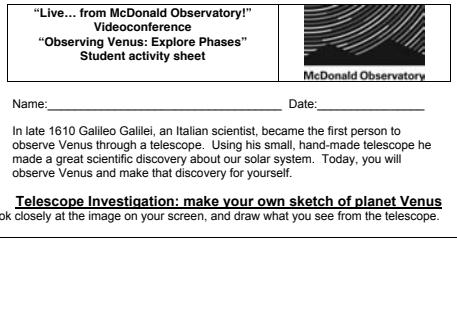
Live from McDonald Observatory: Observing Venus: explore how it changes
Videoconference
Teacher Edition for grades 9-12

Introduction

The videoconference will introduce students to McDonald Observatory, telescopes, and a few astronomical objects near and far astronomers explore. The student sheets are designed to help the student discuss important concepts. Students should be directed to not fill in their sheets until prompted.


"Live… from McDonald Observatory!"
Videoconference
"Observing Venus: Explore Phases"
Student activity sheet

McDonald Observatory

Name:_____ Date:_____

In late 1610 Galileo Galilei, an Italian scientist, became the first person to observe Venus through a telescope. Using his small, hand-made telescope he made a great scientific discovery about our solar system. Today, you will observe Venus and make that discovery for yourself.

Telescope Investigation: make your own sketch of planet Venus

Look closely at the image on your screen, and draw what you see from the telescope.

Describe your observation of Venus. Did you find anything interesting?

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Our Science Journal: Make your own sketch of planet Venus!

Prior to the videoconference, students should have filled in the pre-assessment sheet. The drawings and words that they use will help you gauge their pre-conceptions as well as prepare them for encountering new information about Venus.

If the weather conditions are favorable at McDonald Observatory, the image of Venus your students will see is live, real-time and captured by the telescopes digital video-cameras. Even in favorable conditions, the image of Venus may appear wavy and distorted. This is because the air above the telescope is turbulent during the day. This turbulence makes the light from Venus, passing through the air, appear wavy and distorted. If clouds block Venus or equipment problems occur, supplemental recordings will be provided. Before actually observing Venus, the facilitator will familiarize students with the dome, telescope, video-camera and control system. The facilitator will provide commentary and demonstrations to make important links between the physical concepts and Venus.

In the box, students should draw Venus exactly as they see it on their screen. Depending on the location of Venus in its orbit around the sun on the day of your videoconference, students might draw a crescent shaped Venus, or they might draw a gibbous shaped Venus (more than half the disk but not the entire disk). Since the planet is always completely covered by a thick cloud layer, we don't see surface features, and Venus does not have rings, or moons, so these elements should not appear in drawings.

Did you discover anything interesting about planet Venus? Among other things to notice, students might answer that they have discovered that Venus is in a crescent, or, gibbous shape, like that of the moon. This is an important discovery because as the videoconference facilitator will demonstrate, for us to see an entire cycle of phases, Venus must orbit the Sun. Your students have begun to make the same great discovery that Galileo Galilei made in 1610. During his time most people believed that Earth was at the center of the Universe, around which the planet Venus, the Sun, planets and stars would orbit, known as the "Ptolemaic System". It was believed that while orbiting the Earth, Venus would move through "epicycles" (small circles) producing a cycle of phases. The resulting phases would either be always crescent or always gibbous, but not both. By observing with his telescope patiently, he saw Venus go through an entire cycle of phases including crescent and gibbous, *disproving* that the sun was orbiting Venus. Galileo's experiments in physics and discoveries in astronomy are recognized by our title for him, the "Father of Modern Science".

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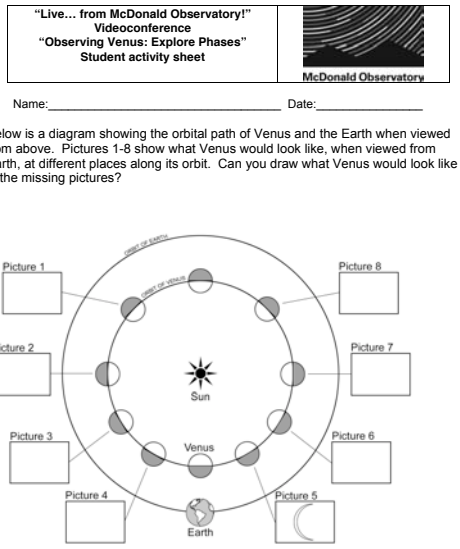
Watching Venus change:

During the videoconference, students will see drawings that Galileo made while he was observing Venus. Galileo's drawings show that Venus changes in apparent size as well as phase. By observing demonstrations, students make the connection between the drawings Galileo made and the physical concepts related to Venus' orbit.

