

# Print, Web, and Podcast ToV Public Outreach

## Jay M. Pasachoff

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As part of alerting the general public to the subtly spectacular transit of Venus as an intellectual marvel not available to us from Earth until AD 2117/2125, in addition to our scientific plans (Pasachoff et al., this meeting), I provided a variety of print, web, and podcast discussions of the transit of Venus. Months before the transit, I had:

(1) an article in the children's magazine *Odyssey* (May/June 2011); (2) a discussion in the National Geographic Society's BreakingOrbit blog (March 1, 2011), [http://newswatch.nationalgeographic.com/2011/03/01/watch\\_planet\\_transit\\_2012\\_venus/](http://newswatch.nationalgeographic.com/2011/03/01/watch_planet_transit_2012_venus/); (3) and a year's advance notice at "June 5: Transit of Venus." <http://365daysofastrology.org/2011/06/05/june-5th-transit-of-venus/>. (4) At the 2011 Nantes DPS, I participated in "Transits of Venus in Public Education and Contemporary Research," with online video at <http://transitofvenus.nl/wp/2011/10/16/four-giants-talk-about-transits/>. Subsequently, (5) I gave a 22-minute lecture about the transit of Venus, "Transit of Venus—Will You Be Watching?," on the Phi Beta Kappa website: <http://www.pbk.org/home/playpodcast.aspx?id=772> and enlargeable at <http://www.youtube.com/watch?v=FVvaCoNT1pg>. (6) I posted a summary of E/PO at Historical Astronomy Division News, #79, October; <http://had.aas.org/hadnews/HADN79.html>. Closer to the event, a few weeks before the transit (7) I had a Comment in *Nature* ("Transit of Venus: Last Chance to See," *Nature* 485, 303-304) and (8, 9) articles in general-public-accessible journals ("Transit of Venus: Last Chance From Earth until 2117," *Physics World*, 25, 36-41, May; "The 2012 Transit of Venus"; and *Scientific American*, online, <http://www.scientificamerican.com/article.cfm?id=transit-venus-june-5>). The day before the transit (10) I had a radio and podcast Academic Minute (<http://www.wamc.org/post/dr-jay-pasachoff-williams-college>). (11) On transit day, I had an Op-Ed piece in *The New York Times* ("Learning From Celestial Beauty," <http://www.nytimes.com/2012/06/05/opinion/learning-from-celestial-beauty.html>) that was seen by largely a non-scientific audience. Subsequent to the transit, (12) I gave a general-public lecture in Waimea sponsored by the Keck Observatory ([http://keckobservatory.org/news/video\\_venus\\_transits\\_past\\_present\\_future](http://keckobservatory.org/news/video_venus_transits_past_present_future)), and (13) an invited public evening lecture at the AAS meeting in Anchorage ([http://aas.org/meetings/aas220/video\\_session\\_127](http://aas.org/meetings/aas220/video_session_127)). A few weeks later, I had a podcast on (14) <http://365daysofastrology.org/?s=pasachoff> (June 29). (15) My article for *Sky & Telescope* appeared in the October issue (<http://skyandtelescope.com>). (16) My editorial "Syzygy x 3" will appear in the *Observer's Handbook 2013* of the RASC. (17) "Science at the June 6/5 Transit of Venus," *Inquiries of Heaven*, the newspaper of the International Astronomical Union General Assembly in Beijing. (18) My various efforts as well as links to links to history and science of transits of Mercury and Venus are assembled at <http://www.transitofvenus.info>.

**Acknowledgments:** My expeditions to the transits of Venus of 2004 and 2012 were supported by grants from the Committee for Research and Exploration of the National Geographic Society.

### UPCOMING SOLAR EVENTS CALENDAR

## 2 Catch a Pass! (of Venus with the Sun)

by Jay M. Pasachoff

Transit History  
The story of transits of Venus goes back almost 2000 years to the great Greek astronomer Ptolemy. He knew that the planets orbited around the Sun were closer, rather than further, than the Sun. He used this knowledge to calculate the planets' positions accurately enough that he could predict a transit. But he wasn't visible in Europe.

