The Great Space Telescopes

A Deeper Look Into Space

Presented By Stevan Akerley
3/31, Rescheduled toApril 29, 2014
National Space Society
Space Ambassador # 1129

Space Ambassador Mission

To Communicate **the benefits of space exploration to our daily lives,**
To Inspire and Educate **young people and the public**
To Pursue Careers in Science, Engineering, and Mathematics.

To Inspire a New Generation of Leaders **to take an active role … to create the future ...**

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- http://www.virgingalactic.com

Why Do We Have The Telescopes

For thousands of years our ancestors looked up at the heavens, beheld the stars, and wondered what they were. They told stories about them and associated them with the gods, and gave them names. But they didn't really understand them.

400 years ago the first telescopes were used to look farther and deeper into space, to look at the planets and stars. We began to understand – but there was so much more…

Today we use telescopes to improve our understanding of

Physics The Limits of Newtonian Physics, Einstein's Theory of Relativity
What happens at the extreme limits String Theory, Evidence of Dark Matter, Dark Energy

The Universe Cosmic Structure of Galaxies, Nebula, Star Systems, Black Holes
The Big Bang, Cosmic Expansion, What are Dark Matter and Dark energy doing ?

The Outer Solar System What does it include ? (Planets, Dwarf Planets, Moons, Asteroids, Comets, The Kuiper Belt, The Oort Cloud)

Earth's Neighborhood Understanding Our Planetary Neighbors, Moon, Near Earth Objects (NEO's), Mars, Venus, The Sun, Solar Wind, Radiation, Comets, Meteorites, etc.

Threats Past, Present, and Future Significant damage and mass extinctions have occurred and are associated with meteorites (February, 2013 Meteorite over Russia, 1908 Tunguska Event)

Future Opportunities (finding and using the resources for humanities future civilization in space)

How Many Space Telescopes Are There ?

- **Since 1970 there have been more than 90 Space Telescopes placed into Orbit by NASA and ESA.**
- **An Average of 2 per year.**
- **Some Are Longer Lived Than Others.**
- **61 Are No Longer Active, 26 Are Still Active.**
- **They Are Working in 8 Different Frequency Ranges of the Electromagnetic Spectrum**

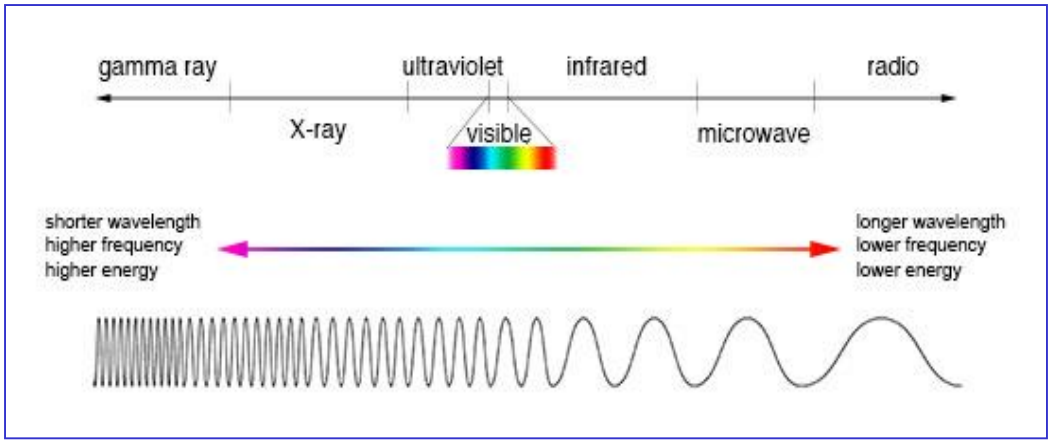
  GAMMA RAY X- RAY Ultraviolet
  Visible Infrared and Sub millimeter
  Microwave Radio Particle Detection

  Future Telescopes TO BE LAUNCHED Include
  The James Web Telescope, PLATO and Gravity Waves (Telescope?)

- **A Review of The Electromagnetic Spectrum**
  (See http://en.wikipedia.org/wiki/Electromagnetic_spectrum)

WHY ???

- **Outside of Atmospheric Interference**
- **Away from Light & Electromagnetic Pollution**
- **To See Through Interstellar Dust and Gases**

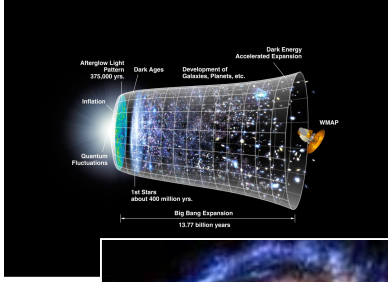


What Are The Great Space Telescopes ?

1. **Hubble Space Telescope / NASA, ESA / 1990 / Visible, UV, Near-IR / Deep Space Objects**
   598 km ± 12 km Earth Orbit
2. **Chandra X-ray Observatory / NASA / 1999 / X-ray / Various**
   120,000 km ± 20,000km Earth Orbit
3. **Spitzer Space Telescope / NASA / 2003 / IR / Distant and Nearby Objects**
   Sun-Earth Trailing Heliocentric
4. **Herschel-Planck Observatory / ESA / 2009 / Microwave / Cosmic Microwave Background**
   Sun-Earth Orbit L2
5. **Kepler Mission / NASA / 2009 / Visible / Extrasolar planets**
   Sun-Earth Heliocentric orbit (similar to L4 Orbit)
6. **NEOWISE NASA / 2009 / IR / 500 km Earth Orbit**
7. **James Webb Space Telescope, NASA / Future/ Successor of Hubble. JWST (Build on Hubble)**
8. **PLATO Planetary Transit ESA / Future 1.5 Million km Night Side**
9. **Fermi Gamma-ray Space Telescope / NASA / 2008 / Gamma-ray / Various**
   555 km Earth Orbit
10. **Swift Gamma Ray Burst Explorer / NASA / 2004 / Gamma ray, X-ray, UV, Visible / Various**
11. **INTEGRAL / ESA / 2002 / Gamma ray, X-ray, Visible / Various**
12. **XMM-Newton / ESA / 1999 / X-ray / Various**
13. **GALEX / NASA / 2003 / UV / Galaxies**
14. **COROT / CNES & ESA / 2006 / Visible / Extrasolar planets**
15. **STEREO / NASA / 2006 / Visible, UV, Radio / Sun and Coronal Mass Ejections**

Definitions

Universe – The entirety of creation from the "Big Bang", to all of the Galaxies evident in the farthest reaches of space and time.



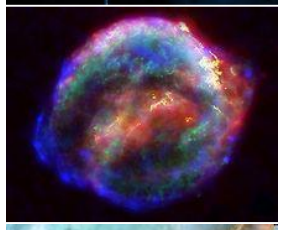
Galaxy – Large space structure consisting of Billions of stars, some like our own Milky Way

Quasars - is a very energetic galactic nucleus with a compact central region, that surrounds a super-massive black hole.

Most stars end as **White Dwarfs** (<1.44 Solar Mass Max)
or **Neutron Stars** (>1.44 Solar Mass to 10 Solar Mass),

Super Novas – a very energetic stellar explosion (stars with Solar Mass > 1.7) .
Super novae are extremely luminous and cause a burst of radiation that often briefly outshines an entire galaxy, before fading over several weeks or months. (creation of denser elements)

Black Holes - a region of space/time from which gravity prevents anything, including light, from escaping. (Solar Mass greater than 10-15X).



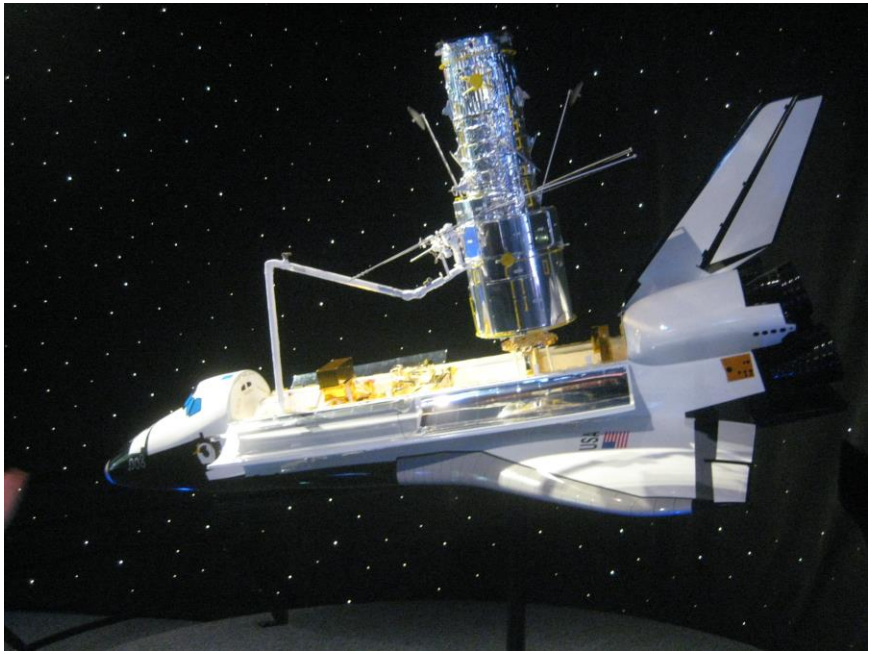
Pulsars - a highly magnetized, rotating neutron star that emits a beam of electromagnetic radiation, like a lighthouse beacon. It frequently has a companion star feeding it.

Nebula – A luminous or non-luminous mass of material, dust & gases in interstellar space.
Frequently includes remnants of a super nova, and a birthing area for new stars

Solar systems – A star with orbiting Planets,
Asteroids and other material.

The Hubble Space Telescope

http://hubblesite.org/the_telescope/team_hubble/servicing_missions.php



Fun Facts

- Hubble weighs 24,500 lbs, and is 43.5 ft long
- Primary Mirror is 7 ft, 10.5 inches across.
- Used by 4000 astronomers world wide.
- Operating for more than 2 decades.
- About 6000 DVD's of data.

Launched by Shuttle, with 5 Shuttle Servicing Missions over 20 years.

Mission 1
Mission 2
Mission 3A
Mission 3B
Mission 4

New Instruments for Hubble on Last Mission

Wide Field Camera 3 (WFC3)

a spectrograph that breaks light into its component colors, revealing information about the object emitting the light, sees exclusively in ultraviolet light. COS improves Hubble's ultraviolet sensitivity at least 10 times, and up to 70 times when observing extremely faint objects. Replaces WFC2

Cosmic Origins Spectrograph (COS).

WFC3 sees three different kinds of light: near-ultraviolet, visible and near-infrared, though not simultaneously. The camera's resolution and field of view is much greater than that of previous instruments. Replaces COSTAR

The Hubble Space Telescope

http://www.nasa.gov/mission_pages/hubble/story/index.html#.Uv03W_tvAk5

NASA, ESA / 1990 / Visible, UV, Near-IR / Deep Space Objects

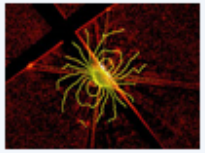
Hubble Accomplishments

Age of the Universe

Thanks in part to the Hubble Space Telescope, we know the universe is 13.7 billion years old.

At Galaxies' Cores

Nearly all galaxies may harbor supermassive black holes.



How Planets Form

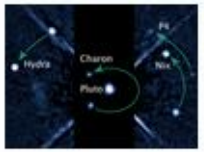
The Hubble Space Telescope has helped scientists determine the process of how planets are born.

Extrasolar Organic Matter

The Hubble Space Telescope detected the first organic molecule discovered on a planet outside our solar system.

Dark Energy

The Hubble Space Telescope detected a distant supernova that suggests the universe only recently began speeding up.

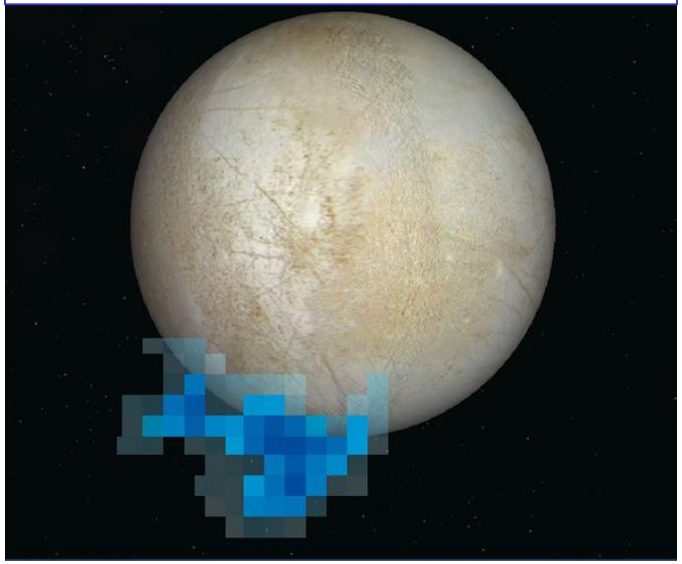


Plutonian Moons

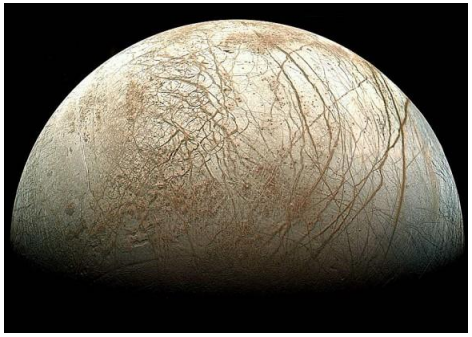
Hubble found four moons around dwarf planet Pluto.

