GAIA FACTSHEET

"We have a mission, it is working and I am convinced that it will totally change astronomy"
Timo Prusti, Gaia Project Scientist (June 2014)

Gaia has started to make the largest, most precise 3D map of our Galaxy

One billion stars

- Gaia has a unique role to play in the global family of major telescopes. It is a survey telescope that will map the entire sky, rather than observing small patches of sky in depth.
- Gaia will map the positions, velocities and properties of 1 billion stars - all the way to the galactic centre and beyond.
- Each of those one billion stars will be observed about 70 times over the five year mission – making an average of 40 million observations every day.
- 1 billion stars is about 1% of our Milky Way galaxy.
- Gaia is likely to detect tens of thousands of asteroids, comets, failed stars, variable stars, exploded stars, star clusters, visible galaxies and exoplanets.
- Exoplanets may be discovered at a rate equivalent to 5 new planets every day of its 5 year mission.

Currently our knowledge of the galaxy is based on indirect measurement, theoretical models and assumptions.

- Gaia will probe the origin, age, structure and evolution of the Milky Way, to understand its past, present and future.
- Expand theories on how stars and solar systems evolve.
- Answer questions about the mysterious dark matter - the invisible substance that controls the motion of stars.
- Provide new tests of Einstein's General Theory of Relativity.

Gaia's camera is the most powerful ever to be flown in space

- The accuracy of the camera is equivalent to being able to measure the width of an astronauts' thumbnail from Earth when the astronaut is on the Moon.
- Gaia can measure the positions of objects that are 400 000 times fainter than can be seen with the naked eye.
- The Gaia pixel is one of the most complicated ever manufactured.

8 megapixels	1000 megapixels (1 billion pixels)
1 CCD the size of a fingernail	106 CCDs on board, each measuring 6 cm x 4.5 cm, arranged in a focal plane half a square metre in area

Gaia is a fully European mission

- Gaia's CCDs are provided by e2v Technologies of Chelmsford UK, who worked solidly for 5 years to produce the CCDs required for the final mission.
- The Cambridge Gaia Data Processing Centre will be part of the front line in processing Gaia's images.
- The Electrical Service Module, responsible for a wide range of tasks - including transmitting the science data and the critical micro-propulsion system - were built by Airbus Defence and Space in Stevenage and Portsmouth.
- See more about UK involvement at http://gaia.ac.uk/gaia-uk
- By the end of the mission, the data archive will exceed 1 Petabyte (1 million Gigabytes), equivalent to about 200 000 DVDs worth of data.
- The Gaia catalogue will be published between 2016 and 2023.
- Gaia's first science discoveries will be made public from late 2014. Keep your eye on http://gaia.ac.uk/selected-gaia-science-alerts to find out how you can get involved in follow up observations.

RESOURCES

How big is 1 million?

- Give out a single sheet of MILLIMETRE-SQUARED graph paper.
- Work out the number of squares per sheet.
  (For example, for 180mm x 280mm = 50,400 squares per sheet.)
- How many sheets required for 1 million?
  (Example = 20 sheets)
- Stick the sheets together or show as previously prepared.

- 1 billion stars would require 20,000 sheets in this example. Calculate how large an area would be covered by paper.
- We currently know accurate distances to about 700 stars.
  Shade in a section of squares to show this number to give perspective on what Gaia hopes to achieve.

How big is 1 billion?

With reference to Gaia, 1 Billion = 1 thousand million

Count to 1 billion - out loud - as fast as you can!
Without stopping to eat or sleep, it will take you about 95 years.

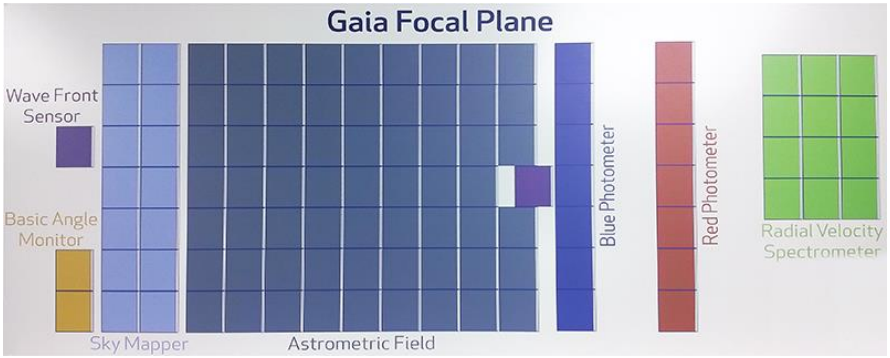
1 billion is a lot bigger than 1 million. Do this simple demonstration to get an idea:

