



NIGHTLIGHTS

10am, Friday, February 24, 2010
8pm, Saturday, February 25, 2012

Out of This World

featuring The Planets

Students at the Symphony

**Welcome to the Springfield Symphony Orchestra
February 24 and 25, 2012
Clark State Performing Arts Center
Springfield, Ohio**

**This is your guide to an
exciting concert!**



SPRINGFIELD SYMPHONY
ORCHESTRA

Introduction

This very special performance of The Planets will have three components:

- Beautiful music composed by Gustav Holst
- Spectacular NASA images and animations
- Actors reading the words of important scientists.

To enhance your understanding of the sights and sounds of the performance, this guide provides helpful background information.

In Part One you'll find interesting facts about celestial objects, from the entire Known Universe to “nearby” Planets and Moons.

In Part Two you can read about the lives and work of William and Caroline Herschel, Cecelia Payne, Galileo Galilei, Albert Einstein, and Gustav Holst.

Welcome aboard. Enjoy your journey.



Part One

Celestial Objects



The Known Universe

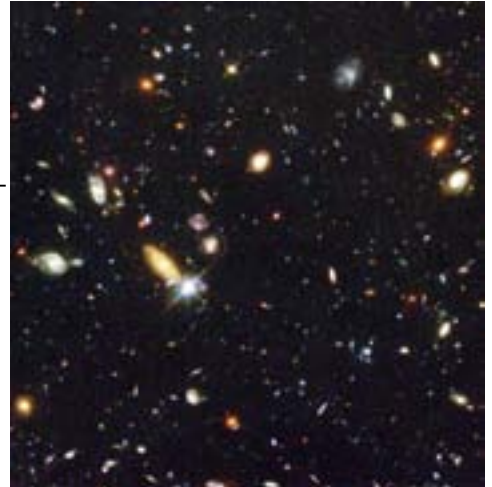
What it is: All of the matter, energy, space, and time that we can detect with our eyes and our instruments.

How big: The farthest detectable objects, whose light has been traveling for 13.6 billion years, are now at a distance of approximately 46 billion light-years (one light-year is about 6 trillion miles).

How much mass: The total mass of the visible and dark matter and energy is about 10^{53} kilograms.

Can you see it? Yes, but only those portions of the Universe whose light has had time to reach Earth.

Interesting speculation: Our Known Universe may be only one of many universes that make up the “multiverse.”



Galaxies

What they are: Galaxies are immense collections of hundreds of billions of stars, dust, gas, and dark matter, all bound together by gravity.

How many stars: Most galaxies contain between 100 million and 1000 billion stars.

How big: Most galaxies have diameters of 3,000 and 300,000 light-years.

How far away: The closest big galaxy beyond our own Milky Way is the Andromeda Galaxy, which is about 2.5 million light-years away.

Can you see them? On a clear, moonless night, you may be able to see the Andromeda Galaxy with your unaided eyes.

Interesting fact: There are four main types of galaxy: spiral, barred spiral, elliptical, and irregular. The irregulars may be made by galaxy collisions.



Our Galaxy - The Milky Way

What it is: The disk-shaped spiral galaxy in which we live.

How many stars: Our galaxy contains between 100 billion and 400 billion stars.

How big: The diameter of our galaxy is about 100,000 light-years.

Can you see it? From our position inside the disk of our galaxy, the Milky Way looks like a band of stars in the sky.



Interesting fact: At the center of our Milky Way Galaxy lies a supermassive black hole whose mass is several million times bigger than the mass of our Sun.

Nebulae

What they are: A nebula is a cloud of gas and dust in interstellar space. Some nebulae are associated with star birth; others are produced by dying stars.

How big: Nebulae range in diameter from a few light-years to several hundred light-years.

How far away: Most nebulae lie a few thousand light-years from Earth.

Can you see them? The Orion Nebula is easily visible as a fuzzy patch of light just below the belt of Orion.



Interesting fact: There are many different types of nebula: “emission” nebula are hot and give off their own light; “reflection” nebula reflect light from nearby stars; “dark” nebula absorb light and look like black clouds; “planetary” nebula are made of material blown off by dying stars, and have nothing to do with planets.