Hubble may have detected Geysers on Europa's South Pole (Moon of Jupiter)

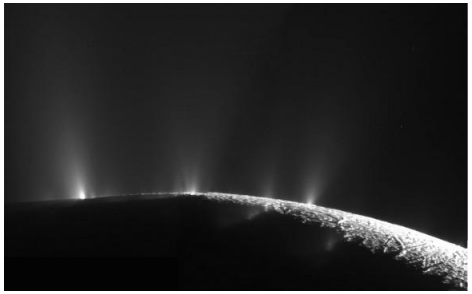
A south polar water vapor plume on Europa is shown in blue in this Hubble Space Telescope data image, which is superimposed on a visible light image of the Jupiter moon's leading hemisphere. Image released Dec. 12, 2013. Saturn's moon Enceladus also has water vapor plumes.
Credit: Lorenz Roth, Southwest Research Institute/USGS

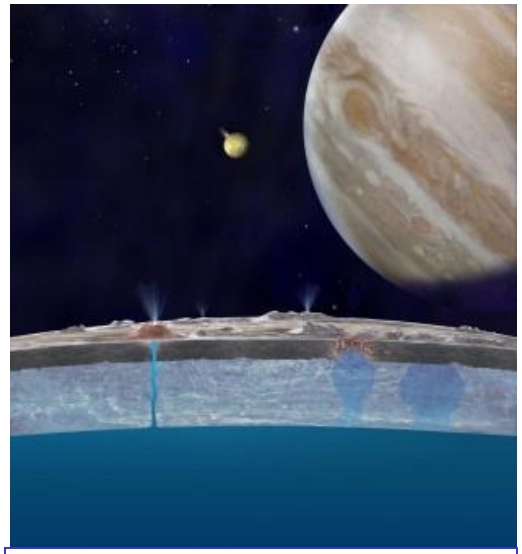


An artistic view of what this might look like on the surface

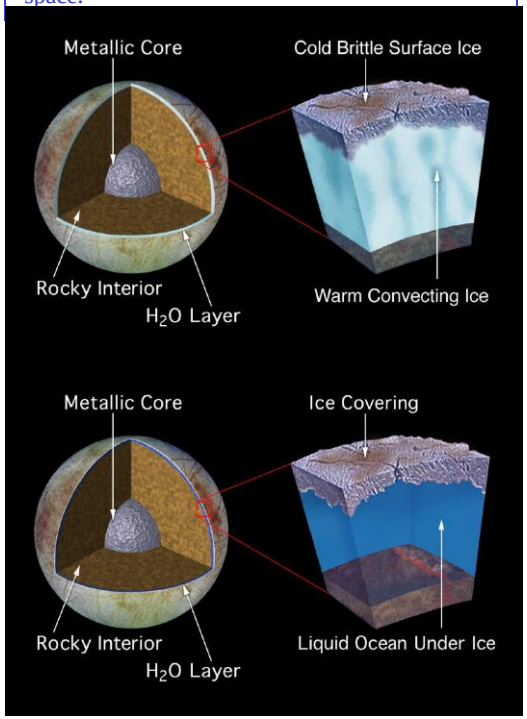


An image of Europa's surface (Moon of Jupiter) looks very similar to an image of the surface of Enceladus (moon of Saturn)





Tidal forces deform rocky interior, heating it up, thus warming the surrounding water. The Icy Crust splits open and releases water vapor into space.



Chandra X-ray Observatory

NASA / 1999 / X-ray / Various

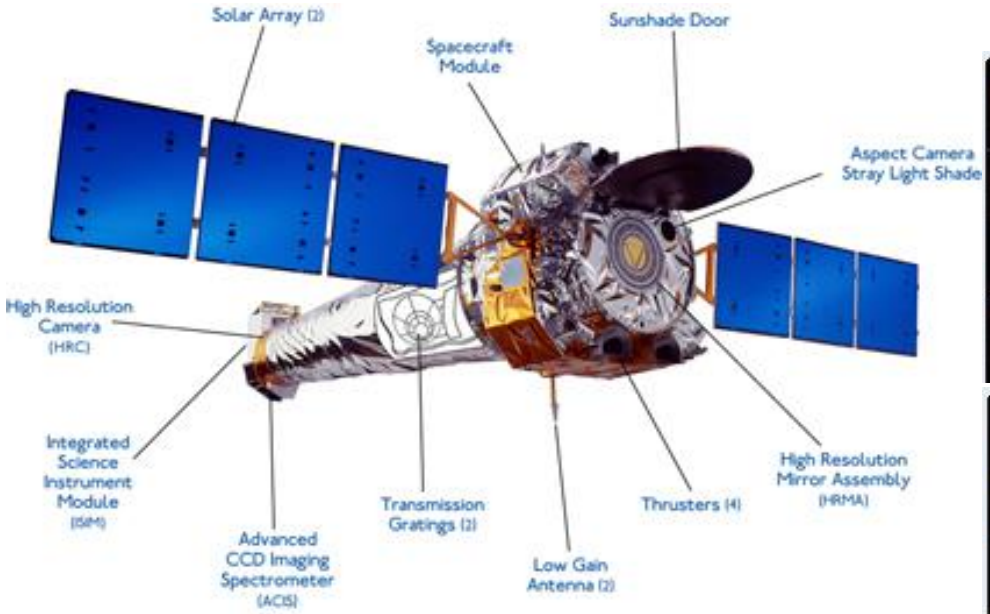
Fun Facts

- Chandra flies 200 times higher than Hubble – more than 1/3 of the way to the moon!
- Chandra is the largest satellite the shuttle has ever launched. At 45 feet long, larger than Hubble, and Weighs 10,600 lb.
- Chandra's resolving power is equivalent to the ability to read a stop sign at a distance of twelve miles.
- The electrical power required to operate the Chandra spacecraft and instruments is 2 kilowatts, about the same power as a hair dryer.
- The light from some of the quasars observed by Chandra will have been traveling through space for ten billion years.
- STS-93, the space mission that deployed Chandra, was the first NASA shuttle mission commanded by a woman.
- Chandra can observe X-rays from particles up to the last second before they fall into a black hole!!!

Chandra X-ray Observatory

NASA / 1999 / X-ray / Various

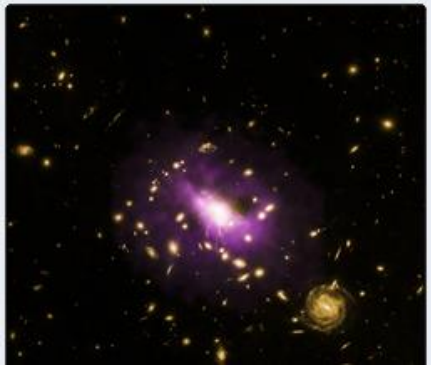
http://chandra.harvard.edu/about/spacecraft.html



CENTAURUS A:
A New Look at an Old Friend

This galaxy, at a distance of about 12 million light years from Earth, contains a gargantuan jet blasting away from a central supermassive black hole.

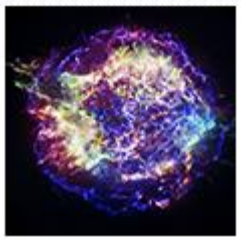
More (6 Feb 14)



RX J1532.9+3021:
Extreme Power of Black Hole Revealed

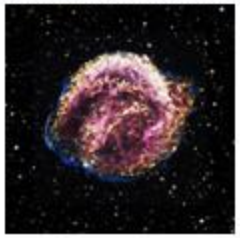
The black hole is in a galaxy cluster located about 3.9 billion light years from Earth.

More (23 Jan 14)



15 Nov 13
Cassiopeia A
A supernova remnant located about 10,000 light years from Earth

28 Oct 13
NGC 6946
An assortment of images from Chandra's public repository.



11 Sep 12
Kepler's Supernova Remnant
The debris from a supernova observed in 1604.

28 Jun 12
IGR J11014-6103
A pulsar found racing away from a supernova remnant about 30,000 light years from Earth.

15 Mar 13
G306.3-0.9
A newly discovered supernova remnant by Swift in the Milky Way is among the youngest known.

13 Feb 13
W49B
A highly distorted supernova remnant, produced by a rare type of explosion.

Extreme Power of Black Hole Revealed

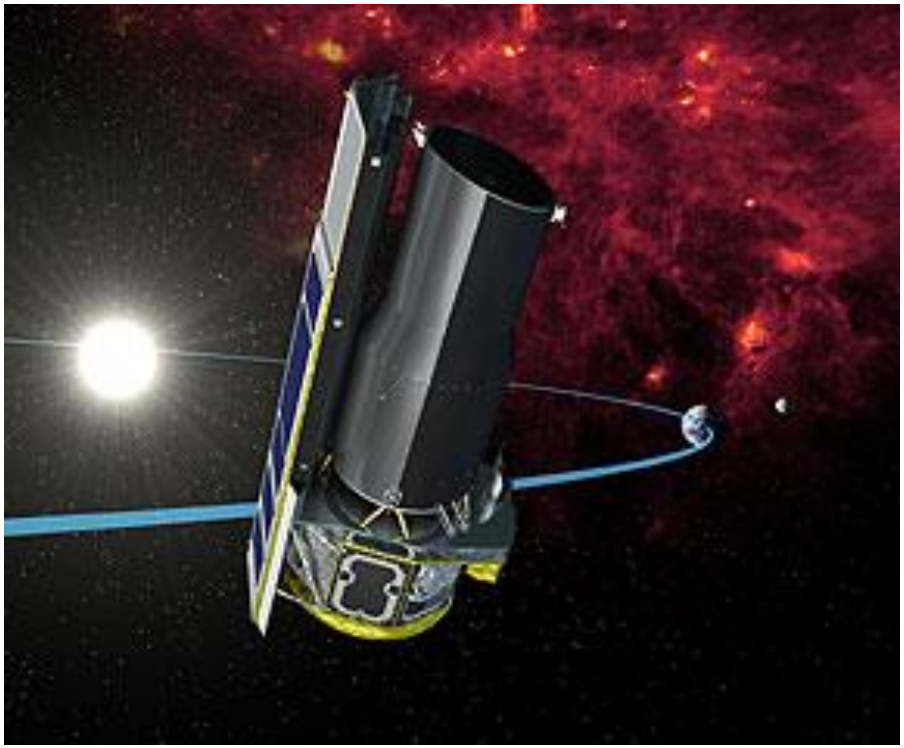
Astronomers have used NASA's Chandra X-ray Observatory and a suite of other telescopes to reveal one of the most powerful black holes known. The black hole has created enormous structures in the hot gas surrounding it and prevented trillions of stars from forming.

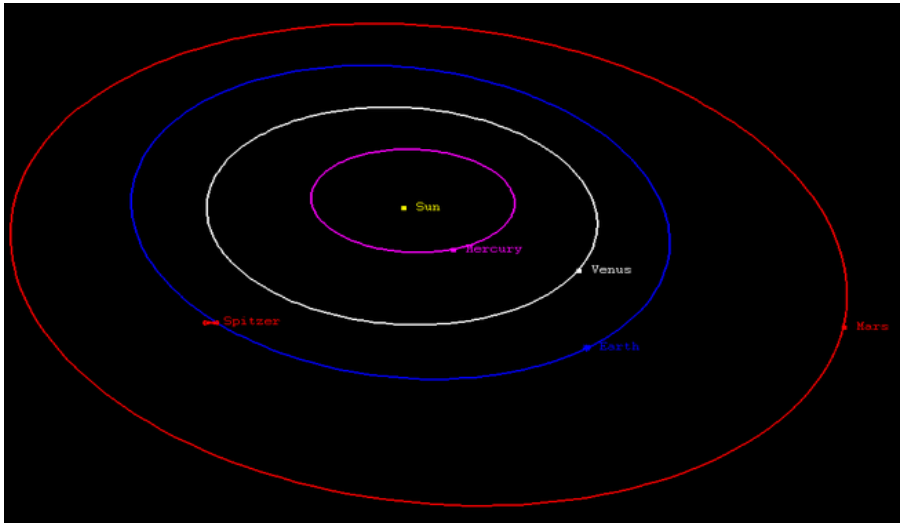
The black hole is in a galaxy cluster named RX J1532.9+3021 (RX J1532 for short), located about 3.9 billion light years from Earth. The image here is a composite of X-ray data from Chandra revealing hot gas in the cluster in purple and optical data from the Hubble Space Telescope showing galaxies in yellow. The cluster is very bright in X-rays implying that it is extremely massive, with a mass about a quadrillion - a thousand trillion - times that of the sun. At the center of the cluster is a large elliptical galaxy containing the supermassive black hole.

Spitzer Space Telescope

http://www.spitzer.caltech.edu

NASA / 2003 / IR / Distant and Nearby Objects





The Spitzer Space Telescope is a space-borne, cryogenically-cooled infrared observatory. It is one of NASA's Great Observatories Programs, and an important scientific and technical cornerstone of the Astronomical Search for Origins Program

Fun Facts

Launch Vehicle/Site:	**Delta 7920H ELV / Cape Canaveral, FL**
	25 August 2003
Estimated Lifetime:	**2.5 years (minimum) to 5+ years (goal)**
Orbit:	**Earth-trailing, Heliocentric**
Telescope:	**85 cm diameter (33.5 Inches), Made of lightweight Beryllium, cooled to less 5.5 K**
Cryogen / Volume:	**Liquid Helium / 360 liters (95 Gallons)**
Launch Mass:	**950 kg (2094 lb),**
	Observatory: 851.5 kg,
	Cover: 6.0 kg,
	Helium: 50.4 kg,
	Nitrogen Propellant: 15.6 kg

Jet Propulsion Laboratory
California Institute of Technology

SPITZER SPACE TELESCOPE

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04.03.14

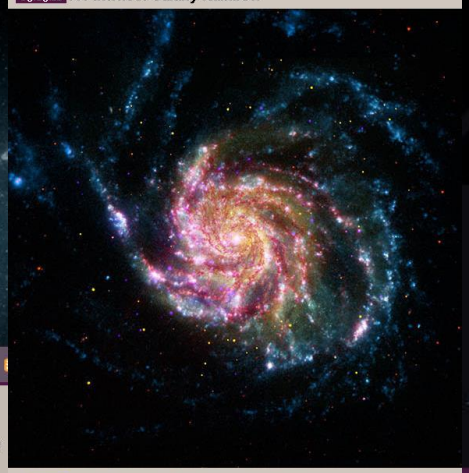
New Tool Finds Buried Treasure in Spitzer Archives

News 1 2 3 | Featured Image | Interactive Spitzer | Video Showcase

Like 137 Tweet 10 +1 0 Pin it

Our Solar System is swarming with asteroids and comets. Although astronomers have identified many thousands of these space rocks, new candidates turn up all the time; some small fraction of which might even pose a threat of colliding with Earth.

05.23.12 A Pinwheel Galaxy Rainbow

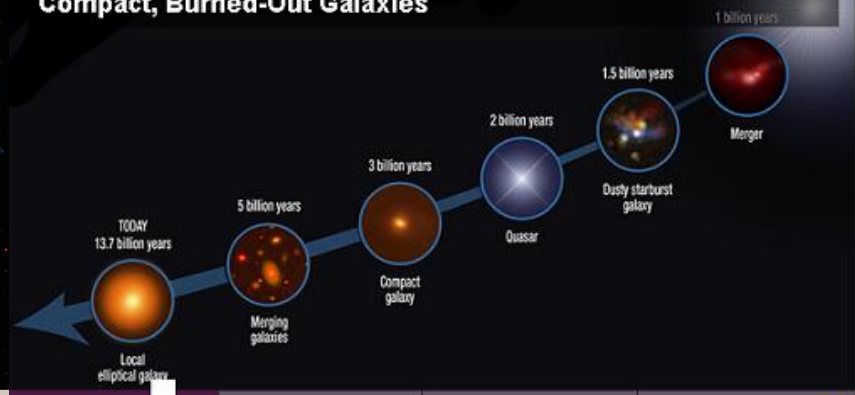


Like 237 Tweet 45 +1 22 Pin it

This image of the Pinwheel Galaxy, or M101, combines data in the infrared, visible, ultraviolet and x-rays from four of NASA's space telescopes. This multi-spectral view shows that both young and old stars are evenly distributed along M101's tightly-wound spiral arms. Such composite images allow astronomers to see how features in one part of the spectrum match up with those seen in other parts. It is like seeing with a regular camera, an ultraviolet camera, night-vision goggles and X-Ray vision, all at once!

