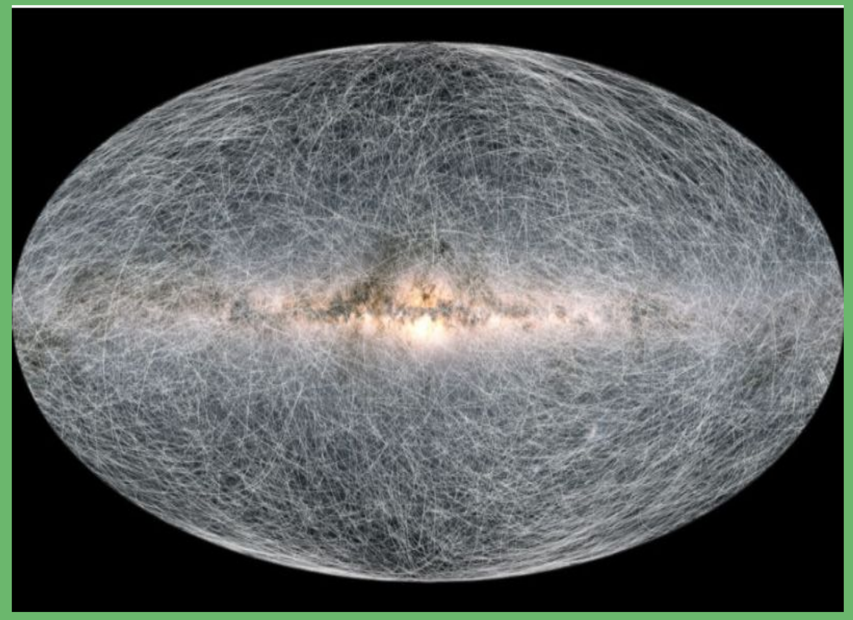

Gaia

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Hipparcos vs Gaia

- Position accuracy on a star: Hipparcos - 2 microarcseconds ; Gaia - 24 microarcseconds
- Type of telescope: Hipparcos uses Schmidt ; Gaia uses three curved mirror
- Photometry instrument : Hipparcos uses BP/VP(blue and violet) ;Gaia uses a RP/BP (red/blue)
- Number of objects observed overall : Hipparcos - 118,300 ; Gaia - billions (272 billion positional measurements, 54.4 billion photometric data points, and 5.4 billion radial velocity data)
- Gaia provides observable data 70 times of a star
- Brightness observed max: Hipparcos - 12 magnitude ; Gaia - 20 magnitude

Discussion

- Maps motions, luminosity, temperature and composition of stars
- Carries the largest digital camera into space with nearly one billion pixels. By comparison, smartphone cameras have around 10 million pixels.
- Detects celestial objects that are a million times fainter than the unaided human eye can see
- Stars, close and far have their distances measured to the extraordinary accuracy
- The data archive exceeds 1 Petabyte (1 million Gigabytes), equivalent to about 200 000 DVDs worth of data.
- The map produced helped encoded the origin and subsequent evolution of the Milky Way.
- Provided basic observational data to analyze a wide range of important questions related to the origin, structure, and evolutionary history of our galaxy

Introduction

Gaia (top left picture) is an European Space Agency mission to chart a three-dimensional map (top right picture) of stars in the Milky Way Galaxy. Gaia is providing unprecedented positional and radial velocity measurements with high accuracies needed to produce a stereoscopic and kinematic census of about one billion stars in our Galaxy and the Local Group. In the process, it would reveal the composition, formation, and evolution of the Galaxy.

Equipment

- The payload module contains the optical instrument and all electronics required to manage its operation and process its raw data
- The astrometric instrument - measuring stellar positions on the sky.
- The photometric instrument - provides color information for celestial objects by generating two low-resolution spectral
- The Radial Velocity Spectrometer - reveals the velocity of the star along the line of sight by observing the Doppler effect
- The mechanical service module consists of mechanical, structural and thermal elements
- The electrical service module offers support functions like electrical power control and distribution, central data management and Radio communications with the Earth.
- It is powered by solar arrays and nuclear power