Stars

What they are: Gaseous spheres converting mass into energy by nuclear fusion in their cores.

How big: Most stars have diameters of 100,000 to 50,000,000 km.

How far away: Most of the stars visible to the unaided eye lie between 50 and 150 light-years from Earth.

Can you see them? Away from city lights, you can see several thousand stars on a clear, moonless night.



Interesting fact: There are more stars in the known Universe than grains of sand on all the beaches in the world.

Our Star - the Sun

What they are: Our Sun is a slightly smaller-than-average star.

How big: The Sun's diameter is about 1.4 million km, which means that about 1 million Earths would fit inside the Sun.

How far away: The Sun's distance from Earth is about 150 million km (93 million miles).

Can you see it? Yes, when you're on the side of the Earth facing the Sun - but you should NEVER look directly at the Sun.



Interesting fact: The Sun produces about 400 million billion billion watts of power.

Planets

What they are: Planets are spherical bodies that orbit a star. “Terrestrial” planets are rocky, and “Jovian” planets are made primarily of gas.

How many: Our solar system has eight planets, and we’ve detected over 600 “extra-solar” planets orbiting other stars.

How big: In our solar system, planets’ diameters range from less than half Earth’s (that’s Mercury) to 11.2 times bigger than Earth’s (that’s Jupiter).

How far away: The closest planet (Venus) gets within 38 million km of Earth.

Can you see them? Mercury, Venus, Earth, Mars, Jupiter, and Saturn are visible to the unaided eye.

Interesting fact: An Earth-sized planet has been discovered orbiting within the “habitable zone” of star Kepler-22 in the constellation Cygnus.



Moons

What they are: Moons are natural satellites (usually rocky bodies) which orbit planets.

How many: Our solar system contains over 600 moons, most of which orbit the large, outer (Jovian) planets.

How big: The largest moon is Jupiter’s Ganymede, whose diameter is about 50% larger than Earth’s Moon (so Ganymede is bigger than the planet Mercury).

How far away: Most moons orbit several hundred thousand to a few million kilometers from their planet. Earth’s Moon is about 400,000 km from Earth.

Interesting facts: Saturn’s moon Titan has lakes of liquid hydrocarbons on its surface, and Jupiter’s moon Europa may have liquid water underneath its icy surface.



Part Two

People



William and Caroline Herschel



Dates: William:
Born November 15, 1738 in Hanover, Germany
Died August 25, 1822 in Slough, England

Caroline:
Born March 16, 1750 in Hanover, Germany
Died January 9, 1848 in Hanover, Germany

Nationality: Both German (William later became an English citizen)

Major Work: William

- Built over 400 state-of-the-art telescopes
- Discovered Planet Uranus and several moons
- Discovered many nebulae
- Discovered infra-red radiation in sunlight
- Composed 24 symphonies

Caroline

- First woman to discover a comet
- Discovered several nebulae and comets
- First woman to earn a salary for doing science
- Produced star and nebula catalogs

Bios: William Herschel and his younger sister Caroline grew up in a very musical family - their father was an oboist and their siblings played several instruments. Bouts of smallpox and typhus stunted Caroline's growth and left her scarred, but she had a beautiful singing voice.

In 1757, at age 19, William emigrated to England, where he played the organ and violin for several orchestras and became a music teacher. Caroline followed her brother in 1772, just about the time he was becoming interested in making astronomical observations using telescopes he built himself. After discovering the planet Uranus in 1781, William was appointed to the post of King's Astronomer, and Caroline became his observing assistant. After years of recording and organizing William's observations, copying (and correcting) star charts, and supporting William in every way, Caroline received her own telescope, with which she discovered eight comets and eleven nebulae.

William married Mary Pitt in 1788, which meant that Caroline had to move out of his house. William and Mary's son John became an accomplished astronomer in his own right.

Cecilia Payne

Dates: Born May 10, 1900 in Wendover, England
Died December 7, 1979 in Cambridge, MA

Nationality: British and American

Major Work: Discovered that the Sun (like most stars) is made primarily of Hydrogen and Helium



First woman to become Astronomy Professor and Department Chairperson at Harvard.