01.29.14

NASA and ESA Telescopes Help Solve Mystery of Ultra-Compact, Burned-Out Galaxies



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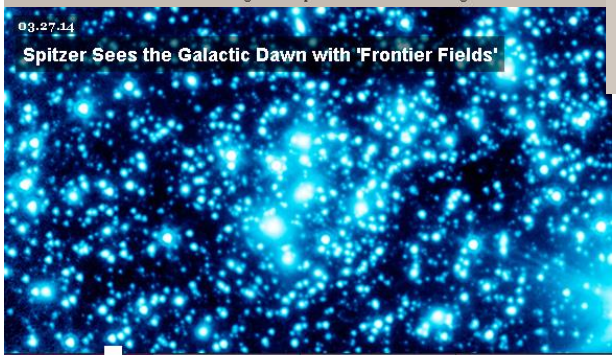
Astronomers using NASA's Hubble and Spitzer Space Telescopes, Europe's Herschel Space Observatory, and many ground-based telescopes have pieced together the evolutionary sequence of compact elliptical galaxies that erupted and burned out early in the history of the universe.

03.27.14

Spitzer Sees the Galactic Dawn with 'Frontier Fields'



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Tweet 32 +1 26 Pin it 1

NASA's Spitzer Space Telescope, in tandem with other major NASA observatories, has recently embarked on a major new mission to glimpse the universe's very first galaxies.

02.20.14 Featured Image

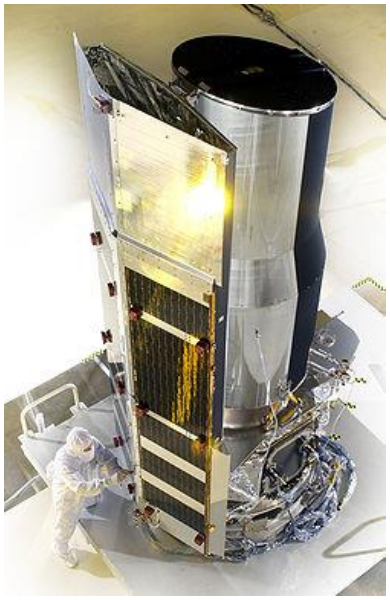
The Shocking Behavior of a Speedy Star

Like 198 Tweet 14 +1 10 Pin it

The antics of a speeding star are on display in a new image from NASA's Spitzer Space Telescope.

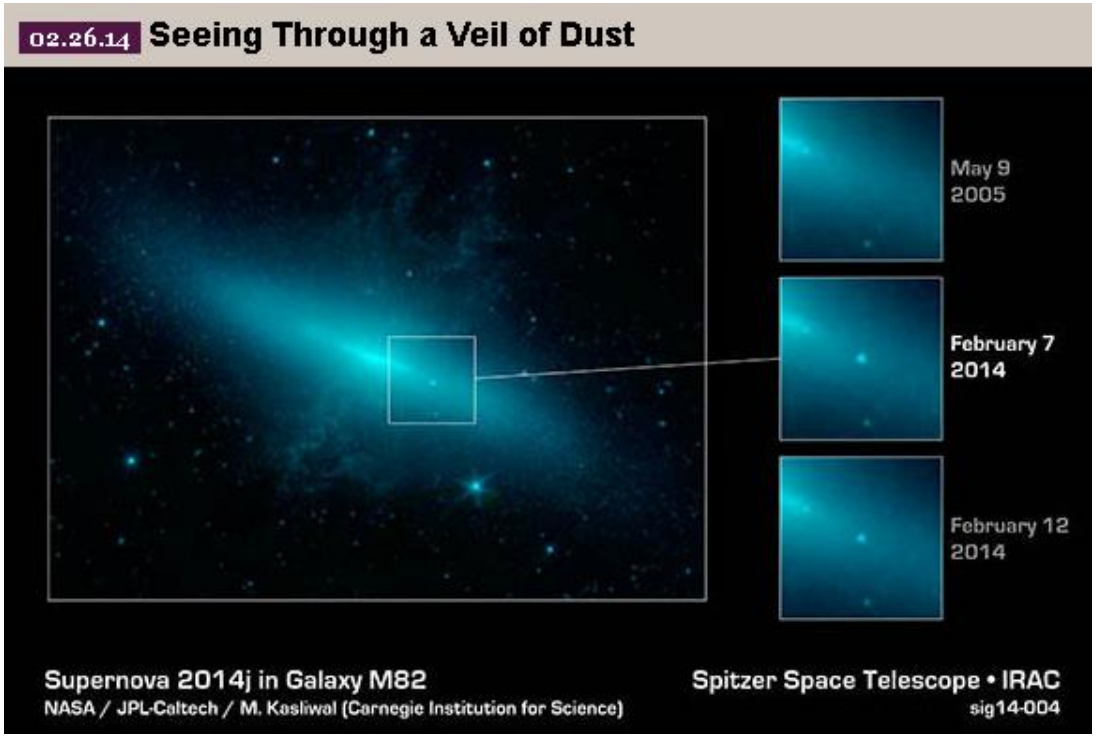
http://www.spitzer.caltech.edu

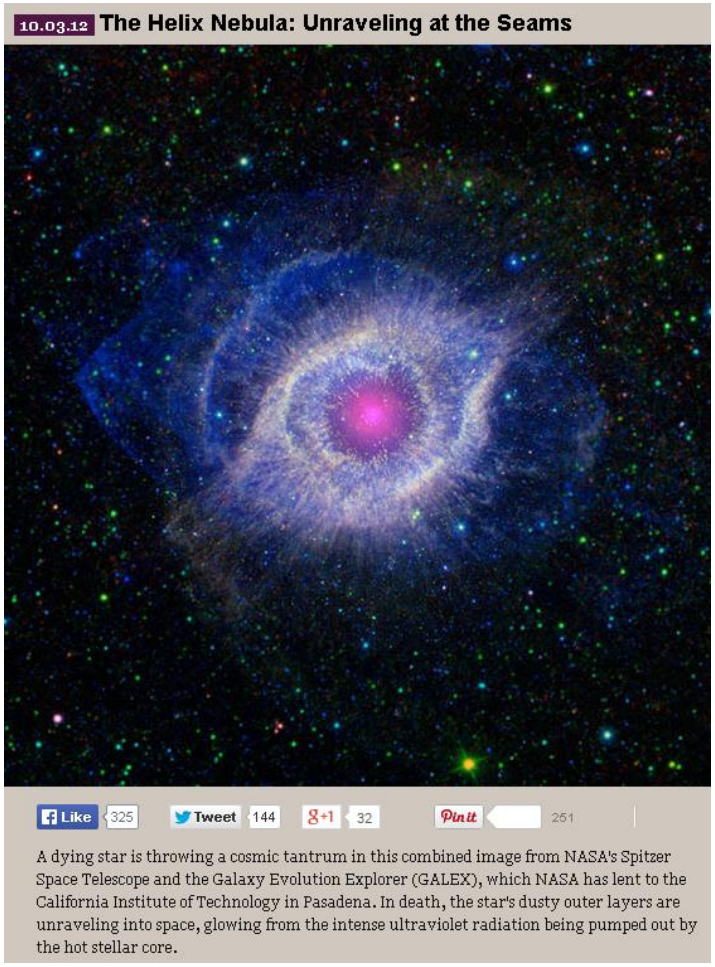
Visit the web pages, See the Images and Understand - Marvel at the Universe



Spitzer Space Telescope

NASA / 2003 / IR / Distant and Nearby Objects

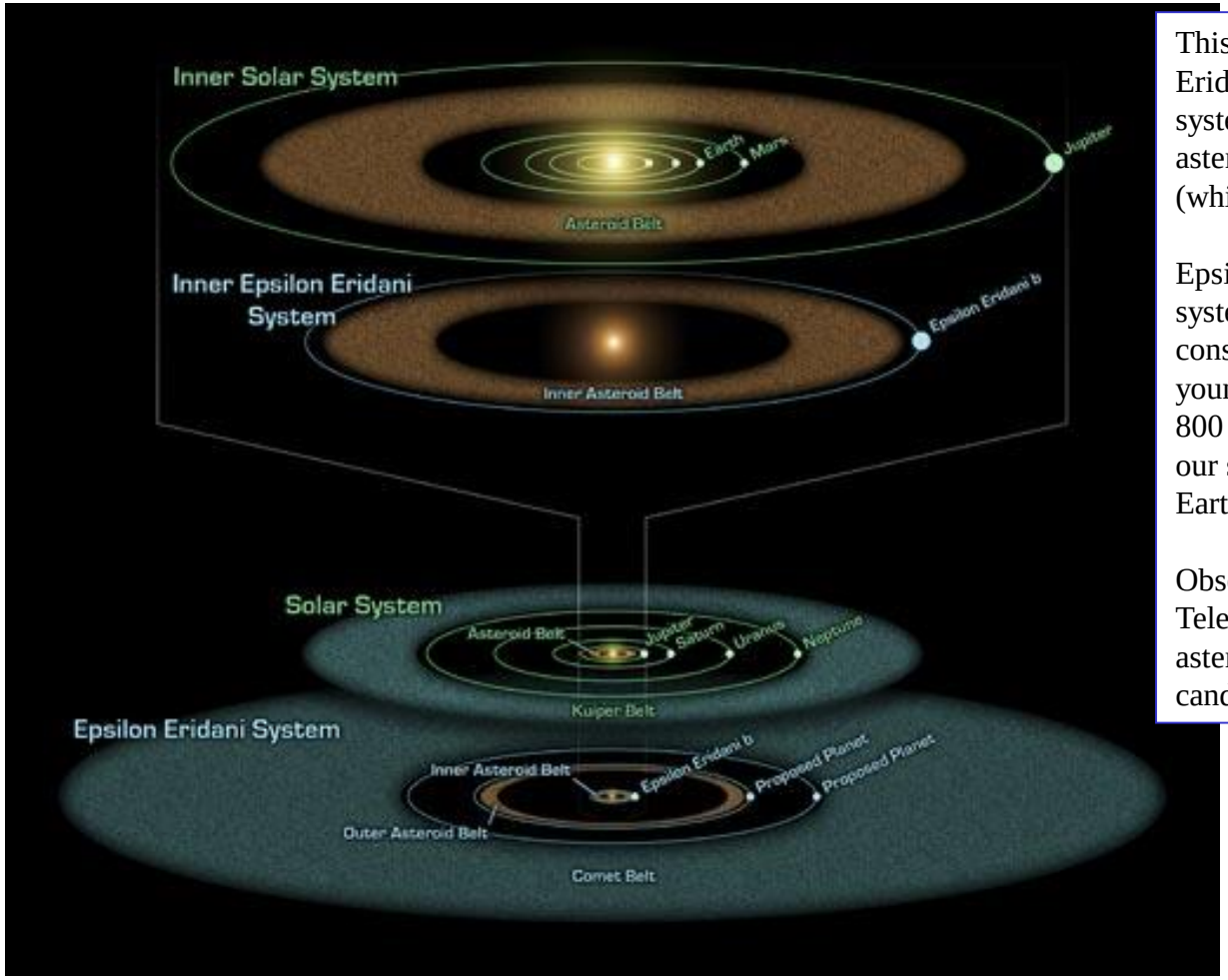




Spitzer Sees A Young Star with

A Young Solar Systems

http://www.nasa.gov/mission_pages/spitzer/multimedia/20081027b.html



This artist's diagram compares the Epsilon Eridani system to our own solar system. The two systems are structured similarly, and both host asteroids (brown), comets (blue) and planets (white dots).

Epsilon Eridani is our closest known planetary system, located about 10 light-years away in the constellation Eridanus. Its central star is a younger, fainter version of our sun, and is about 800 million years old -- about the same age of our solar system when life first took root on Earth.

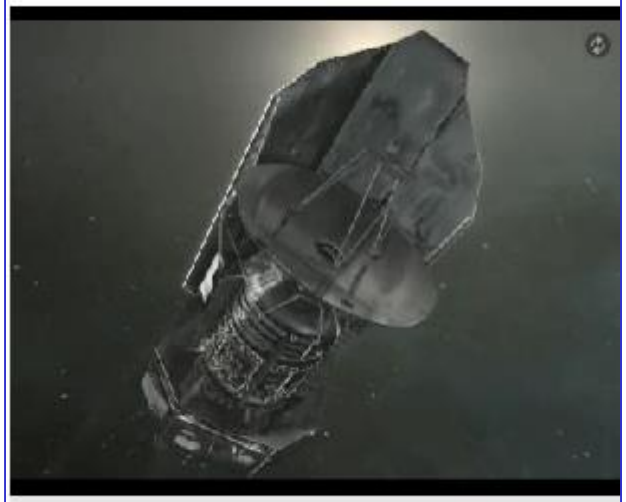
Observations from NASA's Spitzer Space Telescope show that the system hosts two asteroid belts, in addition to previously identified candidate planets and an outer comet ring.

Herschel-Planck Observatory

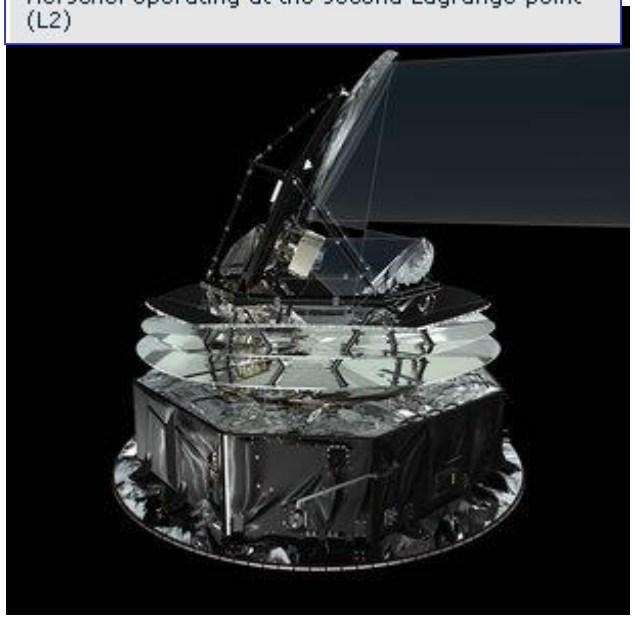
http://www.esa.int/Our_Activities/Space_Science/Planck

ESA / 2009 / Microwave / Cosmic Microwave Background (From The Big Bang)

CUTTING-EDGE SPACECRAFT



Herschel operating at the second Lagrange point (L2)



Herschel and Planck are stationed at the second Sun-Earth Lagrange point (L2), 1.5 million km from Earth. This point is theoretically stationary in space with respect to the Earth and Sun, which means that for Herschel, Earth and the Sun will always be in the same general direction.