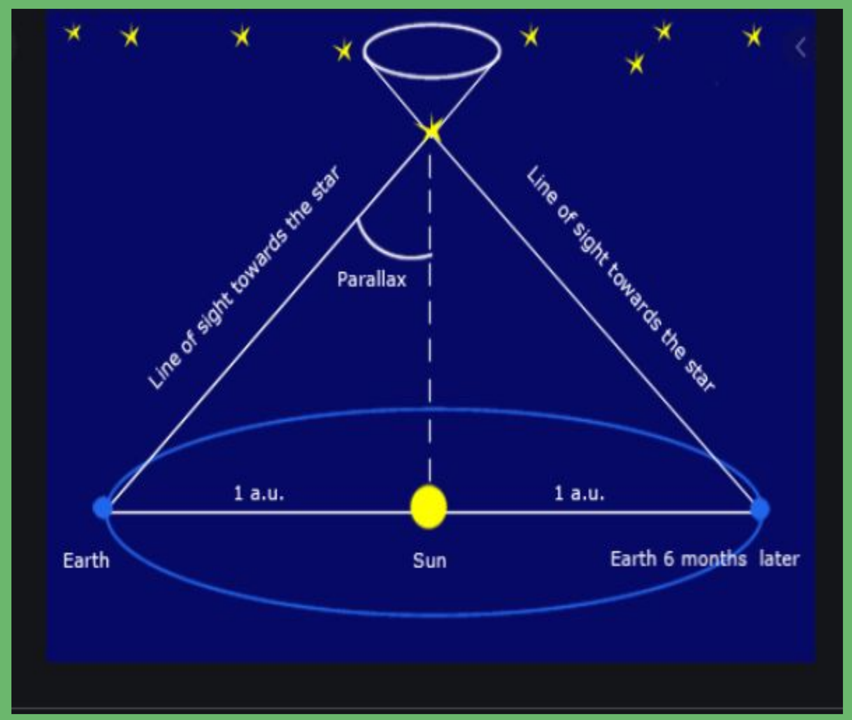
Limitations

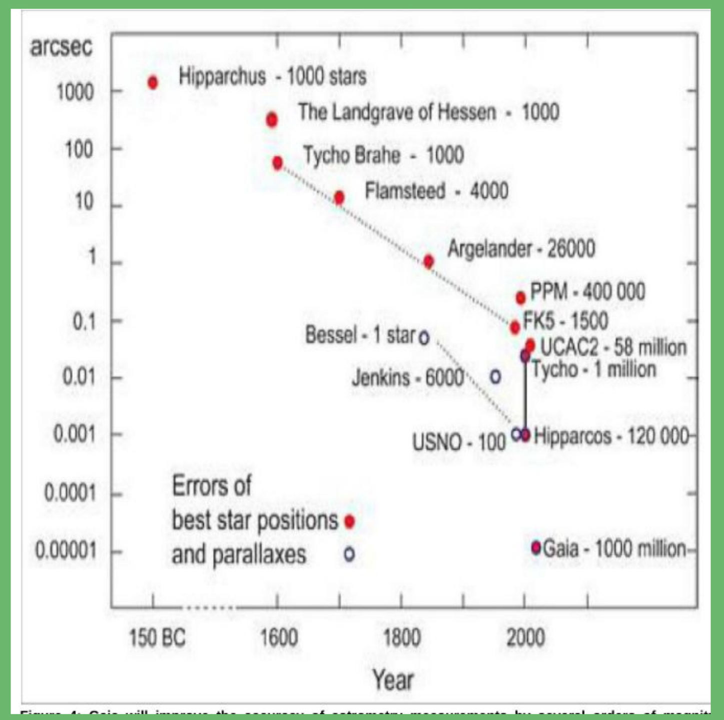
- Operates between 100 degrees Celsius and -150 degrees Celsius, which prevents water vapors from freezing.
- Stray light - limits the ability to detect far away and faint objects
- Gaia's interior could not be equipped with optimal radiation shielding, and so it's performance has suffered.
- The equipment - if something gets damage, there is no way to fix it since it's in space
- Gaia is located at the L2 point hence servicing the spacecraft is impossible

Contributions

- Discovered thousands of exoplanets, tens of thousands of brown dwarfs, 20000 exploding stars
- Probes the distribution of dark matter
- Measured some 500,000 distant quasars
- Can measure the positions to an accuracy of 24 microarcseconds for objects
- Creates a three-dimensional map of the Milky Way more precisely than any other telescopes

