Venus Transit
5–6 June 2012 (from 22:00 to 4:56 UT)
Australia, Japan, Norway

Objective
The main objective of the venus-2012.org project is the observation of the Venus Transit that will take place on 5th/6th June 2012 (see Fig. 1) from three locations: Australia, Japan and Norway. In particular the project will:

1) **Perform live broadcasting** of the event (sky-live.tv).
2) **Promote educational activities** using images obtained during the transit (astroaula.net).

Figure 1. Earth map showing visibility of the Venus transit in 2012 (credit F. Espenak, NASA/GSFC).

The Phenomenon
A **transit** of an astronomical object occurs when it appears to move across the disc of another object which has a larger apparent size. There are different types of transits, like the Galilean moons on Jupiter’s disc, and exoplanets moving across their mother star. But it is the transit of the inner planets, Mercury and Venus, across the Sun’s disc that capture the interest of the general public because the phenomenon can be observed without telescopes.

While there are around 13 or 14 Mercury transits every century (the last one was on 7th May 2003), the Venus transits are an extraordinarily unusual phenomena. On average only **two** occur in just over a **century**. These two transits are separated by 8 years and the interval between these pairs of transits alternate between 105.5 and 121.5 years. Sometimes, as it happened in
1388, one transit of the pair does not take place because it does not coincide with the passage through a node of the orbit. Only six observations of the Venus transits have been reported: in 1639, 1761, 1769, 1874, 1882 and 2004.

The next transit will be on 5th–6th June 2012 and it will be our last opportunity to observe this peculiar phenomenon, with the next one not taking place until 2117!

The Black Drop effect
Just after the internal contact between the discs of the Sun and Venus, the disc of the planet seems to remain attached to the rim of the solar disc for a couple of seconds, becoming deformed and assuming a black drop shape. This phenomenon is repeated right before the last internal contact (Fig. 2). This effect is known as the “Black-Drop” effect and it prevents the accurate measurement of the time of contact between the disc of the planet and the disc of the Sun\(^1\). This was the main cause of the inaccuracy in the observations used to calculate the distance between Sun and Earth. During the last Venus & Mercury transits, the black drop effect was studied intensively, both from the optical theory point of view and in simulation experiments. Even though this effect was first attributed to Venus’s atmosphere, using images of the transit of Mercury by the TRACE satellite (Transition Region and Coronal Explorer, NASA, USA) it was found\(^2\) that the main causes of the Black-Drop effect are image blurring (due to atmospheric seeing and telescope diffraction) and solar limb darkening. This implies that the development of the Black-Drop effect as seen by an Earth bound observer mainly depends on the atmospheric conditions and the quality and size of the telescope used.

Figure 2. The Black-Drop effect observed during the interior contact of the Venus transit in June 2004. (credit: J.C. Casado).

Expedition Locations
The expedition will consist of three groups (see Fig. 3): Group1 (G1) Cairns (Australia); Group2 (G2) Sapporo (Japan) and Group3 (G3) Tromsø (Norway), and will be coordinated and directed by Dr. Miquel Serra-Ricart, Astronomer of the Institute of Astrophysics of the Canary Islands and Site Manager of Teide Observatory.

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\(^1\) See a method to increase precision of the contact timings: [http://www.transitofvenus.nl/blackdrop.html](http://www.transitofvenus.nl/blackdrop.html)

\(^2\) See the scientific paper: [http://nicmosis.as.arizona.edu:8000/POSTERS/TOM1999.jpg](http://nicmosis.as.arizona.edu:8000/POSTERS/TOM1999.jpg)
Figure 3. Observing points of the Venus transit. Locations are: 1) Cairns, Australia 2) Sapporo, Japan 3) Tromsø, Norway.

Broadcasts
The Venus transit will last for 6 hours and 40 minutes. The event broadcast will be performed at two levels:

1) **Live Connections.** Three live connections lasting 70 minutes each. They will coincide with the most interesting points of the transit (see Fig. 4 and time table in Annex 1).