This provides a stable thermal environment and a good view of the sky. Since the Earth is far away, Herschel is not disturbed by its radiation belts.

ESA 4 Cornerstone Missions;

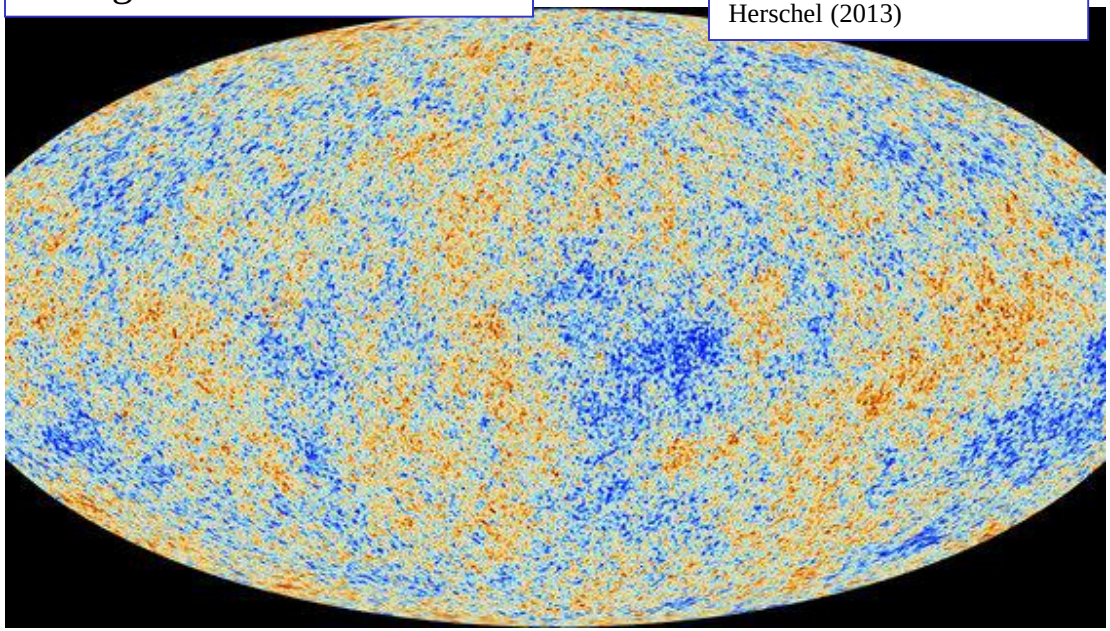
Rosetta

Planck

Gaia

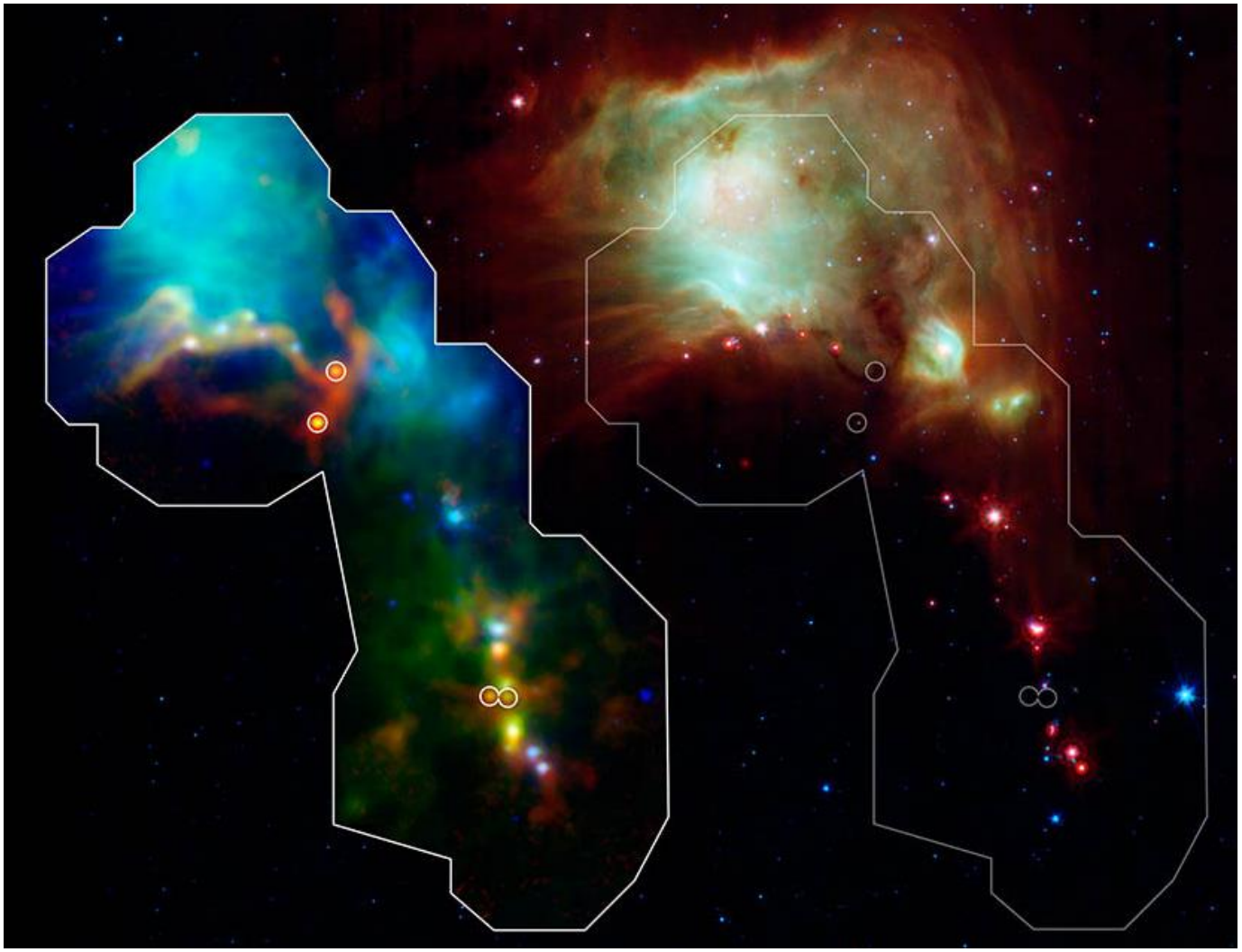
Herschel (2013)

Background Radiation



Herschel-Planck Observatory

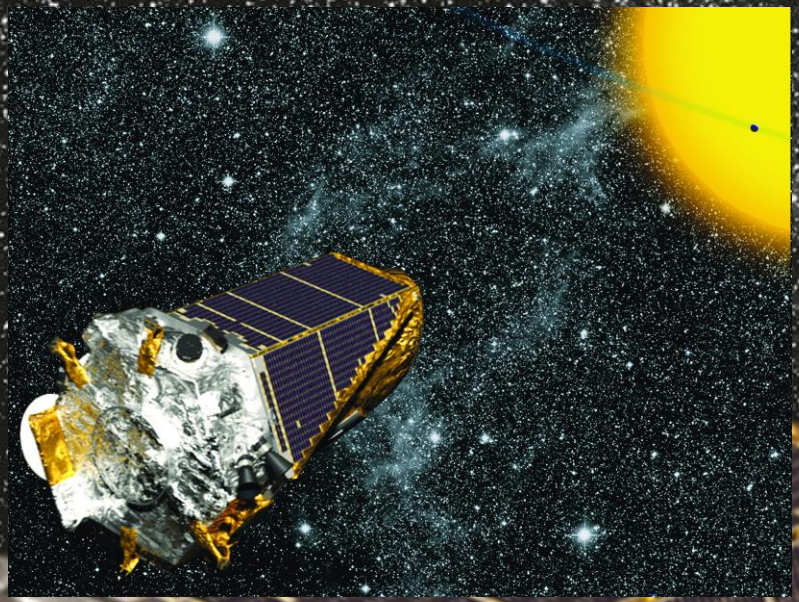
ESA / 2009 / Microwave



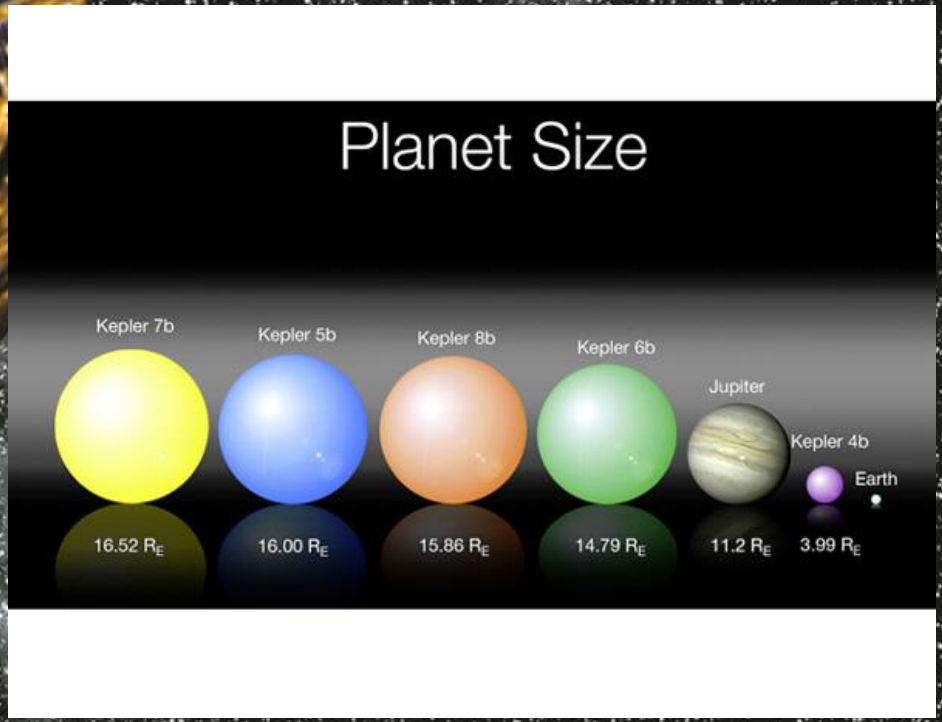
Astronomers have found some of the youngest stars ever seen thanks to the Herschel space observatory, a European Space Agency mission with important NASA contributions. Dense envelopes of gas and dust surround the fledging stars known as protostars, making their detection difficult until now. The discovery gives scientists a window into the earliest and least understood phases of star formation.

A mosaic of infrared images (orange) taken by Herschel and X-ray images (blue) taken by the XMM-Newton telescope of the Andromeda galaxy

http://kepler.nasa.gov/

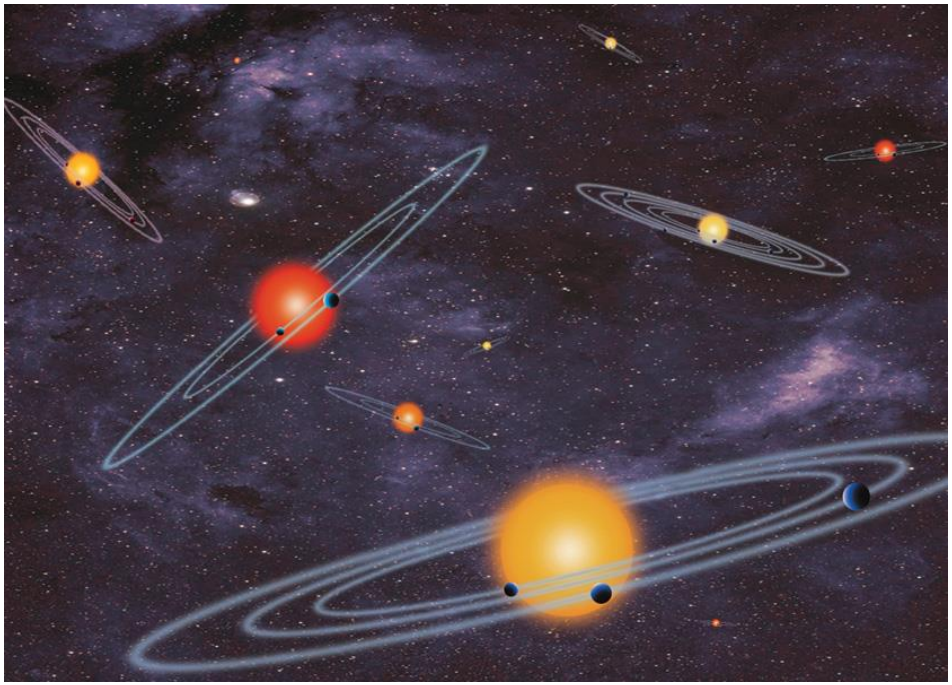


Nearly 95 percent of the planets discovered are smaller than Neptune, which is almost four times the size of Earth. This discovery marks a significant increase in the number of known small-sized planets more akin to Earth than previously identified exoplanets, which are planets outside our solar system.



Kepler Mission

NASA / 2009 / Visible / Extrasolar Planets

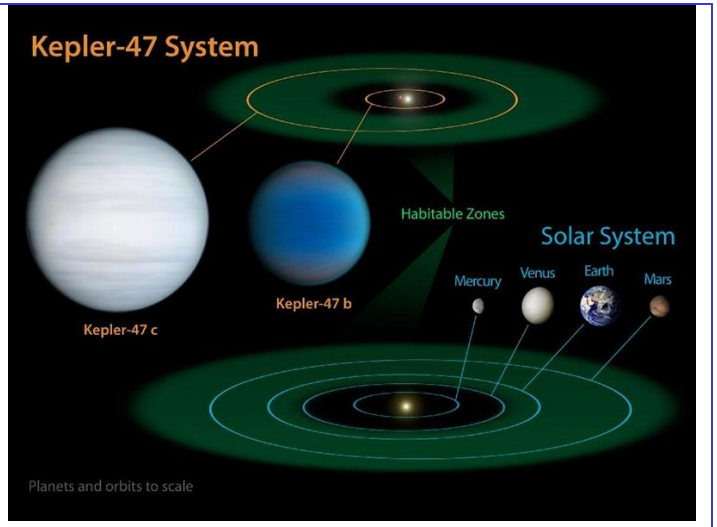


Star System Bonanza (Illustration)
This artist concept depicts "multiple-transiting planet systems," which are stars with more than one planet. The planets eclipse, or transit, their host stars from the vantage point of the observer. This angle is called edge-on. NASA's Kepler Space Telescope has found hundreds of these multiple-planet systems.

February 26, 2014
NASA's Kepler mission announced the discovery of **715 new planets**. These newly verified worlds orbit **305 stars**, revealing multiple-planet systems much like our own solar system.

1,700 Confirmed planets outside our solar system.