Bio: Cecilia Payne was raised in England by her mother after Cecilia's father (a lawyer and musician) died when Cecilia was only four years old. One year later, Cecilia saw a meteor in the night sky and decided to become an astronomer. She earned a scholarship to study Botany, Chemistry, and Physics at Cambridge University, graduating in 1922 (but not officially receiving a degree, since she was a woman).

After graduation, Celcilia realized that she had little opportunity to become a professional astronomer in England, so she emigrated to the United States to study and work with famous American astronomer Harlow Shapley at the Harvard College Observatory.

In 1925, Celcilia completed her studies and wrote a dissertation that was called at the time "the most brilliant Ph.D. dissertation ever written." In her Ph.D. research project, Cecilia had studied the "spectra" produced by passing the light from the Sun and other stars through a prism. Using those spectra to determine the temperature and composition of the Sun and stars, Cecilia reached the stunning conclusion that these objects are not made of the heavy elements prevalent on Earth - instead, she concluded that they are made mostly of the lightest elements - hydrogen and helium. This finding was so revolutionary that renowned astronomers Henry Norris Russell of Princeton and Harlow Shapley thought it was "clearly impossible" and convinced Celilia to insert a sentence into her dissertation saying that the apparent high abundance of light elements - one of the greatest discoveries in the history of science - was "almost certainly not real."

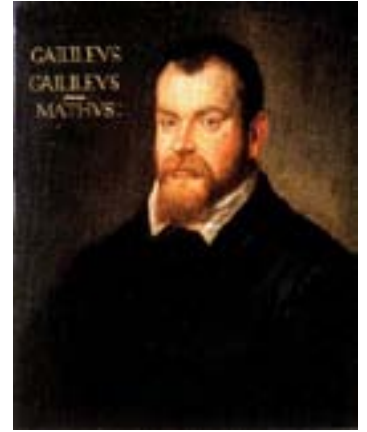
Within a decade, Russell, Shapley, and the astronomical community realized that Cecilia had been right all along. Years later, when asked about this incident, Cecilia Payne showed no resentment toward the men who had caused her to disavow her great discovery.

Galileo Galilei

Dates: Born February 15, 1564 in Pisa, Italy
Died January 8, 1642 in Florence, Italy

Nationality: Italian

Major Work: First used telescope for astronomy
Discovered moons of Jupiter
Discovered phases of Venus
Observed sunspots and lunar craters
First expressed scientific laws mathematically



Bio: When Galileo was a young man, his father (an accomplished musician and music theorist) attempted to steer Galileo toward a lucrative career in medicine. But Galileo was fascinated by the workings of the natural world beyond the human body; he chose to study swinging pendulum bobs and spheres rolling down inclined planes.

Studying at the University of Pisa, Galileo began to doubt certain aspects of conventional wisdom, such as Aristotle's assertion that heavy objects fall faster than light ones. When Galileo became a professor of mathematics at the University of Padua, he began applying his understanding to the invention of mechanical instruments. But when he heard in 1609 that Hans Lippershey in Holland was using lenses to make distant objects appear closer, Galileo's life (and the world) changed forever. Within a few weeks, Galileo had built a very powerful telescope that allowed him to study the stars, planets, and moons as no one had before.

Galileo's observations convinced him that the Earth-centered system of Ptolemy could not be correct, and that the Sun-centered system of Copernicus offered better explanations for his observations. That conclusion put Galileo on a collision course with the Holy Office of the Inquisition, the institution within the Catholic Church responsible for finding and punishing heretics. In 1600, the Inquisition had burned Giordano Bruno at the stake, in part for his belief that the stars in the night sky are distant suns, possibly orbited by planets inhabited by intelligent beings.