Stellar Parallax





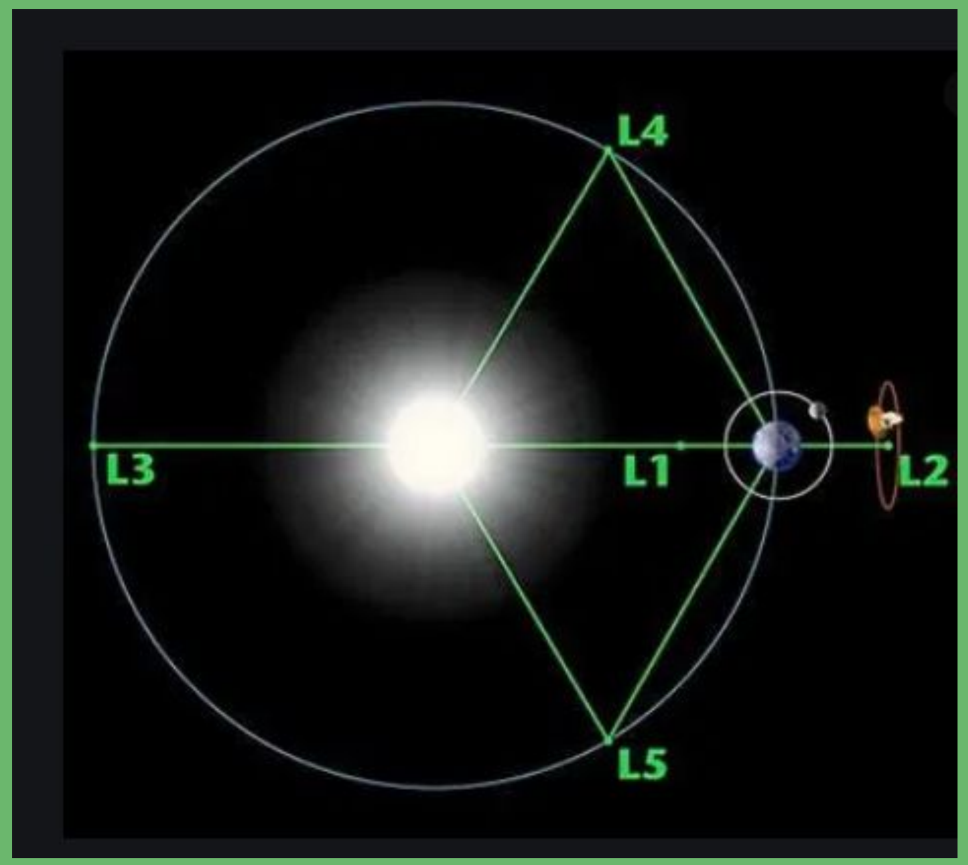
The Earth describes a yearly orbit around the Sun (shown as the blue ellipse in the figure, the picture on the left). Observing the stars from Earth creates therefore some very useful peculiarities. Consider, for example, the measurement of the position of a star. With respect to the Sun, most stars only show a linear motion, but when observed from Earth, the direction in which we see the star depends on where in its orbit the Earth is, or, in other words, the time of the year we measure it, and the direction of the star as seen from the Sun (the dashed line in the figure above). As seen from Earth, the position at which we observe any star will, over the period of a year, describe a small ellipse on the sky (the white ellipse in the figure). This ellipse is the projection of the Earth orbit as seen from the Sun, at the distance of the star. Therefore, the further away a star is, the smaller will be this ellipse. This effect is called the stellar parallax. Determining the size of the major axis of the ellipse provides the value of the parallax (see figure above), which is the most direct method of measuring distances to nearby stars. It uses basic geometry in which the Earth orbit forms the baseline. One serious problem in the determination is the fact that the typical distances between stars in the solar neighbourhood are very large compared to the available baseline, the diameter of the Earth orbit around the Sun. The nearest star is about 270 000 times further away from us than the Sun, which is already at a respectable distance of 150 million km.

How Data is processed

- Compressed data approximately 60 TB (terabyte) stored in an InterSystems Caché database
- Gaia sends back data for about eight hours every day at about 5 Mbits. ESA's three 35-meter-diameter radio dishes of the ESTRACK network in Cebreros, Spain, Malargüe, Argentina and New Norcia, Australia, receive the data.

Gaia's Lagrange Point

- Lagrange Points - positions in space where the gravitational forces of the Sun and the Earth keeps the spacecraft in a stable position
- Used by spacecraft to reduce fuel consumption to stay in place; In this case, Gaia uses the Lagrange 2 point.
- The craft headed towards the Sun–Earth Lagrange point L2 located approximately 1.5 million kilometers from Earth.
- The L2 point provides a very stable gravitational and thermal environment. There, it uses a Lissajous orbit that avoids blockage of the Sun by the Earth, which would limit the amount of solar energy the satellite produces through its solar panels, as well as disturb the spacecraft's thermal equilibrium.
- After launch, a 10-meter-diameter sunshade was deployed. The sunshade always faces the Sun, thus keeping all telescope components cool while powering Gaia.



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This is a project done in Dr. Mukherjee's Space Science class.