Binary Stars

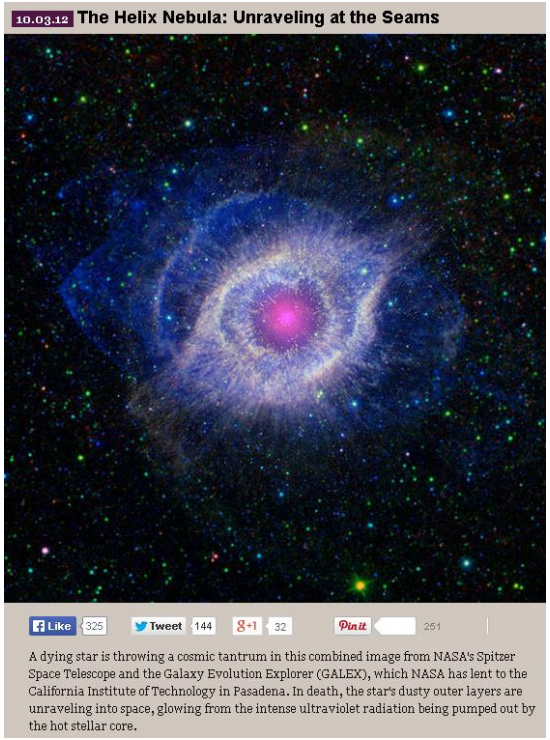


Extraterrestrial Life May be Common around Binary Stars
Low-mass binary stars could make the best hosts for alien life because their combined energy extends the habitable region farther away than would exist around a single star Mar 11, 2013
By Nola Taylor Redd and SPACE.com

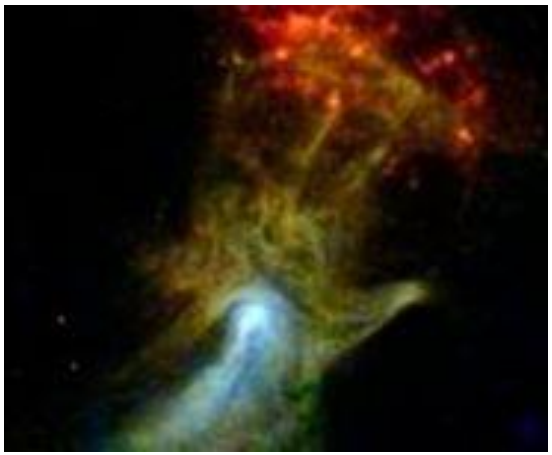
http://www.jpl.nasa.gov/news/news.php?release=2014-062

http://www.nasa.gov/ames/kepler/digital-press-kit-kepler-planet-bonanza/

Intermission



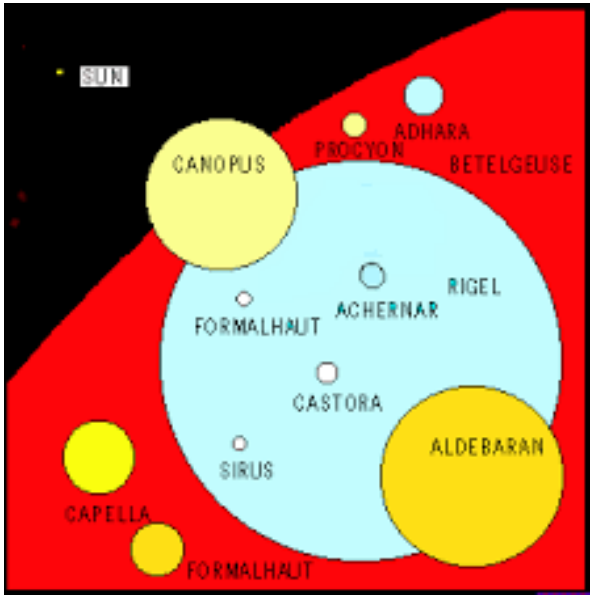
"Eye of God" (Nebula) Image

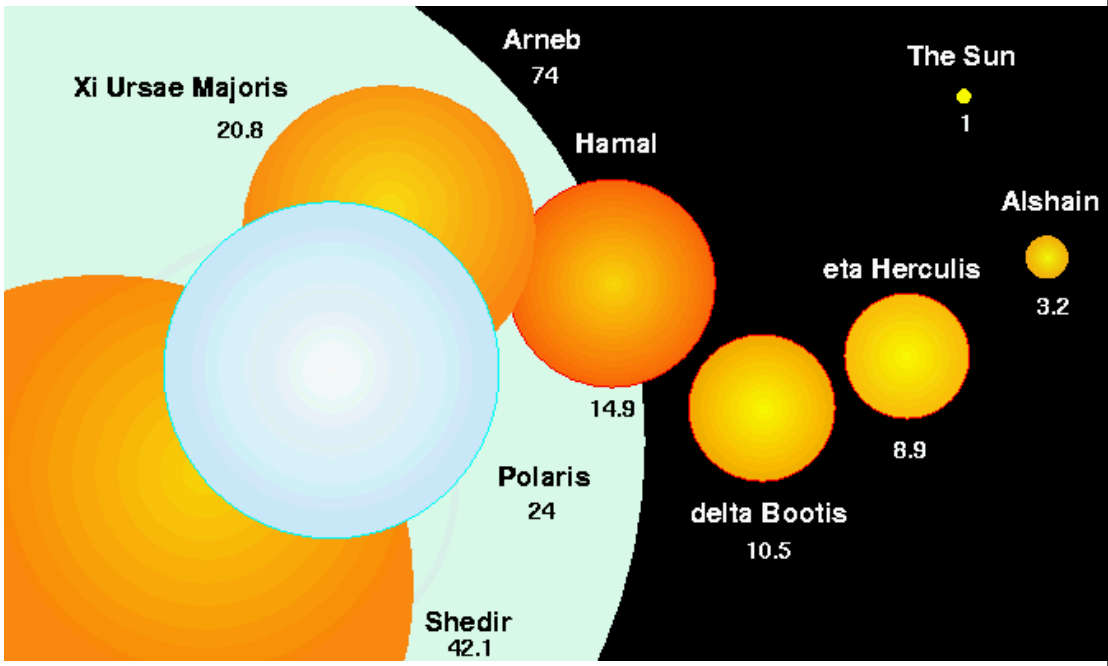


"Hand of God" (Nebula) Image by NASA Nu STAR Telescope

http://www.youtube.com/watch?v=HEheh1BH34Q

http://www.wimp.com/starsize/





NEO WISE

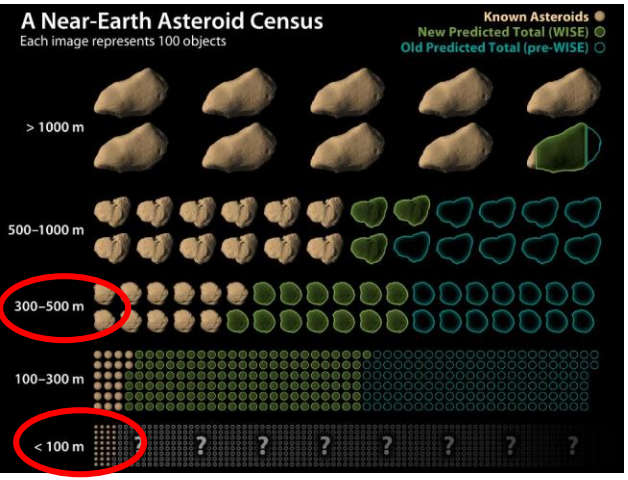
http://neowise.ipac.caltech.edu/

New observations by NASA's Wide-field Infrared Survey Explorer (WISE), shows near-Earth asteroids in the mid-size range.

NASA has found 90 percent + of the largest near-Earth asteroids (A 1998 Congressional goal).

Astronomers estimate there are roughly 19,500 mid-size near-Earth asteroids.

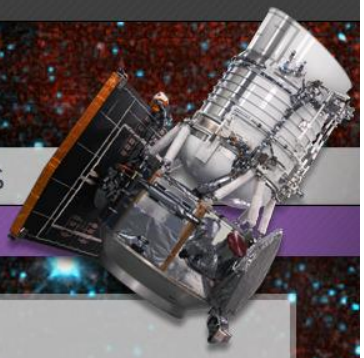
The majority of these mid-size asteroids remain to be discovered. (between 330 to 3,300-feet wide)



ipac

THE NEOWISE PROJECT

FINDING, TRACKING AND CHARACTERIZING ASTEROIDS



This image of the asteroid Ida was taken by the Galileo spacecraft in 1993 en route to the planet Jupiter.

Credit: NASA/JPL

What is NEOWISE?

The NEOWISE project is the asteroid-hunting portion of the Wide-field Infrared Explorer (WISE) mission. Funded by NASA's Planetary Science Division, NEOWISE harvests asteroids and comets from the WISE images and provides an archive for searching the WISE data for solar system scientists.

The mission began its life as WISE for its first eight months of survey operations until the frozen hydrogen cooling the telescope was depleted. The mission continued as NEOWISE for an additional four months, finishing up its survey of the inner solar system.

The NEOWISE project was responsible for archiving the millions of individual images collected by the WISE telescope. To date, the NEOWISE team has delivered infrared detections of more than 158,000 minor planets to the scientific community, including more than 34,000 new discoveries.

NEOWISE data have been used to set limits on the numbers, orbits, sizes, and probable compositions of asteroids throughout our solar system, and the mission discovered the first known Earth Trojan asteroid.

When acknowledging the NEOWISE project, please cite Mainzer et al. 2011 ApJ 731, 53

Current Status

The team is scheduled to release the final processed version of the images and catalog from the Post-Cryogenic Survey Phase at the end of May, 2013.

The NEOWISE project is currently reprocessing all survey data to extend the search for asteroids and comets to fainter limits. We expect that this will result in delivery of many more detections of minor planets at infrared wavelengths.

The team is also chartered to search for evidence of cometary activity as well as to generate a final catalog of asteroid and comet physical properties for all known minor planets that can be identified in the NEOWISE data to NASA's Planetary Data System.

The Future

The WISE spacecraft is currently in hibernation mode. Its solar panels are still pointed at the Sun, and during a brief contact in November 2012, it was in good health.

In December 2012, NASA's Human Exploration Operations Division solicited a proposal from the NEOWISE team to restart the spacecraft and resume the search for potentially hazardous near-Earth objects. Although the solid hydrogen is gone, the mission could still operate at its two shortest infrared wavelengths, returning valuable data on the numbers, orbits, sizes, and compositions of asteroids and comets.

The proposal to NASA was submitted on January 31, 2013.

News

- 01-28-2014 • NASA Preparing for 2014 Comet Watch at Mars
- 01-23-2014 • NEOWISE Celebrates First Month of Operations After Reactivation
- 01-07-2014 • Recently Reactivated NASA Spacecraft Spots Its First New Asteroid

Links

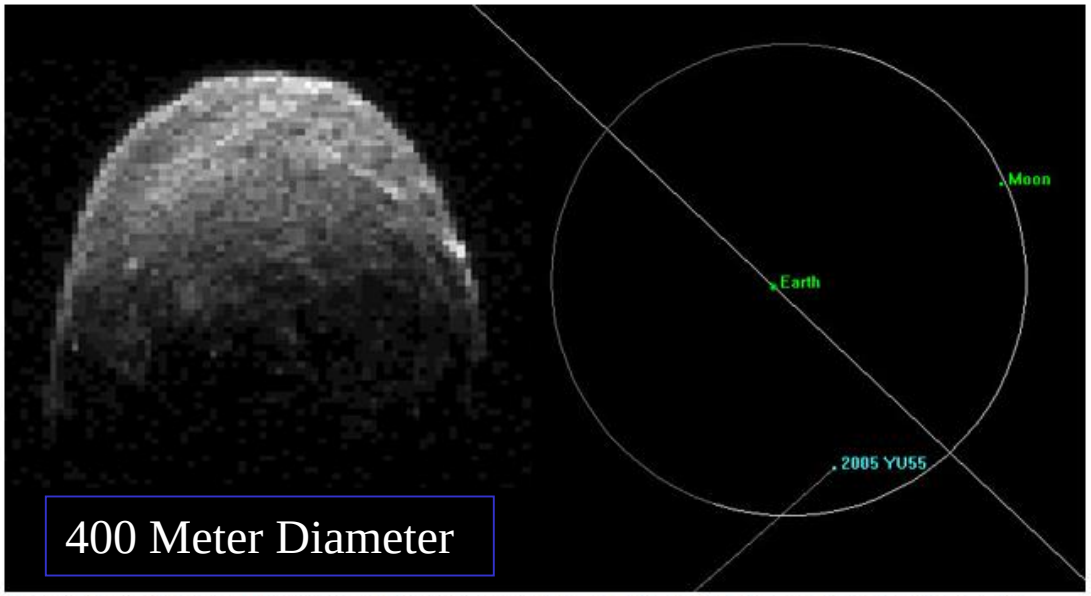
- NEOWISE Publications
- Data Access @ IRSA
- WISE Project Website
- WISE @ NASA

NEO's (Near earth Objects)

Closer to Home But Harder to See

Many Giants pass between the Earth and the Moon.

NASA Releases Updated Radar Movie of Asteroid 2005 YU55



This radar image of asteroid 2005 YU55 was obtained on Nov. 7, 2011, at 11:45 a.m. PST (2:45 p.m. EST/1945 UTC), when the space rock was at 3.6 lunar distances, which is about 860,000 miles, or 1.38 million kilometers, from Earth. Credit: NASA/JPL-Caltech

Many NEO's Do Hit Earth - Reference Information

The Chelyabinsk Meteor in 2013

A Near Earth (Object) asteroid entered Earth's atmosphere over the southern Ural region of Russia, on February, 15, 2013.

- **At a Velocity of 42,900 mph, almost 60 times the speed of sound,**
- **It Exploded at an altitude of 18.4 miles, or 97,400 feet over Chelyabinsk Oblast,**
- **The light from the meteor was brighter than the Sun, observed in neighboring republics.**
- **Eyewitnesses also felt intense heat from the fireball explosion and a powerful shock wave.**
- **It was 20–30 times more powerful that the atomic bomb detonated at Hiroshima.**
- **Estimated initial mass of about 13,000 tons, and about 66 feet in Dia.**
- **Largest known natural object to have entered Earth's atmosphere since the 1908 Tunguska Event**
- **The Chelyabinsk meteor is also the only meteor confirmed to have resulted in a large number of injuries.**

The Tunguska Event in 1908

A cometary fragment or a stony meteorite, that exploded over the Tunguska (Siberia) Region of Russia

- **It was approx. 60 meters (200 ft) across,**
- **It destroyed a wide, remote, forested area of Siberia.**
- **Leveling and scorching trees over a 24 mile diameter area.**
- **If it had arrived 3 hours later it would have destroyed St. Petersberg**

Also See A Planetary Defense Policy Recommended by Al Globus
http://space.alglobus.net/papers/PlanetaryDefensePolicy2014.pdf

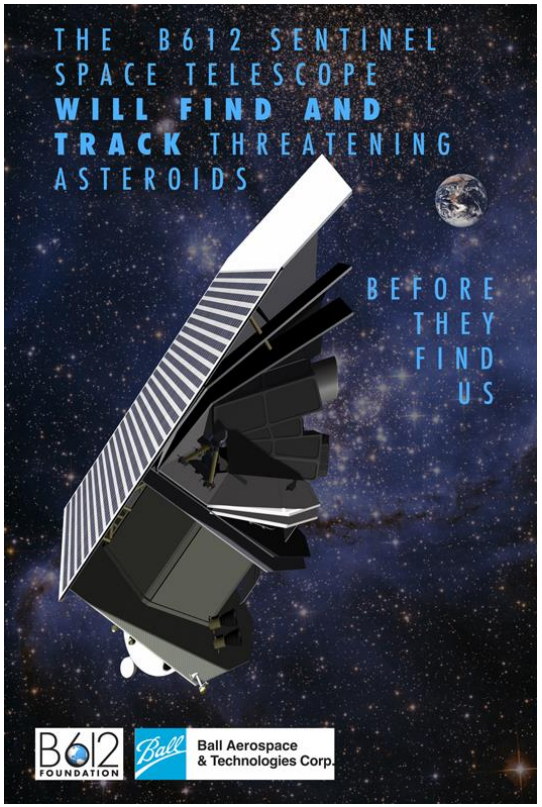
The B612 Sentinel Space Telescope

Future/IR

Between 2000 and 2013, a network of sensors that monitors Earth around the clock listening for the infrasound signature of nuclear detonations detected 26 explosions on Earth ranging in energy from 1 to 600 kilotons – all caused not by nuclear explosions, but rather by asteroid impacts. These findings were recently released from the Nuclear Test Ban Treaty Organization, which operates the network.