### NATIONAL GEOGRAPHIC

Inspiring people to care about the planet since 1888

### Astronomy 2012: Watch a Planet Transit With Your Own Eyes!

Posted by Victoria Jaggard of National Geographic News on March 1, 2011

If you've been following the exploits of NASA's Kepler spacecraft, you probably already know that the mission finds new planets using what's called the transit method.

In short, Kepler stares at a bunch of stars and records when there's a periodic dip in a star's light caused by an object passing in front. With enough data and some careful followup work, scientists can tell whether the passing object is a planet orbiting the star.

So far, Kepler has confirmed 15 new planets using transits, and an additional 1,200 planetary candidates were recently announced.

And next year, people around the world will be able to watch a transit of an Earth-size planet with their own eyes.

OK, fine, I admit—the planet in question is our own Venus. But that's still pretty cool, because Venus transits are exceedingly rare.

What follows is an edited transcript of a conversation I had last week with National Geographic grantee Jay Pasachoff, an astronomer at Williams College in Massachusetts and an expert on eclipses and transits.

So what does a Venus transit look like from Earth?

### 365 DAYS OF ASTRONOMY

YOUR DAILY ASTRONOMY PODCAST

## June 5th: Transit of Venus

Podcast: Download (0.0KB)  
Date: June 5, 2011  
Title: Transit of Venus  
Podcaster: Jay Pasachoff  
Organization: Williams College  
Links: Transit of Venus website, Working Group on Eclipses of the International Astronomical Union  
Description: A year from today, on June 5, 2012, in the United States and June 6, 2012, in Europe, a transit of Venus across the face of the sun will be visible. It is a very unusual and exciting event and one that almost all the people of the world can see since only a few parts of the world, mainly the eastern part of South America and the western part of Africa are excluded from seeing any part of the transit and all the other people of the world will be able to see it just by looking up.  
Bio: Jay Pasachoff, Chair of the International Astronomical Union's Working Group on Eclipses, is Field Memorial Professor of Astronomy at Williams College. He has viewed 50 solar eclipses, and is an expert

### 365 DAYS OF ASTRONOMY

YOUR DAILY ASTRONOMY PODCAST

## June 29th: Transit of Venus 2012 Observations

Podcast: Download (0.0KB)  
Date: June 29, 2012  
Title: Transit of Venus 2012 Observations  
Podcaster: Jay Pasachoff  
Organization: Williams College  
Links: Transit of Venus website, Working Group on Eclipses of the International Astronomical Union  
Description: Hated astronomer Dr. Jay Pasachoff talks about the 2012 transit of Venus, about which he spearheaded observations from the ground and from space. Bio: Jay Pasachoff, Chair [...]

### Four giants talk about transits

Posted on October 16, 2011 by Steven van Roode

### Transits of Venus in public education and contemporary research

presented by J. M. Pasachoff at the EPIC OPS October 6, 2011

### Sun Earth Day 2012: The Transit of Venus

presented by L. Mayo at the EPIC OPS October 6, 2011

### A VT-2012 project for the observation of the next Transit of Venus

presented by J. E. Aron at the EPIC OPS October 6, 2011

### The aureole of Venus: light refraction in the mesosphere during the transit of Venus

presented by P. Tang at the EPIC OPS October 6, 2011

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### Academic Minute

4:13 PM FRI AUGUST 6, 2010

### Dr. Jay Pasachoff, Williams College

Listen 02:30

Albany, NY — In today's Academic Minute, Williams College astronomy professor Dr. Jay Pasachoff discusses the majesty of the solar eclipse.

Dr. Pasachoff is Director of Hopkins Observatory, Chair of the Astronomy Department, and Field Memorial Professor of Astronomy at Williams. He earned his Ph.D. at Harvard.

### 15 A Glorious Transit of Venus

JAY M. PASACHOFF

Millions of people saw June's transit of Venus, but for research astronomers, it was a golden opportunity to advance science.

The most extraordinary predictable astronomical events of this new millennium have come and gone. Even total solar eclipses, commonly thought of as rare, can be seen somewhere in the world every 16 months or so. But transits of Venus across the face of the Sun now come in 8-year pairs with a gap of either 105½ or 121½ years before the next pair. So only the youngest of today's children might see the next pair of transits, in 2117 and 2125.

