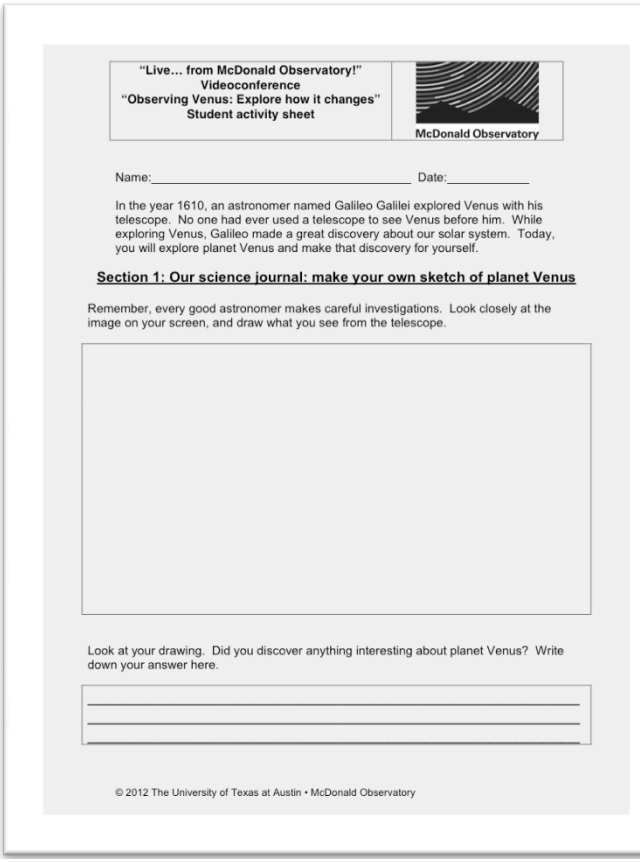
Live from McDonald Observatory: Observing Venus: explore how it changes
Videoconference
Teacher Edition for grades 3-5

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 how it changes"
Student activity sheet

McDonald Observatory

Name:_____ Date:_____

In the year 1610, an astronomer named Galileo Galilei explored Venus with his telescope. No one had ever used a telescope to see Venus before him. While exploring Venus, Galileo made a great discovery about our solar system. Today, you will explore planet Venus and make that discovery for yourself.

Section 1: Our science journal: make your own sketch of planet Venus

Remember, every good astronomer makes careful investigations. Look closely at the image on your screen, and draw what you see from the telescope.

Look at your drawing. Did you discover anything interesting about planet Venus? Write down your answer here.

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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 the entire Universe, including Venus and the Sun orbited the Earth. By observing with his telescope patiently, he saw Venus go through an entire cycle of phases and was able to *disprove* 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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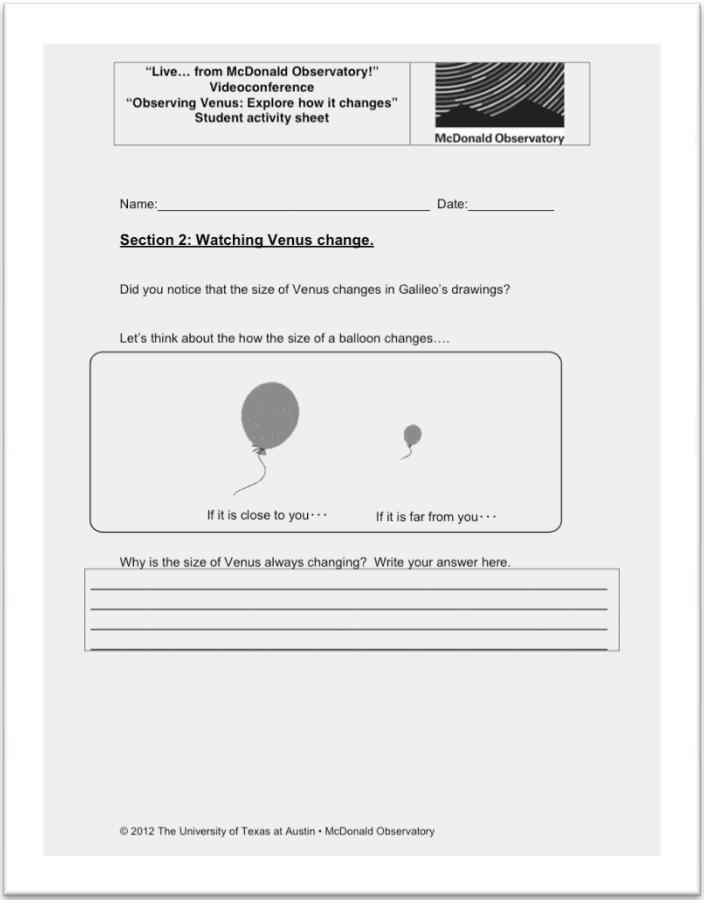
Watching Venus change:

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. By observing demonstrations, students make the connection between the drawings Galileo made and the physical concepts related to Venus' orbit.

While the videoconference facilitator will describe and demonstrate the changing phases of Venus, for younger students the primary objective in this videoconference is for students to observe and understand why the apparent size of Venus changes. The images of the balloons are to help the student relate their knowledge of how objects appear to change when they are close, or far away.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McDonald Observatory

Name:_____ Date:_____

Section 2: Watching Venus change.