To put this data in perspective, the atomic bomb that destroyed Hiroshima in 1945 exploded with an energy impact of 15 kilotons. While most of these asteroids exploded too high in the atmosphere to do serious damage on the ground, the evidence is important in estimating the frequency of a potential "city-killer-size" asteroid.

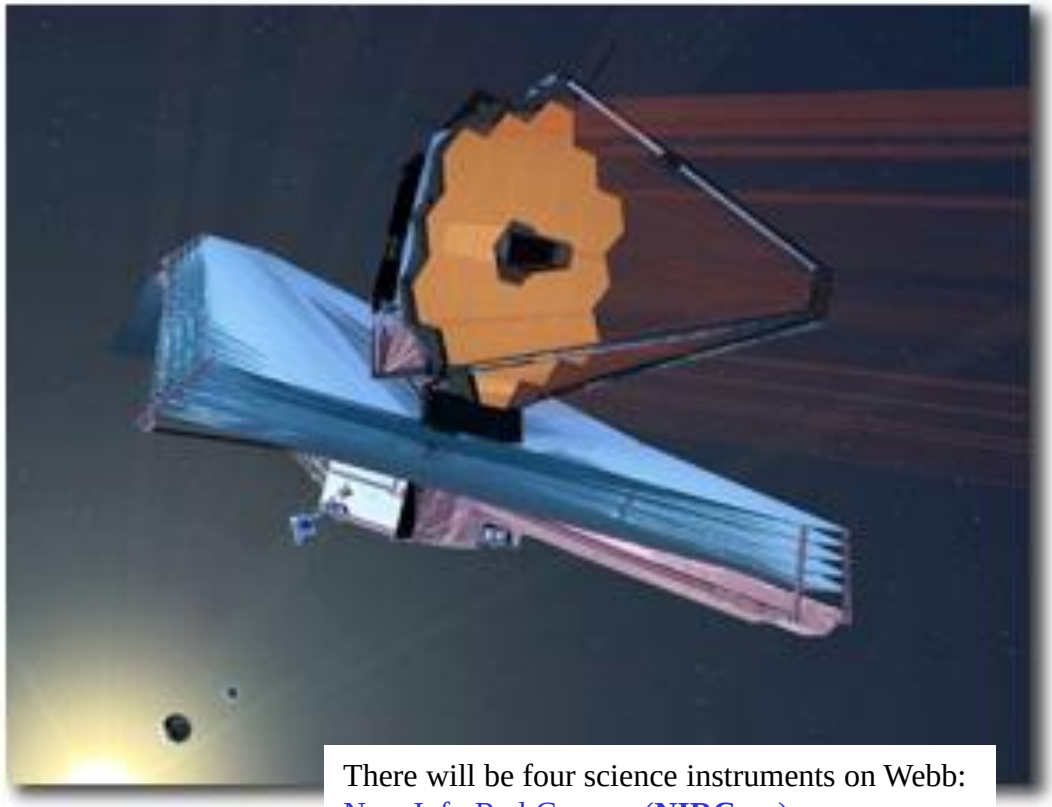
The U.N. plans to set up an "International Asteroid Warning Group" for member nations to share information about potentially hazardous space rocks. If astronomers detect an asteroid that poses a threat to Earth, the U.N.'s Committee on the Peaceful Uses of Outer Space will help coordinate a mission to launch a spacecraft to slam into the object and deflect it from its collision course.



James Webb Space Telescope

http://jwst.nasa.gov/about.html

NASA / Future/IR/ Successor of Hubble. JWST (Build on Hubble)



There will be four science instruments on Webb:
Near InfraRed Camera (**NIRCam**),
Near InfraRed Spectrograph (**NIRSpec**),
Mid-InfraRed Instrument (**MIRI**),
Fine Guidance Sensor/ Near InfraRed Imager and Slitless Spectrograph (**FGS-NIRISS**).
Webb's instruments will be designed to work primarily in the infrared range of the electromagnetic spectrum, with some capability in the visible range. It will be sensitive to light from 0.6 to 28 micrometers in wavelength.

The James Webb Space Telescope (sometimes called JWST)

- large infrared telescope
- 6.5-meter primary mirror.
- 2018 launch date.

It will study every phase in the history of our Universe,

- first luminous glows after the Big Bang,
- formation of solar systems
- planets like Earth,
- evolution of our own Solar System.

It is named after a former NASA administrator, James Webb.

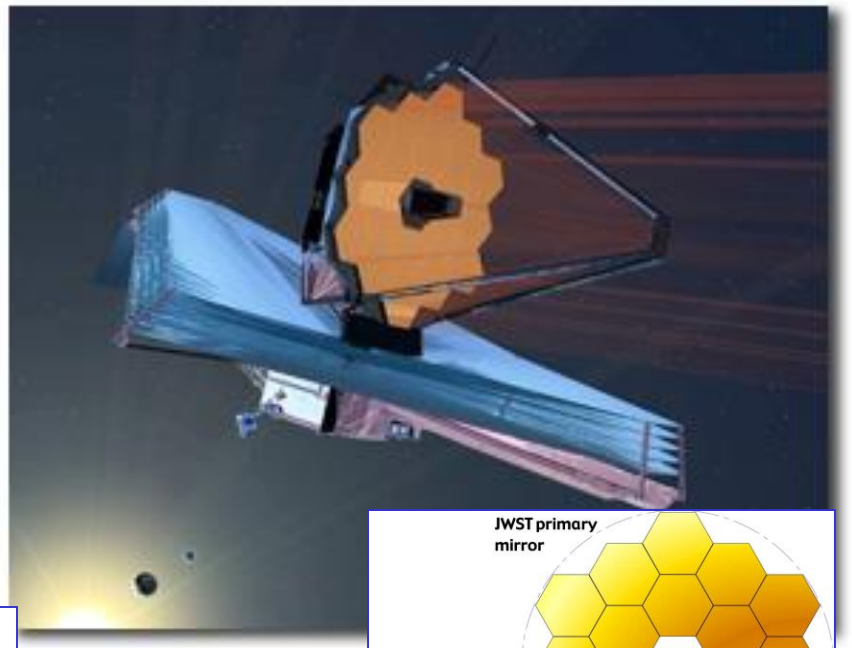
Several innovative technologies have been developed for Webb.

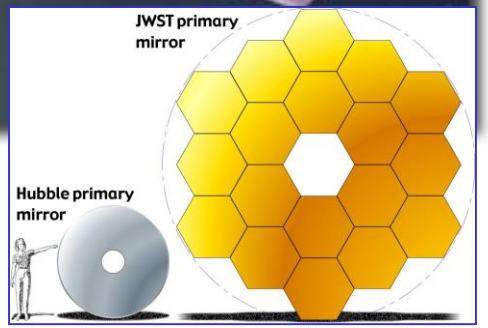
- Folding, segmented primary mirror,
- Adjusted to shape after launch;
- Ultra-lightweight beryllium optics;
- Detectors able to record extremely weak signals,
- Micro shutters pin point object selection
- Cryocooler to cool the mid-IR detectors to 7K.

James Webb Space Telescope

NASA / Future/IR/ Successor of Hubble. JWST (Build on Hubble)

http://jwst.nasa.gov/about.html

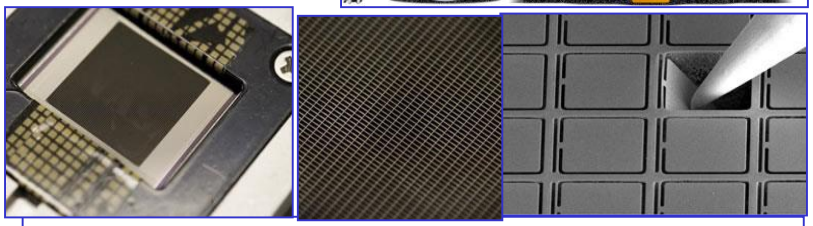




Primary Mirror Structure

The Backplane structure is designed to provide unprecedented thermal stability at temperatures colder than -400°F (-240°C).

Made of advanced graphite composite materials mated to titanium and invar fittings and interfaces.



Microshutters are a new piece of technology being used on the Near Infrared Spectrograph (NIRSpec) instrument

One of the James Webb Space Telescope's science goals is to look back through time to when galaxies were young.

Webb will do this by observing galaxies that are very distant, at over 13 billion light years away from us.

To see such far-off and faint objects, Webb needs a large primary mirror 6.5 meters (21 feet 4 inches) across.

If the Hubble Space Telescope's 2.4 meter mirror were scaled to be large enough for Webb, it would be too heavy to launch into orbit.

The Webb team had to find new ways to build the mirror so that it would be light enough and yet very strong & stable

Each mirror segment weighs 20 kg (46 lbs.) and is made of beryllium

The European Space Agency Selects The PLATO Space Telescope

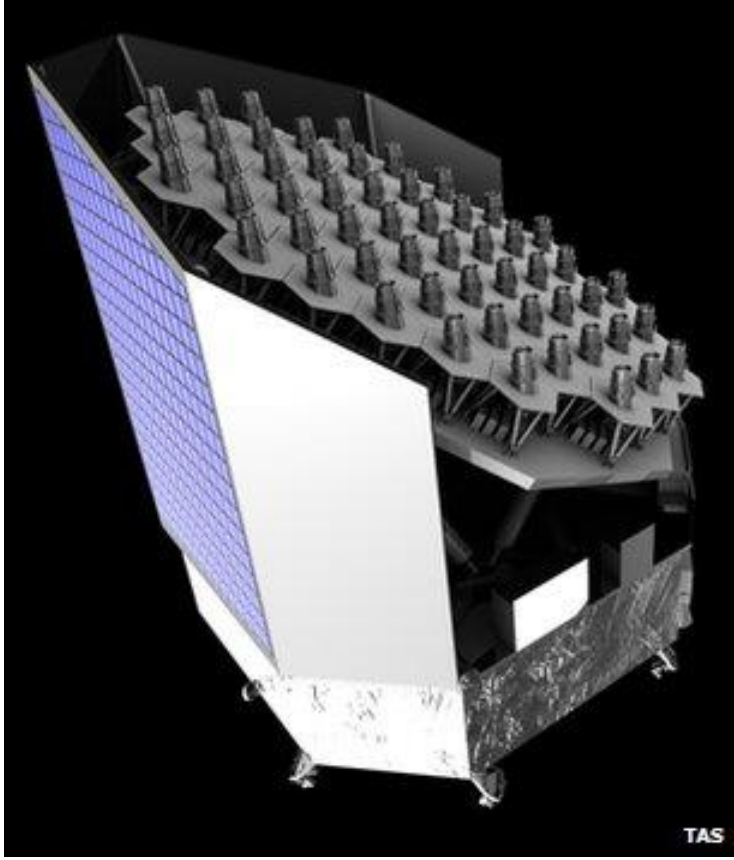
Feb. 17, 2014 By Jonathan Amos Science correspondent, BBC News

ESA's newest medium-class science mission PLATO (short for Planetary Transits and Oscillations of stars). The observatory, which is slated to blast off in 2024, will scan up to a million stars for signs of orbiting planets, with an emphasis on worlds that could be similar to our own.

Astronomers have so far found over 1,700 planets beyond our Solar System, but none as yet has been shown to be truly Earth-like in terms of its size and distance from a Sun similar to our own.

Mission Leader - Dr Heike Rauer at DLR, the German space agency.

http://www.bbc.co.uk/news/science-environment-26267918



- **The Design calls for a suite of 34 telescopes** to be mounted on a single satellite platform
- Mission should confirm and characterise hundreds of **rocky worlds in habitable zones**
- Its technology would have the sensitivity also to **detect the planets' moons and rings**
- Intricate measurements of the host stars (asteroseismology) would yield key information
- To launch from Sinnamary in French Guiana on a Soyuz rocket in 2023/2024
- Plato would be stationed **1.5 million km from Earth on its "nightside"**

Distant Galaxies

Looking Back in Time

"THE BIG MYSTERY"

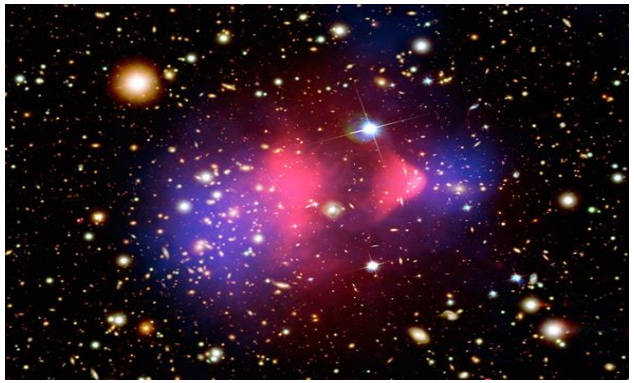
The Universe is expanding at an unexpected rate……

We do not see all energy (Electromagnetic Spectrum)

We do not see all matter…….

Shining light on dark matter by Jeff Foust
Monday, February 24, 2014
To detect dark matter, it's helpful to have an idea of what you're looking for. Scientists have proposed many ideas for what dark matter might be, but most now think it's in a form known as weakly interacting massive particles, or WIMPs. As the name suggests, these particles could be heavy, yet rarely interact with other articles beyond gravity.

"It's a relic of the first fraction of the second of the universe," explained Rocky Kolb of the University of Chicago during a half-hour talk at the AAAS meeting. "A few hundred million are in this room at this instant, flying around at a million kilometers per hour, and about 10^{12} [one trillion] will pass through you during this talk."