A career of scientists around the world endeavored to use ground- and space-based resources to get the most complete record possible of the transit across much of the spectrum. Public education programs and published articles brought tens of millions of people to see the transit across North America and around the world. My colleagues and I were particularly eager to use this rare transit opportunity both to study Venus' atmosphere and to help astronomers who want to hone their techniques for characterizing transiting exoplanets.

The 2004 Transit of Venus  
When the 2004 transit of Venus came around, no human alive had ever seen such an event. However, the Gallapagos ornithologist Charles Darwin in 1835 — so also could have been the 19th-century transit.

In the run-up to the 2004 transit, Brad Schaefer (Louisiana State University) realized that most of the published explanations of the so-called black-drop effect, widely attributed to Venus' atmosphere, were incorrect. This effect refers to the extended black link that connects Venus' silhouette when it's fully onto the Sun's disk with the black sky outside the Sun. For a minute or so, second and third contacts, this black drop had prevented observers from accurately measuring the exact contact times. Since Edmund Halley in 1716 had worked out a method of using accurate timing of a transit of Venus to triangulate the Earth-Sun distance, the black-drop effect frustrated his measurements of the size and scale of our solar system (see issue 28).

After hearing Schaefer present his paper, I contacted Glenn Schneider (University of Arizona) to propose and analyze archival Sun images dating from the 1999 transit of Mercury that we obtained from NASA's Transition Region and Coronal Explorer (TRACE) spacecraft. Since Mercury has essentially no atmosphere of any significance, and TRACE observed from

### 17 INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA, AUGUST 20 - 31, 2012

## SCIENCE AT THE 6/5 JUNE 2012 TRANSIT OF VENUS

The transit of Venus that was visible from China and elsewhere in Asia on June 6 and in the U.S. on June 5 provided an unusual opportunity for such an event to be observed both to study Venus' atmosphere and as a terrestrial analogue to the exoplanet transits now so widely observed from Kepler, CoRoT, and earthbound telescopes. For over six hours on that date, Venus' silhouette was visible against the Sun, larger than any sunspots.

Johannes Kepler missed predicting the transit of 1639, leaving it to be predicted and seen only by Jeremiah Horrocks and one correspondent. Transits of Venus as seen from Earth come in pairs separated by 8 years, with alternate gaps of 105.5 and 121.5 years between pairs. The 1761/1769 pair saw hundreds of expeditions around the world to attempt to determine the solar parallax, arguably the most important question in astronomy of the time, given that distances of the planets were known only proportionally from Kepler's third law. The 1874/1882 pair saw photography added. Timing at all those transits was compromised by the black-drop effect, blackness joining Venus' silhouette with the sky outside the solar limb. Glenn Schneider and I showed from a transit of Mercury observed with NASA's TRACE spacecraft that the entire effect is explained by a combination of the solar limb darkening and the telescope's point-spread function, correcting a widespread misunderstanding that Venus' atmosphere played a role. We have now seen the 2004 and 2012 pair of transits. The earlier one, though observations were optimized for the black-drop effect, turned out to show Venus' atmosphere appearing as an arc silhouetted against the sky between the first two and again between the last two contacts, as Venus' atmosphere refracted sunlight toward Earth. Observations of the 2012 transit were therefore optimized for studying Venus' refractive atmosphere, taking advantage of the geometrical coverage and revealed the solar limb darkening.

Although the next transits of Venus will not be visible from Earth until 2117 and 2125, we have arranged for NASA's Cassini spacecraft orbit at Saturn to view a transit of Venus on December 21, 2012. The 0.01% effect and a broadband spectral-difference code, we calculate, detectable with extensive averaging over time, providing an analog in our solar system of exoplanet transits.