At this point in the videoconference, the facilitator will have introduced a demonstration of how Venus appears to change as it orbits the Sun, as viewed from Earth. The demonstration is meant to provide a visual clue for how both the apparent size *and* phase of Venus change together. We see Venus go through a cycle of change: from a large crescent to a smaller gibbous phase and back to a large crescent.

if Venus is located anywhere between the Earth and Sun it appears as a large crescent phase. However, we don't see any sunlight on Venus when it passes in front of Earth, because the sunlight would be seen on the opposite side. If Venus is located anywhere on the far side of the Sun it appears as a smaller gibbous, or full phase. Students will now consider the diagram.



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Name:_____ Date:_____

Below is a diagram showing the orbital path of Venus and the Earth when viewed from above. Pictures 1-8 show what Venus would look like, when viewed from Earth, at different places along its orbit. Can you draw what Venus would look like in the missing pictures?

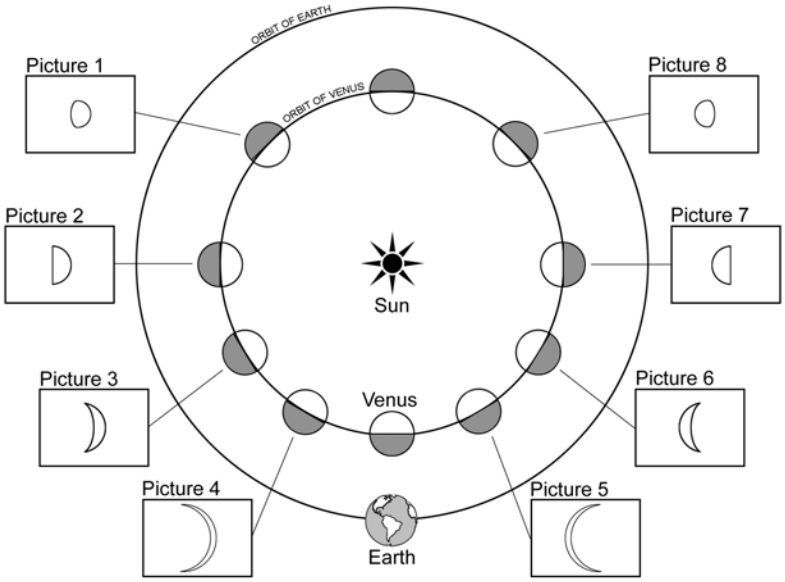
Notice the phase of Venus in the drawing you made earlier. Using the above diagram of the orbit of Venus, determine where Venus is currently located in its orbit. Which picture (1-8) is the closest representation of the phase of Venus as seen today?

Picture #_____ represents the phase and orbital position of Venus as seen today.

The diagram shows a top-down view of Venus and Earth orbiting the Sun. Pictures 1-8 represent the Venus phase we would see from Earth at corresponding points along Venus's orbit.

What would Venus look like in the missing pictures?

Answer: The apparent size and phase of Venus depends on where the planet is located in its orbital path. In each picture, Venus would be the mirror image of the phase on the opposite side of the Sun. For example, Picture #4 is the mirror image of picture #5. Here is how pictures #1-#8 should appear in student work.



In the diagram above, notice that when viewed top-down, Venus never appears to change size, would always appear half illuminated and never go through phases.

Which picture # represents the phase and orbital position of Venus as seen today?

Answer: Students must look at the picture they drew on page 1. By matching their picture to the most similar picture # in the diagram, your students can estimate the current location of Venus in its orbit. The correct answer simply depends on the Venus phase during your videoconference. The facilitator will help the students consider this question critically, and we will arrive at an answer together.

Extended science details:

Your students might also be surprised to learn that we can observe Venus during the nighttime *and daytime*. Venus orbits the Sun closer than Earth, so, to see Venus we can look in the direction of the Sun, during the *daytime* (but we NEVER look at the Sun). Venus can be seen on the East or West side of its orbit around the Sun (when facing south, to the left or right of the Sun). When Venus is on the East side of the Sun, it sets *after* the sun, and is therefore still visible in the evening sky. We then call it the "evening star". When Venus is on the West side of the Sun, it sets *before* the Sun and therefore rises *before* the Sun. We then call it the "morning star".

2012 happens to be a monumental year for observing Venus. Venus's orbit is inclined 3.4% relative to Earth's orbit. Therefore, when Venus passes directly in front of Earth (inferior conjunction), or, passes directly behind the Sun (superior conjunction) the planet usually appears to pass under, or over the Sun. A Venus transit occurs when Venus passes in front of Earth (inferior conjunction), in the precise direction of the Sun. From Earth we see Venus, a dark disk, passing across the face of the Sun. Venus completes an orbit every 227.4 Earth days, overtaking our planet on its inside orbit every 584 days. However, because of the inclined orbit, transits occur only four times every 243 years. Venus transits are among the most rare of predictable astronomical events, occurring in an intricate pattern that repeats itself every 243 years. Transits occur in pairs, with 8 years between transits. Then the next pair of transits, also separated by 8 years, occurs 121.5 years later. The next pair occur 105.5 years later, followed by two more 121.5 years later, and so on. 121.5 yrs, + 8 yrs. + 105.5 yrs. + 8 yrs = 243 yrs. On June 5, 2012 for skywatchers in Texas, the second of a pair of transits occurred, the first of which occurred on June 8, 2004. After 2012, the next pair of transits will not occur until December 2117 and again December 2125. June 2012 was the only opportunity your students had to witness a Venus transit within their lifetime. Observing a Venus transit requires the same protective eyewear you would wear to observe the Sun on any other day. Observing Venus in the evening or morning sky does NOT require protective eyewear.