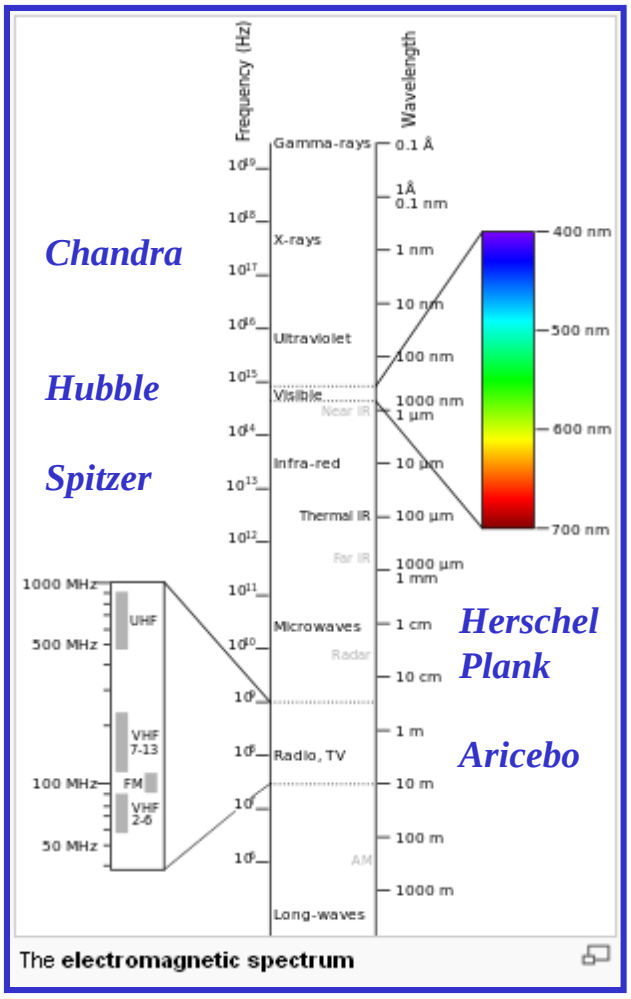


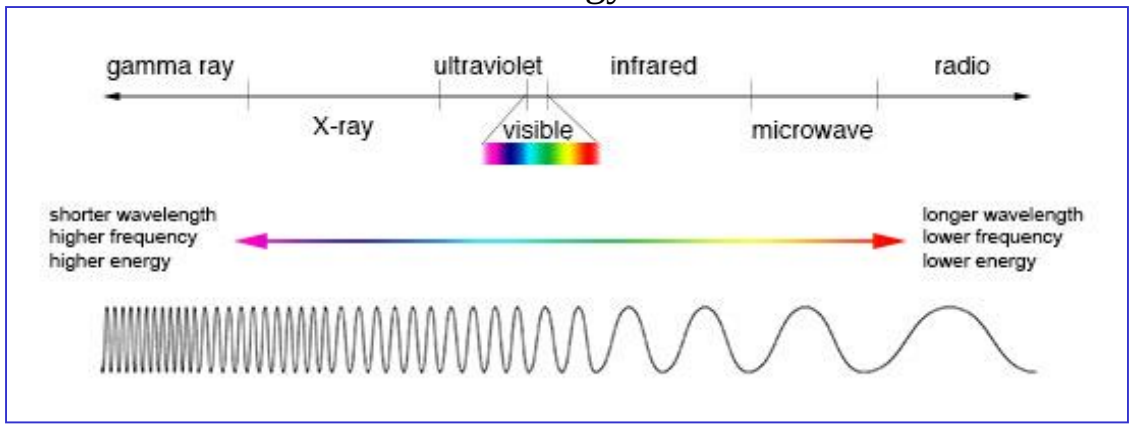
The pink represents the hot gas (by far most of the mass of the luminous matter), and the blue is a visualization of the dark matter based on gravitational lensing measurements.
The Dark Matter Poltergeist - It's real, but what is it? By Katie Mack

We can not see all energy,

(Reference the Electromagnetic Spectrum)

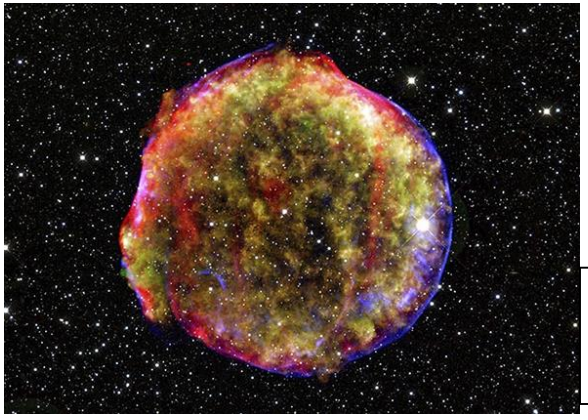
So What about Dark Energy ?



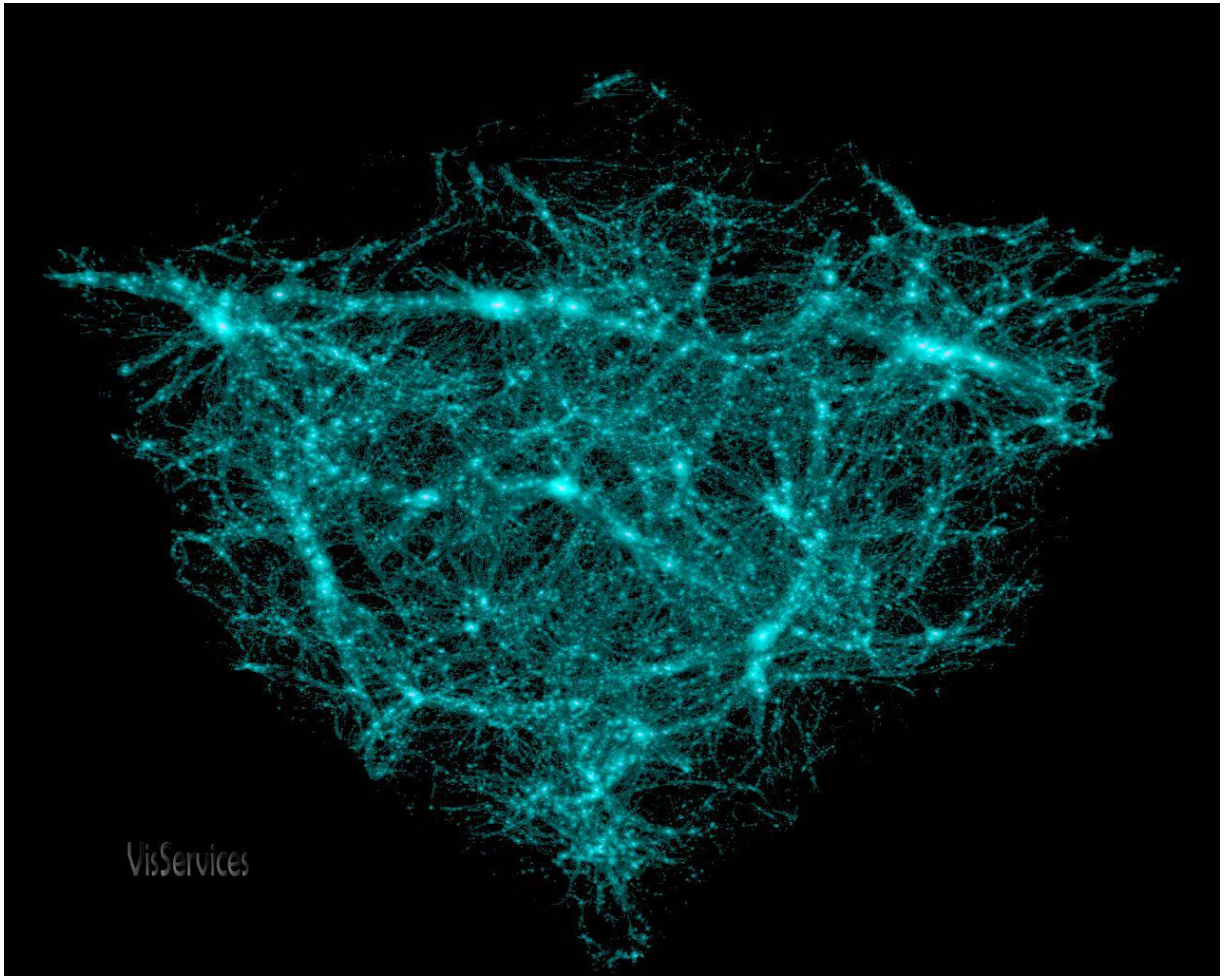


Despite dark energy's magnitude, astronomers didn't know about its existence until recently because its effects are subtle. It doesn't noticeably affect the planets in the solar system or the motion of stars in the galaxy. That subtlety enshrouds it in mystery: Scientists are busily determining what dark energy ***does***, and they have yet to reach any consensus on what dark energy ***is***.

Because dark energy doesn't correspond easily to anything in the standard toolkit of physics, researchers have been free to be creative.

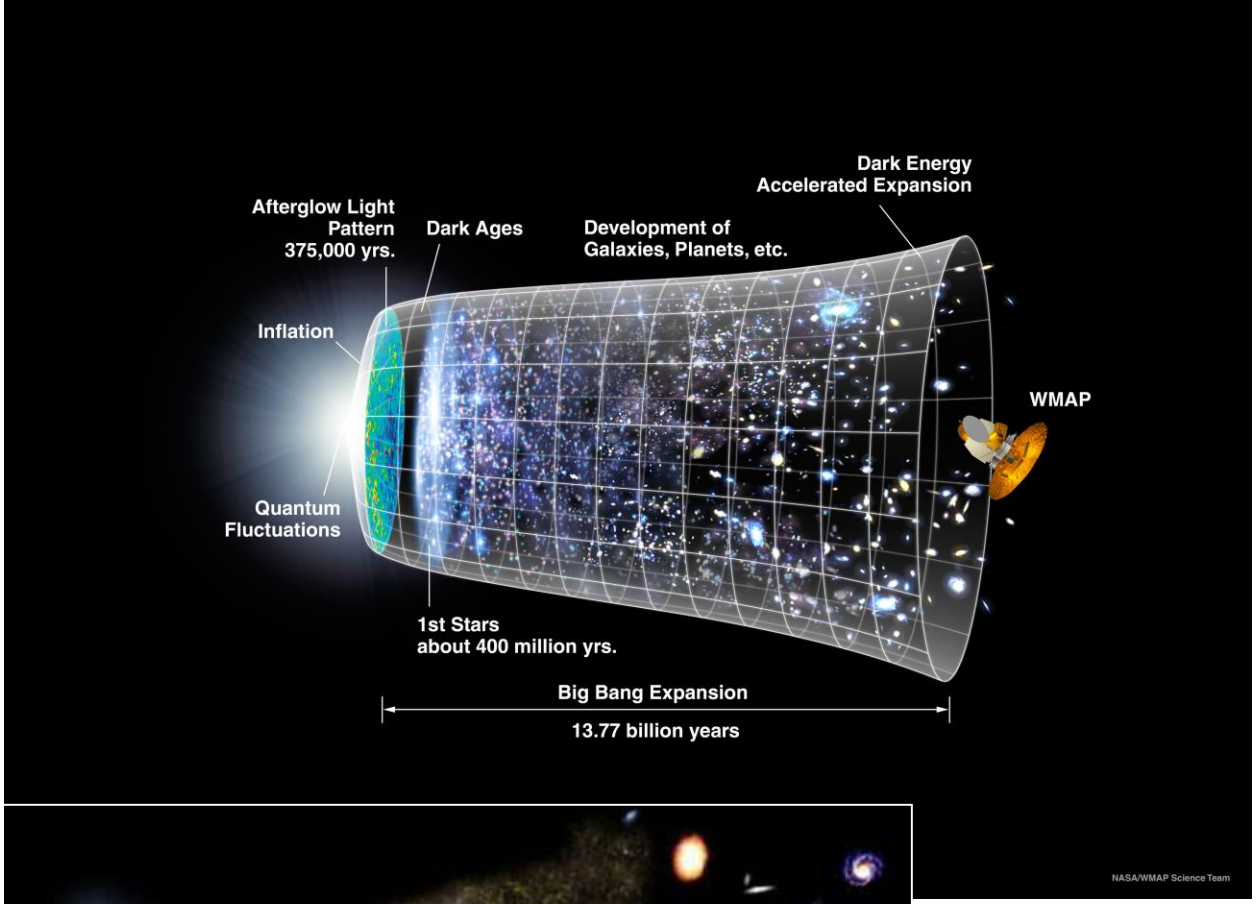


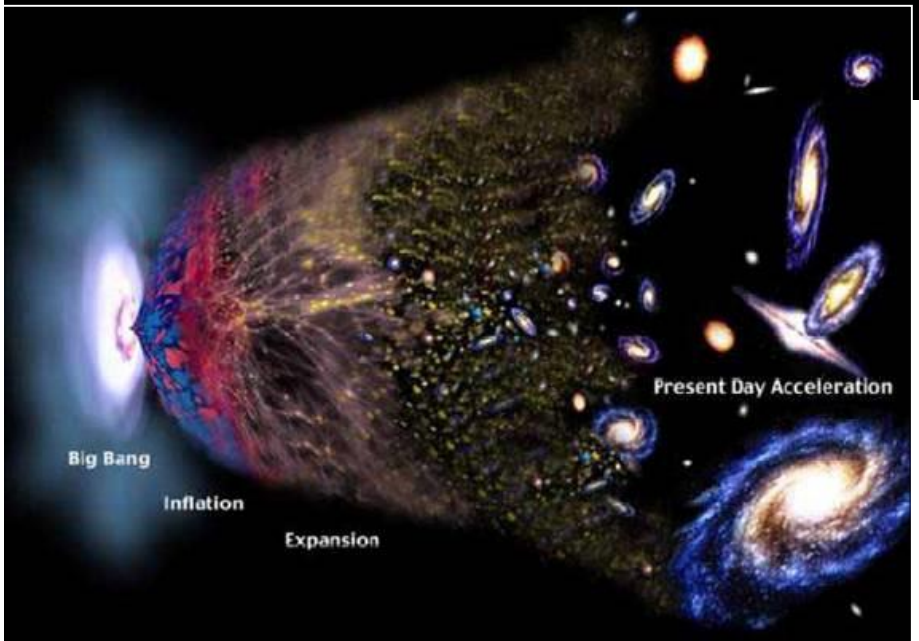
A multi-wavelength image of Tycho's supernova remnant, the result of a stellar explosion first recorded over 400 years ago by astronomer Tycho Brahe. Supernovas have provided clues as to the rate of the universe's expansion.



Dark Matter and the Fate of the Universe

If dark matter acts like cosmic glue, astronomers must be able to explain its existence in terms of the prevailing theory of universe formation. The big bang theory states that the early universe underwent an enormous expansion and is still expanding today. For gravity to clump galaxies together into walls or filaments, there must be large amounts of mass left over from the big bang, particularly unseen mass in the form of dark matter. In fact, supercomputer simulations of the formation of the universe show that galaxies, galactic clusters and larger structures can eventually form from aggregations of dark matter in the early universe.