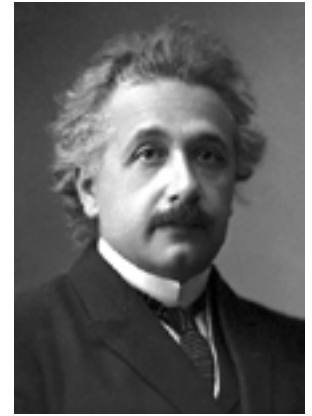
Galileo travelled to Rome in 1615 to discuss his work with the Pope and other Church authorities, and he was warned not to "hold or defend" the Copernican system. Galileo believed the wording of the warning did not prohibit him from using the Sun-centered system as a hypothetical construct, and in 1632 he wrote a book he called the *Dialogue Concerning the Two Chief World Systems*. In this book, Galileo made powerful arguments in favor of the Copernican system, which angered Church authorities. Galileo was summoned to Rome, put on trial, and found to be "vehemently suspect of heresy." He was ordered to recant his statements in support of the Copernican system and was sentenced to life in prison. That sentence was converted to house arrest, which allowed Galileo to return to his home in Arcetri, near Florence. Galileo lived another decade, during which he did pioneering work in the physics of moving bodies.

Albert Einstein

Dates: Born March 14, 1879 in Ulm, Germany
Died April 18, 1955 in Princeton, NJ

Nationality: German and American

Major Work: Explained the Photoelectric Effect (Nobel Prize)
Postulated equivalence of mass and energy
Developed Theory of Brownian Motion
Developed the Theories of Special and General Relativity
Co-developed Bose-Einstein statistics



Bio: When Albert Einstein was only four or five years old, his father showed him a magnetic compass. From that moment forward, Einstein was relentless in his quest to understand the workings of the Universe. Contrary to popular legend, Einstein was not a poor student - he excelled in physics and mathematics. But he detested the rote learning that was required in some classes, preferring to exercise his “curiosity of inquiry.”

After graduating from college in 1900, Einstein took a job in the Swiss Patent Office, reviewing patent applications by day and conducting research toward his Ph.D. in the evening. In 1905, Einstein’s *annus mirabilis* (miracle year), he published four papers that greatly contributed to our modern understanding of space, time, matter, and energy.

In one of those papers, Einstein challenged the conventional notions of the absolute nature of space and time, showing that the length of objects and the rate of time flow depend on the motion of the observer. But this theory applied only to objects moving at constant speed and direction, so Einstein called it the Theory of Special Relativity. He worked for the next ten years to extend his theory to accelerating objects and to include the effects of gravity, which he accomplished in his groundbreaking Theory of General Relativity in 1915. One of the predictions of this theory is that the path of starlight is deflected by gravity; Einstein became world-famous when this prediction was confirmed by observing starlight passing near the Sun during a solar eclipse in 1919.

Einstein fled Germany when Hitler came to power in 1933. Prior to World War II, Einstein co-signed a letter warning President Roosevelt about the potential of nuclear weapons; this may have contributed to the establishment of the Manhattan Project and the development of the atomic bomb. For the rest of his life, Einstein was a vocal advocate for world peace.

Gustav Holst

Dates: Born Sept. 21, 1874 in Cheltenham, England
Died May 25, 1934 in London, England

Nationality: British

Major Work: *The Planets*
St. Paul's Suite
Brook Green Suite
The Perfect Fool
Sita
The Hymn of Jesus
A Choral Fantasia



Bio: Gustav Holst's father was a music teacher and his mother a pianist, so it's not surprising that young Gustav spent many hours practicing the piano and violin in the hope of becoming a professional musician. But Gustav was a sickly child with eye and chest problems, and neuritis in his right arm and hand made practice very painful. He began composing music while in grammar school and earned a scholarship to the Royal College of Music in London in 1892. While there, he studied composition under Irish composer Charles Stanford, took up the trombone, and became a socialist and a vegetarian.

After graduating from college, Holst earned a meager living playing in several orchestras; in his spare time he read the poetry of Walt Whitman, studied Hindu mysticism, and wrote music. He became Director of Music at St. Paul's Girls' School in 1905 and Director of Music at Morley College for Working Men and Women in 1907, retaining both positions for the rest of his life. He continued to compose orchestral suites and choral hymns, achieving great success and public acclaim for *The Planets* in 1919 and *The Hymn of Jesus* 1920.

During a rehearsal in 1923, Holst fell from the conducting platform and suffered a concussion, and the lingering effects of this injury plagued him for several years. But by the time of his death at age 59, Holst had composed over 200 works and positively influenced hundreds of music students.