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## AAS 220th Meeting Video - Session 127

Meetings aas220

## 127.01 - Transits of Venus and Mercury: Exoplanet Analogs in Our Solar System

Jay Pasachoff, Williams College

Since Johannes Kepler's predictions of transits of Mercury and Venus in 1631, and observations by Jeremiah Horrocks and William Crabtree of the 1639 transit of Venus, only 5 other transits of Venus have been observed, in 1761 and 1769, 1874 and 1882, and 2004. Expeditions to see all over the world for the 18th and 19th century transits followed the methods of Halley, and others in the 18th century. The 20th century transits were the result of the solar system, especially the most important planets for exoplanets. I will discuss how the information

### 16 ROYAL ASTRONOMICAL SOCIETY OF CANADA

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## Observer's Handbook

The 2013 Observer's Handbook will be available in early October 2012, taking pre-orders now!

Earth Centered Universe (ECU), free PC planetarium software

is included with each Handbook — see [www.nova-astro.com/handbook](http://www.nova-astro.com/handbook) or Order your Observer's Handbook online here, or click on the appropriate form at page bottom.

105th Year of Publication  
Edited by Dave Chapman

### 6 Venus: it's now or never

Transits of Venus, in which our sister planet passes across the face of the Sun, are predictable but exceptionally rare events. With the next transit due to take place on 5 and 6 June this year, Jay M Pasachoff explores the science and history of these twice-in-a-lifetime occurrences

Two bodies. In 1627 Johannes Kepler, best known for his three laws of orbits, published his *Rudolphine Tables*, which showed the superiority of the Copernican theory and allowed the positions of the planets in the sky to be calculated more accurately. This work led Kepler to predict that both Mercury and Venus would transit the Sun in 1631.

That year's transit of Mercury was observed by the French scientist Pierre Gassendi, but that of Venus was not visible from Europe, and so went unrec-

### Transits of Venus and Mercury

18

1 of Venus Transits, June 8, 2012

Transit of Venus June 8, 2012

Transits of Mercury

Historical Transits of Venus

### 7 Last chance to see

The June 2012 transit of Venus across the Sun offers an opportunity to check our methods for spotting distant planets crossing far-away stars, says Jay M. Pasachoff.

The right of Venus silhouetted against the Sun is exceedingly rare. Since 1631, it has been used to settle a long-standing mystery about the appearance of transiting planets.

### 9 SCIENTIFIC AMERICAN

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## Crossing the Sun: The Last Transit of Venus until 2117

Next week will be the last opportunity this century to see the planet Venus as a little black dot moving across the solar disk—a rare event with a long, important history in astronomy

By Jay Pasachoff

The 2012 Transit of Venus Venus will pass in front of the solar disk on Tuesday, June 5. The next transit will not occur again until 2117, so don't miss one of the rarest of sky shows

### 14

On June 5 in the Americas and June 6 in the rest of the world, people will be able to see one of the rarest predictable events in astronomy: a solar transit of the planet Venus. Over a six-hour period the disk of Venus will be silhouetted against the sun. Seeing it safely requires a special eye-protection filter, available for a dollar or so —alternately, a telescope or binoculars can safely project an image onto a wall or sheet of paper. But if you miss it, your next chance won't come until the year 2117.

### 17 W. M. KECK OBSERVATORY

On the summit of Mauna Kea, Island of Hawaii

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## 17 Video: Venus Transits Past, Present & Future

June 21, 2012

What's the science behind the recent Venus Transit? In this talk by Dr. Jay Pasachoff of Williams College presents brand new images and movies from the recent transit gathered in multiple wavelengths and from many locations. This talk, which includes a detailed history of transit science, was delivered two days after the June 5, 2012, Venus Transit on the Big Island of Hawaii.

### 16 Transits of Venus from Earth, Jupiter & Saturn, Past, Present & Future

from Keck Observatories

The Transit of Venus, the Transit of Jupiter, and the Transit of Saturn are all rare events in our solar system. This video series explores the science and history of these transits.

### 5 The Phi Beta Kappa Society

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## 2011 eBK Video Series: "The June 5, 2012, Transit of Venus," from Jay M. Pasachoff

Jay M. Pasachoff is a prominent astronomer and the Field Memorial Professor of Astronomy at Williams College. He is also the Director of the Hopkins Observatory at Williams College. His work has been sponsored by the National Science Foundation, NASA, and the National Geographic Society, among others. Recipient of the 2003 Education Prize from the American Astronomical Society, Pasachoff's work focuses primarily on local solar