Did you notice that the size of Venus changes in Galileo's drawings?

Let's think about the how the size of a balloon changes....

If it is close to you···

If it is far from you···

Why is the size of Venus always changing? Write your answer here.

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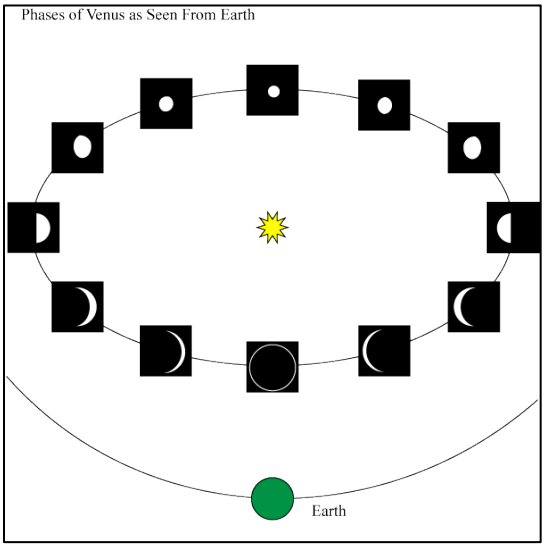
Why is the size of Venus always changing?

The apparent size of Venus depends on where the planet is located in its orbital path. The diagram below illustrates the same concept that the facilitator will demonstrate during the videoconference.



From Earth, we have a side-view of Venus's orbit around the Sun (orbiting counter-clockwise in this illustration), not a top-down view. The planet therefore appears smaller and smaller in size as it orbits away from us, and then it gradually appears larger and larger as it approaches us. If we had a top-down view of the orbit, the apparent size of Venus would never change, but it does. Students must understand this concept before they will understand why Venus goes through an entire cycle of phases.

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As Venus orbits the Sun, we see another cycle of change: how much and where sunlight appears on the planet, called its "phase". Once again, depending on the location of Venus on the day of your videoconference, it may appear as a large crescent, or as a smaller gibbous phase. The facilitator will demonstrate that 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.

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

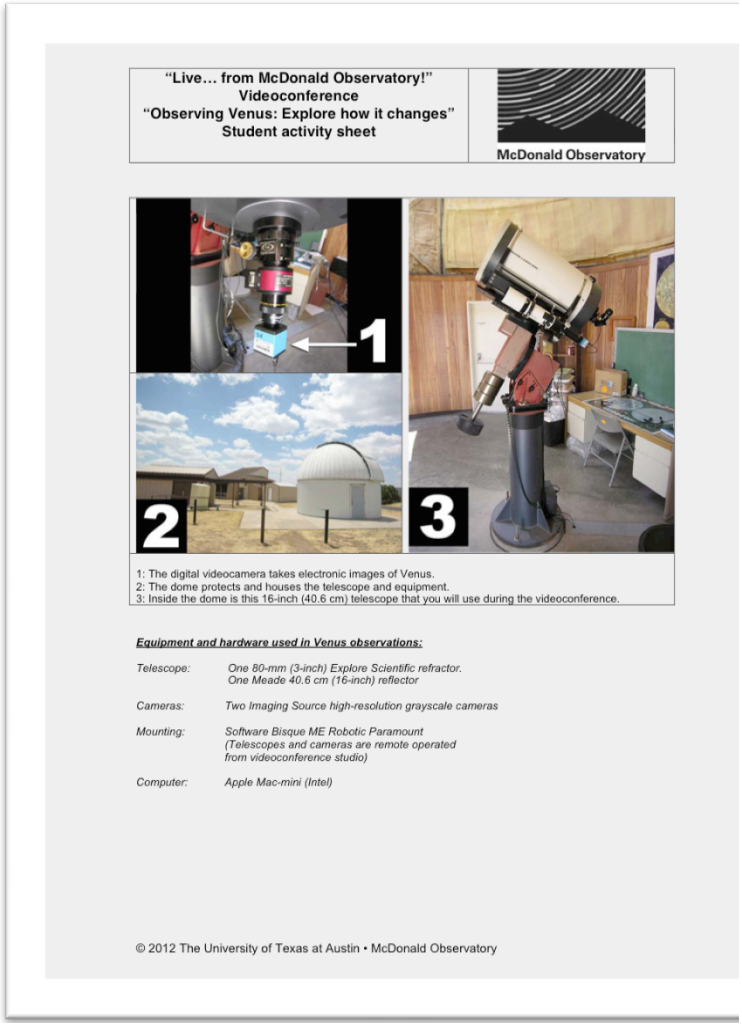
Equipment and Hardware used in solar observations

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.)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1: The digital videocamera takes electronic images of Venus.
2: The dome protects and houses the telescope and equipment.
3: Inside the dome is this 16-inch (40.6 cm) telescope that you will use during the videoconference.

Equipment and hardware used in Venus observations:

Telescope:	*One 80-mm (3-inch) Explore Scientific refractor.* *One Meade 40.6 cm (16-inch) reflector*
Cameras:	*Two Imaging Source high-resolution grayscale cameras*
Mounting:	*Software Bisque ME Robotic Paramount* *(Telescopes and cameras are remote operated from videoconference studio)*
Computer:	*Apple Mac-mini (Intel)*

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/