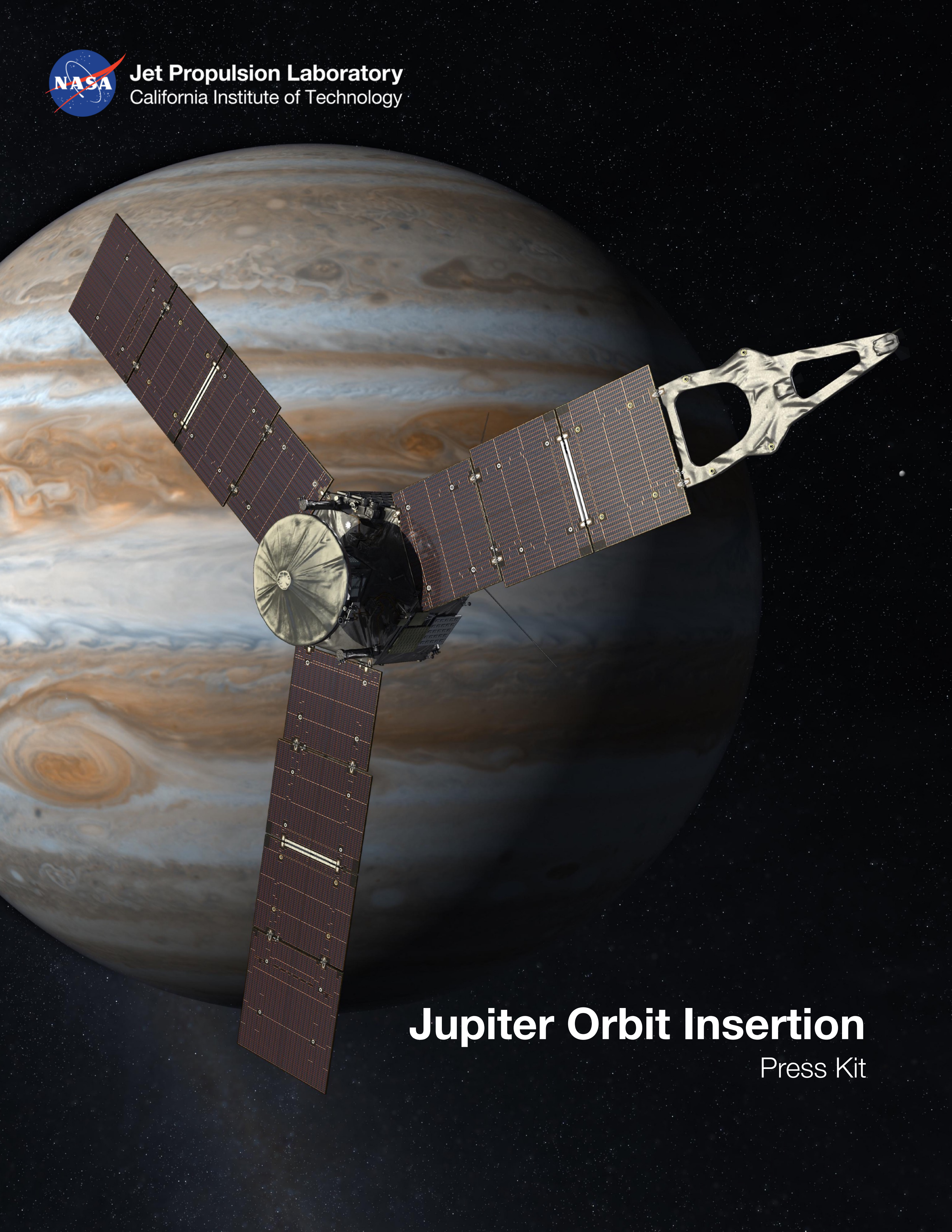
Jet Propulsion Laboratory
California Institute of Technology



Jupiter Orbit Insertion

Press Kit

NASA's Juno spacecraft will arrive at Jupiter in 2016 to study our solar system's largest planet. From a unique polar orbit, Juno will repeatedly dive between the planet and its intense belts of charged particle radiation, coming only about 3,000 miles (5,000 kilometers) from the cloud tops at closest approach.

Juno's primary goal is to improve our understanding of Jupiter's formation and evolution. The spacecraft will investigate the planet's origins, interior structure, deep atmosphere and magnetosphere. Juno's study of Jupiter will help us to understand the history of our own solar system and provide new insight into how planetary systems form and develop in our galaxy and beyond.