- Open Notepad in Windows
- Type 100,000
- Copy/paste (x 9) to make 1 million
- Copy/paste this one line (x 9) to make 10 million
- Copy/paste these 10 lines (x 9) to make 100 million
- Copy/paste these 100 lines (x 9) to make 1 billion

- Imagine that this is £100,000 to get a sense of the scale of £1000,000,000.
  For ideas on how to present this, see http://drewconrad.com/billiondollars

Build the Gaia focal as a 1:1 scale model

- Make a single Gaia CCD by creating a rectangle measuring 6 cm x 4.5 cm.
- Create comparison CCDs:
  Mobile phones CCD sizes vary. For example:
  Iphone5 CCD = 4.54 x 3.42 mm a Nokia 808 CCD = 10.67mm x 8mm
  A high quality digital camera CCD measures about 23mm x 16mm
- BUT for Gaia you will need 106 Gaia CCDs to make the full focal plane!
- Arrange them as below to illustrate the functions of the camera – each function is achieved within a dedicated area on the focal plane. For example:
  The Astrometric Field - each CCD measures star position and brightness.
  The Red and Blue Photometers – star light is split and different wavelengths are directed to record temperature, size and chemical composition of the stars.
  The Radial Velocity Spectrometer (12 CCDs) - measure how fast a subset of stars are moving with respect to towards or away from us.



Gaia will use stellar parallax to find distances to the stars.

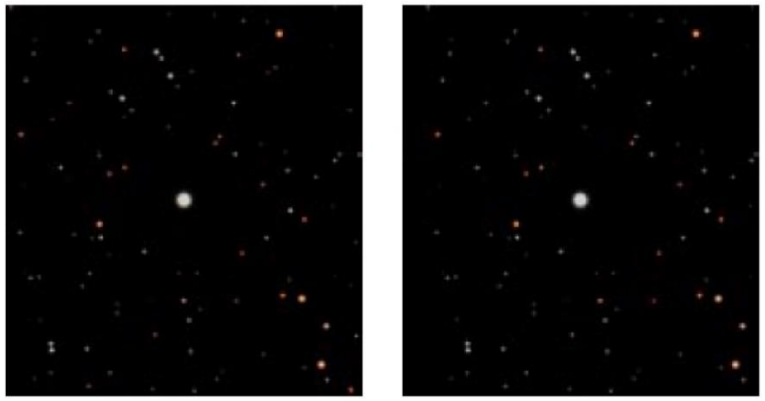
Find the distance, and you can also determine a star's true luminosity, mass and age.

For a simple demonstration and explanation of Parallax see:

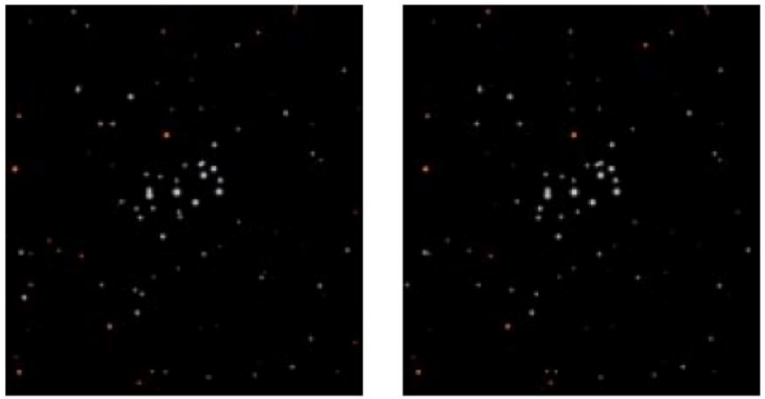
http://www.esa.int/Our_Activities/Space_Science/Gaia/Parallax/

Simple 3D visualisation of the stars

Relative distances calculated from Hipparcos parallax measurements



Sirius

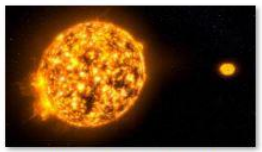


Pleiades

- View images from a distance of about 30 cm under uniform lighting conditions.
- Focus on images, but "relax" the eyes so that they converge at infinity (imagine that you are staring through the paper at a distant point).
- Allow the images to merge and the depth effect appears and then roam across the field, examining the relative distances of the various stars in it.