References and Extensions

Six ways to safely view the Transit of Venus:
http://www.transitofvenus.org/june2012/eye-safety/281-six-ways-to-see-the-transit-of-venus

Transit not visible from your location?
Watch the live webcast from the fun team at NASA EDGE.

NASA activities related to the Galileo mission:
http://solarsystem.nasa.gov/galileo/

StarDate Astro Guide related to Venus:
http://stardate.org/astro-guide/ssguide/venus

StarDate radio script related to Venus and the Venus Express mission:
http://stardate.org/radio/program/2008-09-04

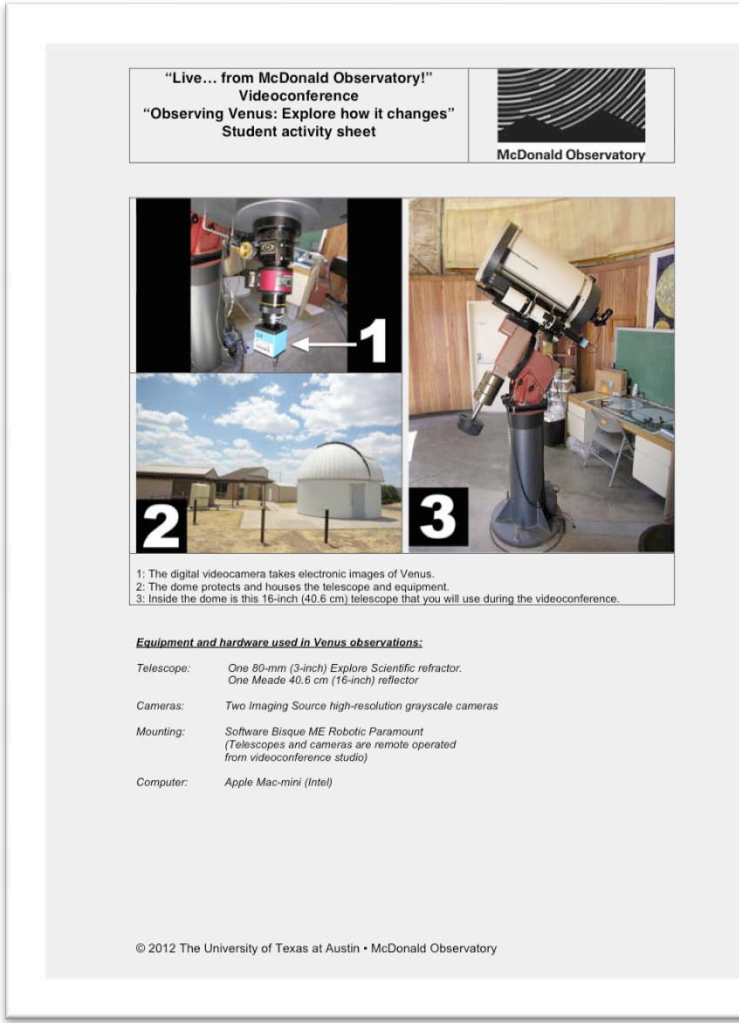
Equipment and Hardware used in solar observations

This page gives students a better understanding of the equipment involved in acquiring the images they are seeing of Venus during the videoconference. The purpose of this page is to allow students to make the connection between science and technology. Technology provides improved means for scientists to acquire a better understanding of the universe.

There are two telescopes here:
• The large, white Meade 16-inch (40.6 cm) telescope is used for high-magnification views of Venus. There is no solar filter used to observe Venus.

•The 3-inch (80-mm) telescope provides a low magnification view.

During the videoconference the facilitator controls the telescope using a computer in the videoconference studio. Students may be surprised to learn that the computer is similar to those that they may use at home or school. Although astronomers use special software on their computers, often a standard home-quality computer is sufficient for the data management of many projects. (Note: astronomers who work on making mathematic models of astronomical phenomena or who have extremely large data bases do require special computers.)



References and Extensions:

Meade Instruments
http://www.meade.com/

TeleVue telescopes
http://www.televue.com/

Adirondack Video Stellacam
http://www.astrovid.com/

The videoconference telescope mount that is remotely controlled
http://wwwbisque.com/Products/Paramount/