Dark Energy
Accelerated Expansion
Afterglow Light
Pattern
375,000 yrs.
Dark Ages
Development of
Galaxies, Planets, etc.
Inflation
WMAP
Quantum
Fluctuations
1st Stars
about 400 million yrs.
Big Bang Expansion
13.77 billion years
NASA/WMAP Science Team


Present Day Acceleration
Big Bang
Inflation
Expansion

The Web Page

A Primer on Space Exploration

Space Exploration

Home | Photos of Earth | Earth's Moon | Mars | Robotics | Space Settlements

An Exciting New Era in Space Exploration

Outline

1. Introduction
2. The Virgin Galactic Story (Videos Available) (Virgin Galactic) (Space Port America)
3. The Earths Atmosphere
   Atmosphere as Viewed From the Space Station at night
4. Typical Rocket Performance
5. Satellites and their Orbits
6. The International Space Station
   Photos from ISS More ISS Photos
   (NASA Video "Walking on Air") (New)
   http://www.nasa.gov/multimedia/videogallery/index.html?media_id=141042671
7. Earth – Moon Neighborhood – Gravity Wells - Libration Pts
8. New NASA Direction 2 paths to Space (New)
   http://www.nasa.gov/multimedia/videogallery/index.html?media_id=143986661
   Commercial services to Low Earth Orbit (New)
   SpaceX Breakout Video http://www.nasa.gov/multimedia/videogallery/index.html?media_id=146881031
   Boeing Breakout Video http://www.nasa.gov/multimedia/videogallery/index.html?media_id=146878321
   ULA Breakout Video http://www.nasa.gov/multimedia/videogallery/index.html?media_id=146882391
   Sierra Nevada Corp. Breakout Video http://www.nasa.gov/multimedia/videogallery/index.html?media_id=146879851
   ATK Breakout Video http://www.nasa.gov/multimedia/videogallery/index.html?media_id=146949401
   NASA Focus on Deep Space & Advanced Technology (New)
   http://www.youtube.com/watch?NR=1&v=dGR41iGEcIs&feature=fvwp
   http://www.nasa.gov/multimedia/videogallery/index.html?media_id=131955371
9. New Companies in the Space Business (updated)
10. Why Go ? Resources – Capabilities – New Life
11. In Situ Resource Utilization (Pending)
12. A Map For Future Space Exploration Progress (Pending)
13. Possible Futures – An Artistic View
14. Questions & Discussion
15. Resources & References

www.AkerleySpaceExploration.com

S. Akerley, 2013

Homework Assignments

http://www.AkerleySpaceExploration.com

http://www.KennedySpaceCenter.com 1-800-621-9826

http://hubblesite.org/the_telescope/team_hubble/servicing_missions.php

http://www.nasa.gov/mission_pages/hubble/story/index.html#.Uv03W_tvAk5

http://chandra.harvard.edu/about/spacecraft.html

http://www.spitzer.caltech.edu

http://www.nasa.gov/mission_pages/spitzer/multimedia/20081027b.html

http://www.esa.int/Our_Activities/Space_Science/Planck

http://kepler.nasa.gov/

http://www.jpl.nasa.gov/news/news.php?release=2014-062

http://www.nasa.gov/ames/kepler/digital-press-kit-kepler-planet-bonanza/

http://www.youtube.com/watch?v=HEheh1BH34Q

http://www.wimp.com/starsize/

http://jwst.nasa.gov/about.html

http://neowise.ipac.caltech.edu/

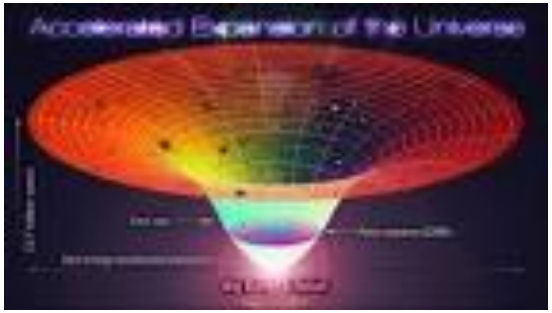
http://space.alglobus.net/papers/PlanetaryDefensePolicy2014.pdf

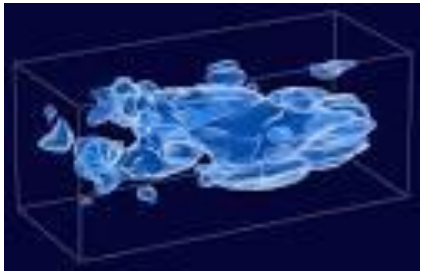
http://www.bbc.co.uk/news/science-environment-26267918

Back Up & Reference

Chandra X-ray Observatory

NASA / 1999 / X-ray / Various





Dark Matter and Dark Energy

http://en.wikipedia.org/wiki/Dark_matter

Dark matter is a type of matter hypothesized in astronomy and cosmology to account for a large part of the mass that appears to be missing from the universe. Dark matter cannot be seen directly with telescopes; evidently it neither emits nor absorbs light or other electromagnetic radiation at any significant level. It is otherwise hypothesized to simply be matter that is not reactant to light.[1] Instead, the existence and properties of dark matter are inferred from its gravitational effects on visible matter, radiation, and the large-scale structure of the universe. According to the Planck mission team, and based on the standard model of cosmology, the total mass–energy of the known universe contains 4.9% ordinary matter, 26.8% dark matter and 68.3% dark energy.[2][3][4][5]

Astrophysicists hypothesized dark matter due to discrepancies between the mass of large astronomical objects determined from their gravitational effects and the mass calculated from the "luminous matter" they contain: stars, gas, and dust. It was first postulated by Jan Oort in 1932 to account for the orbital velocities of stars in the Milky Way and by Fritz Zwicky in 1933 to account for evidence of "missing mass" in the orbital velocities of galaxies in clusters. Subsequently, many other observations have indicated the presence of dark matter in the universe, including the rotational speeds of galaxies by Vera Rubin,[6] in the 1960s–1970s, gravitational lensing of background objects by galaxy clusters such as the Bullet Cluster, the temperature distribution of hot gas in galaxies and clusters of galaxies, and more recently the pattern of anisotropies in the cosmic microwave background. According to consensus among cosmologists, dark matter is composed primarily of a not yet characterized type of subatomic particle.[7][8] The search for this particle, by a variety of means, is one of the major efforts in particle physics today.[9]
Although the existence of dark matter is generally accepted by the mainstream scientific community, some alternative theories of gravity have been proposed, such as MOND and TeVeS, which try to account for the anomalous observations without requiring additional matter.

In physical cosmology and astronomy, **dark energy** is a hypothetical form of energy that permeates all of space and tends to accelerate the expansion of the universe.[1] Dark energy is the most accepted hypothesis to explain observations since the 1990s that indicate that the universe is expanding at an accelerating rate.

Dark matter IS the fabric of space:

At some point in time pure energy is injected into the universe, science refers to this as The Big Bang, to give readers an easy understanding of what happens I will use condensing of gases to give you a batter image of what Dark matter is and what it is doing to energy to form matter, energy is condensed by dark matter/gravity, this crushes protons and neutrons together, as they are forced together, electrons form a field around the nucleus of the atom, atoms combine to form matter, imagine gases being condensed to form a liquid, this same type of process is taking place to form matter from energy as dark matter condenses it .

In the beginning either energy was forced into the universe which was filled with dark matter or the universe began as pure energy and dark matter enveloped the energy compressing it into matter.

Realizations:

Dark matter seems to remain constant not increasing or decreasing in mass while energy continues to be injected into the universe which creates gravity waves, these gravity waves are created as energy is forced into the universe, you can imagine a supernova actually being this process in action and not created by imploding stars, as energy increases within the condensing process reducing the size of atoms, we are literally being squeezed, I know some of you are thinking this could be measured but not as you may think due to everything being relative, as atoms are reduced in size all matter is also reduced/condensed, so let's say the earth is reduced in size by this process as atoms are squeezed smaller and smaller your measuring equipment also becomes reduced in size, you would not notice it because (everything) has changed in size, the earth, moon and sun all reduce in size along with your ruler so everything is relative making measuring this only possible by the distance between stellar bodies.

Measuring the process:

Measure the atom being squeezed is only noticed as dark matter/space increases distances between stellar bodies, you will also notice the distance between the moon, earth and sun and other stellar bodies become further from one another and can be measured today.

Gravity should increase and life would have to adapt to heavier gravity, even though everything is relative as the atom is squeezed I see life forms becoming smaller in the future comparative to the mass of the earth to compensate for the stronger gravity upon the atoms.

The future of the universe:

1. I theorize Energy will continue to fill the universe with dark matter condensing the atoms until it reaches a critical point wherein another big bang will occur tearing the fabric of space/dark matter, possibly expanding the universe, reducing the strength of gravity and the density of dark matter, this would reduce the gravity effect as pressure on the atom is reduced.

Herschel-Planck Observatory

http://www.esa.int/Our_Activities/Space_Science/Planck

ESA / 2009 / Microwave / Cosmic Microwave Background (From The Big Bang)

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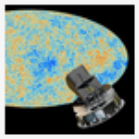

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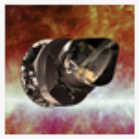

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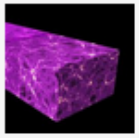

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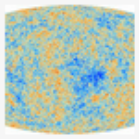

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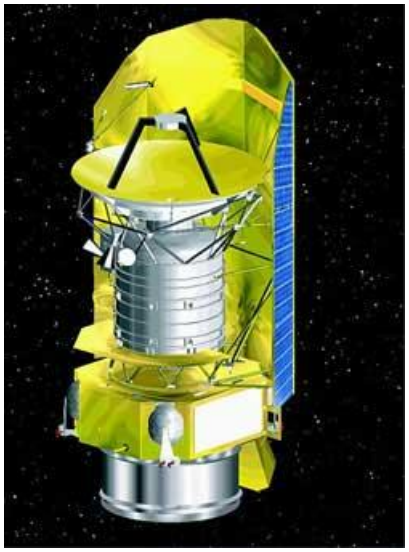

Herschel

Planck

Kepler Mission

NASA / 2009 / Visible / Extrasolar Planets

http://kepler.nasa.gov/Mission/discoveries/

Table of *Confirmed* Planets

Click on the Planet Name and/or the Kepler Object of Interest (KOI) number to get more planet information.

	Planetary Characteristics							Planetary Orbit					Stellar Characteristics					
Name	KOI #	Mass		Radius		Density	Temp*	Transit Duration	Period	Semi-Major axis	Eccentricity	Inclination**	Distance	Effective Temp	Stellar Mass	Stellar Radius	Metallicity***	Right Ascension	Declination
		Jupiter masses	*Earth masses*	*Jupiter radii*	*Earth radii*	*grams/cc*	*Kelvin*	*hours*	*days*	*AU*		*degrees*	*parsecs*	*Kelvin*	*Solar masses*	*Solar radii*		*hh mm ss J2000*	*deg mm ss J2000*
Earth and Jupiter for comparison:														Sun for comparison:					
Earth		0.00314	1.000	0.089	1.000	5.515	255/288		365.25	1.000	0.016			5780	1.000	1.000	0.00		
Jupiter		1.000	317.82	1.00	11.21	1.33	124		4330.60	5.204	0.0484			5780	1.000	1.000	0.00		
The first 3 planets listed were discovered prior to the *Kepler Mission* using ground-based observations. They are listed to allow for inclusion of improved planetary and stellar properties from the Kepler data.																			
Kepler-1b	1.01	1.1990	381.10	1.2720	14.258	0.770	1394	1.7246	2.47063000	0.03556	0.000	83.620	213	5850	0.980	1.000	-0.139	+19 07 14.03	+49 18 59.07
Kepler-2b	2.01	1.7760	564.44	1.3420	15.043	—	2733	4.0440	2.20473700	0.03770	0.000	83.111	320	6350	1.470	1.840	—	+19 28 59.36	+47 58 10.25
Kepler-3b	3.01	0.0810	25.74	0.4220	4.730	1.330	878	2.2968	4.88781620	0.05300	0.198	88.500	38	4780	0.810	0.750	+0.310	+19 50 50.24	+48 04 51.08
Kepler-4b	7.01	0.0770	24.47	0.3570	4.002	1.910	1650	4.1109	3.21346000	0.04560	0.000	89.760	550	5857	1.220	1.490	+0.170	+19 02 27.68	+50 08 8.71
Kepler-5b	18.01	2.1140	671.86	1.4310	16.040	0.894	1868	4.0811	3.54846000	0.05064	<0.024	86.300	—	6297	1.370	1.790	+0.040	+19 57 37.68	+44 02 6.17
Kepler-6b	17.01	0.6690	212.62	1.3230	14.830	0.352	1500	3.6016	3.23472300	0.04567	0.000	86.800	—	5647	1.210	1.390	+0.340	+19 47 20.94	+48 14 23.87
Kepler-7b	97.01	0.4330	137.62	1.4780	16.567	0.166	1540	4.6296	4.88552500	0.06224	0.000	86.500	—	5933	1.350	1.840	+0.110	+19 14 19.56	+41 05 23.27
Kepler-8b	10.01	0.6030	191.64	1.4190	15.906	0.261	1764	3.1984	3.52254000	0.04830	0.000	84.070	1330	6213	1.210	1.490	-0.055	+18 45 9.15	+42 27 3.89
Kepler-9b	377.01	0.2520	80.09	0.8420	9.438	0.524	678	3.8225	19.24000000	0.14000	0.150	89.380	650	5777	1.070	1.020	+0.120	+19 02 17.75	+38 24 3.22
Kepler-9c	377.02	0.1710	54.35	0.8230	9.225	0.383	536	4.1090	38.91000000	0.22500	0.130	89.380	650	5777	1.070	1.020	+0.120	+19 02 17.75	+38 24 3.22
Kepler-9d	377.03	—	—	0.1460	1.640	—	2026	1.9704	1.59285100	0.02730	—	89.950	650	5777	1.070	1.020	+0.120	+19 02 17.75	+38 24 3.22
Kepler-10b	72.01	0.0140	4.56	0.1260	1.416	8.800	1833	1.8029	0.83749500	0.01684	0.000	84.400	173	5627	0.900	1.060	-0.150	+19 02 43.05	+50 14 28.68
Kepler-10c	72.02	0.0630	20.00	0.1990	2.227	<10.000	485	6.8640	45.29485000	0.24070	0.000	89.650	173	5627	0.900	1.060	-0.150	+19 02 43.05	+50 14 28.68
Kepler-11b	157.06	0.0060	1.90	0.1610	1.800	1.720	851	4.1160	10.30390000	0.09100	0.045	89.640	613	5680	0.950	1.100	+0.000	+19 48 27.63	+41 54 32.90