- **Conn. 1** - Venus enters the Solar disc: 5th June 22:04–22:34 UT (00:04–00:34 CET).
- **Conn. 3** - Venus exits the Solar disc: 6th June 04:26–04:56 UT (06:26–06:56 CET).

UT Universal Time ; CET European Central Time

2) **Five-Minutes Time-Lapse.** From 5th June 22:00 UT and every five minutes the Sun–Venus image will be updated from the three points to keep the portal of the broadcast up-to-date.

The broadcasts will be bilingual (Spanish and English) and can be watched on the sky-live.tv website.
Educational activities

Two educational activities will be carried out from the observations of the transit.

Activity 1: Calculation of the Earth-Sun distance.
Activity 2: Phenomenon of the Midnight Sun.

Historically, the Venus transits were the main method for the determination of the Astronomical Unit (AU, Sun–Earth average distance) and, therefore, the scale of the Solar System. Edmond Halley presented a method to determine the AU by measuring the durations of the passage of Venus in front of the solar disc from different locations on Earth. Consequently dozens of expeditions from different countries travelled around the world to observe the transits of the 18th and 19th centuries. The most famous trip was made by Captain James Cook, who was sent to Tahiti to observe the 1769 transit.

In 1771, the French astronomer Jérôme Lalande determined the AU to be 153 million kilometres (± 1 million kilometres) using the data from 1761 and 1769. Observations of the transits in 1874 and 1882 were used to derive a value of 149.59 million km (± 0.31 million km).

The educational activities will be managed through the e-learning open software platform moodle (moodle.org).
Credits

The Seventh Framework Programme of the European Union (EU, FP7/2007-2013, INFRASTRUCTURES-2011-2, INFRA-2011-1.2.1: e-Science environments) collaborates with the broadcast though the GLORIA project – GLObal Robotic telescopes Intelligent Array for e-science” (Grant Agreement – Number 283783).

Web Collaborators

- INAF IASF Bologna.
- Institute of Astrophysics of the Canary Islands.
- University of Warsaw.
- University of Oxford.
- Alared Solutions Web S.L.
- Canarcloud.
- Ireland’s National Education and Research Network.
Collaborators

The FECYT (Spanish Foundation for Science and Technology, Ministry of Science and Innovation) and the IAC (Institute of Astrophysics of the Canary Islands) collaborate in the broadcast under the activity "Citizen Astronomy" within the call for funding for the promotion of scientific culture 2011 (FCT-11-1528). The images of the broadcast will be available to teachers for the practical activity “Calculation of the Earth-Sun distance” (see astroaula.net).

- The Army, Canary Command collaborates in satellite communications.
- The Iberia Group collaborates in transport logistics.

ANNEX 1. Table of local times (6th June 2012).

<table>
<thead>
<tr>
<th>Place</th>
<th>I</th>
<th>II</th>
<th>Max</th>
<th>III</th>
<th>IV</th>
<th>rise</th>
<th>set</th>
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<tr>
<td>Athens (UT+3)</td>
<td></td>
<td></td>
<td>07:38:02</td>
<td>07:55:30</td>
<td>6:03</td>
<td>20:45</td>
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<td>06:37:25</td>
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<td>4:46</td>
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<td>06:55:15</td>
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<td>08:54:14</td>
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<td>22:07</td>
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<tr>
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<tr>
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<td>00:22:07</td>
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<td>06:53:32</td>
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<td>06:55:08</td>
<td>4:56</td>
<td>20:51</td>
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</table>

I - Venus disk is externally tangent to the Sun, transit begins.
II - Venus is internally tangent to the Sun.
Max - Minimum distance between Venus and the centre of the Sun.
III - Venus reaches the opposite solar limb and once again is internally tangent to the Sun.
IV - Venus limb is externally tangent to the Sun, transit ends.