Links to further information

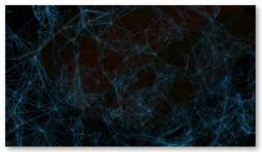
- Journey to a Billions Suns - A 45-minutes 360° fulldome planetarium show
  Also available in a 16 x 9 HD version (still thumbnails below)



twin-stars-in-the-milky-way #billionsuns-media

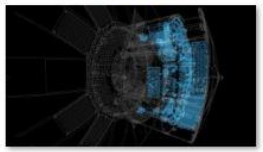
star-cluster-cross-nebula #billionsuns-media

sojuz-kourou-gaia-mission #billionsuns-media



gaia-relative-distances #billionsuns-media

distances-by-parallaxe #billionsuns-media



gaia-satellite-instruments #billionsuns-media

  Contact Adam Majorosi for more info/licensing: *contact@planetariumshow.eu*
  www.planetariumshow.eu

- For more about the 3D Stereo Images of the Sky and to navigate to Red/Green stereo images of Ursa Major, Cygnus and Lyra, Cassiopeia & Scorpius: http://www.rssd.esa.int/index.php?project=HIPPARCOS&page=stereo

- How many stars are there in the Universe? http://www.esa.int/Our_Activities/Space_Science/Herschel/How_many_stars_are_there_in_the_Universe

- The Interactive Books of Gaia : http://sci2.esa.int/interactive/media/start.htm

- Find out more about the global family of Big Telescopes: http://www.stfc.ac.uk/bigtelescopes

- Gaia follows a European tradition and heritage of astrometry - For a history of Astrometry - from Hipparchus to Gaia information see: http://sci.esa.int/gaia/53196-the-oldest-sky-maps/

- For more information about Gaia and the UK: http://gaia.ac.uk

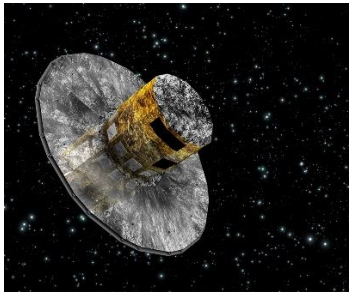
- For ESA site: http://sci.esa.int/gaia/

- http://blogs.esa.int/gaia/
- https://twitter.com/ESAGaia
- www.facebook.com/ESAGaiaMission

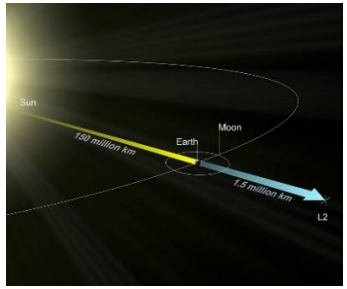
Images / Video suggestions for Download

Please click on image to visit download page

Artist Impressions of Gaia Spacecraft *Credit: (as specified)*



Where is Gaia? *Credit: ESA*



1.5 million km from Earth in a Lissajous-type orbit around the Second Lagrange point (L2)
The gravitational forces of the Sun, Earth and Moon are balanced here.
Gaia's orbit is eclipse-free for the next 6 years, so in a stable thermal environment.

We can see Gaia from ground based telescopes.

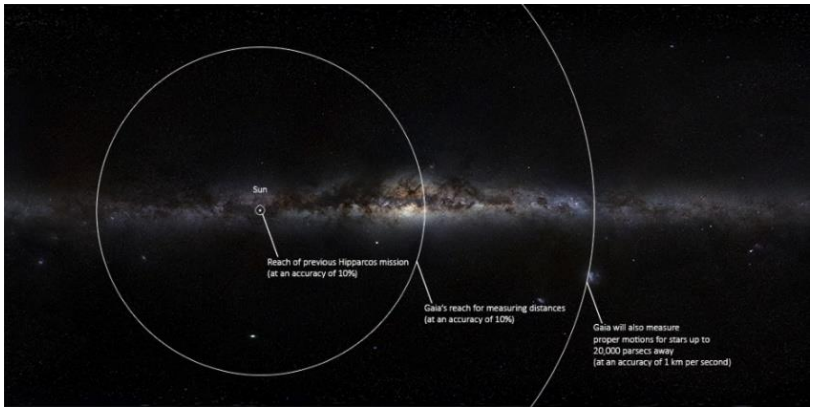
Series of 4 Gaia 1 minute cartoons : http://sms.cam.ac.uk/collection/1638609

Credit: Institute of Astronomy

Gaia's Survey Size1 -4 (jpg – 4 images)

Credit Galaxy image: ESO/S. Brunier

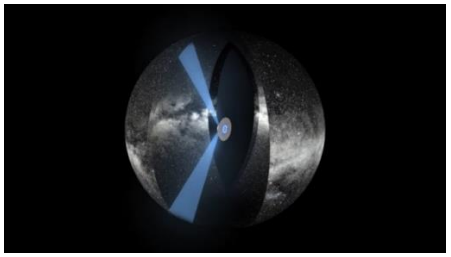
Comparative survey sizes of previous missions compared with Gaia. Available in stage images from Sun to outer reach of Gaia's radial velocity measurements.



Gaia scanning the sky (mov)

Credit: ESA

Animations showing Gaia performing a complete all-sky survey



Inside Gaia's Billion Pixel Camera

Credit: ESA

Excellent animation explaining the functions of Gaia's amazing camera