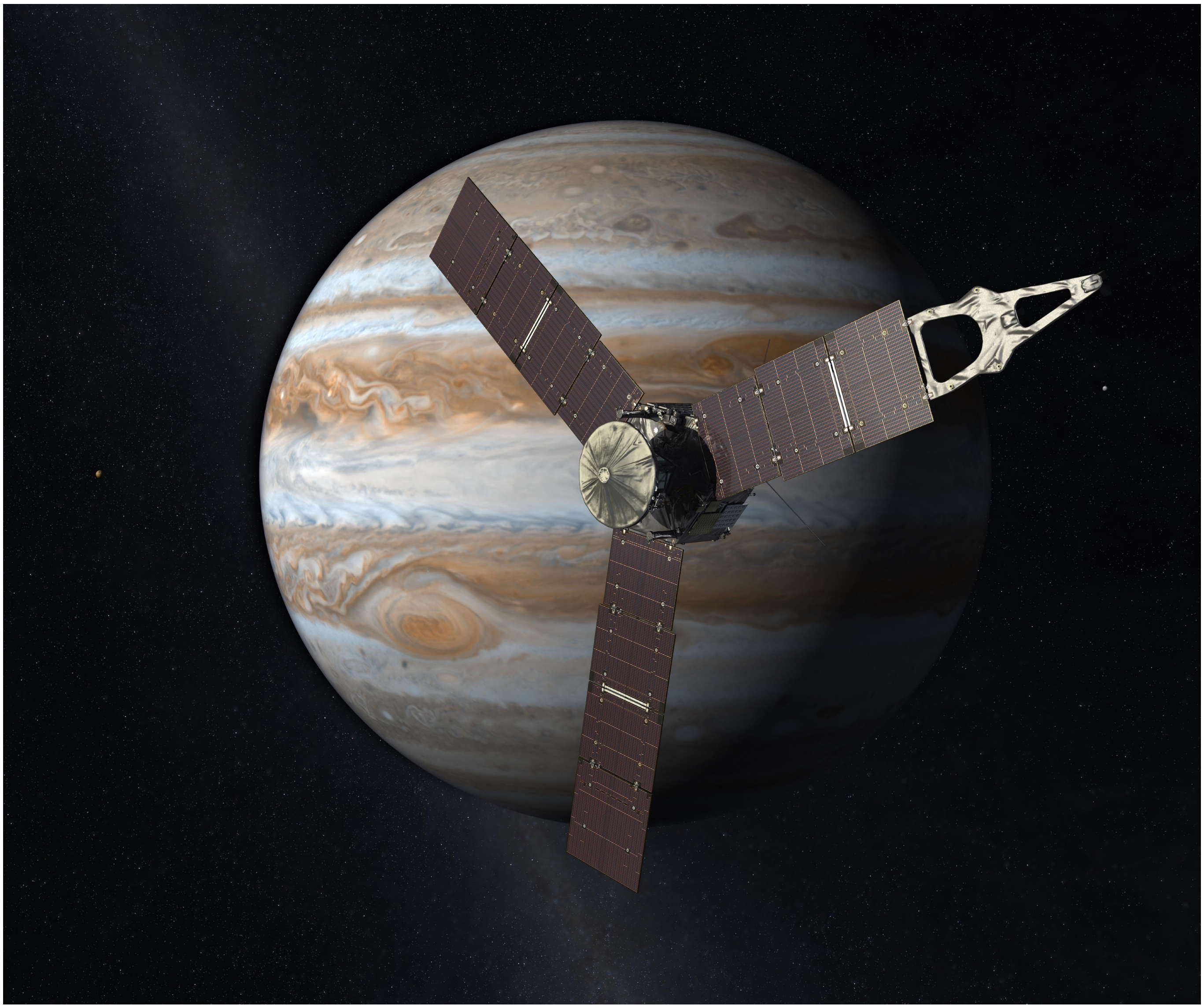


Image credit: NASA/JPL

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Media Services Information

News and Status Reports
NASA and the Juno team will issue periodic status reports on mission activities and make them available online at http://www.nasa.gov/juno and http://missionjuno.swri.edu. NASA released several media advisories before the Jupiter Orbit Insertion with details of press accreditation, media briefings, special media opportunities, on-site logistics at the Jet Propulsion Laboratory, and NASA TV and Web coverage.

Video and Images
Video and images related to the Juno mission are available at the following websites: https://vimeo.com/172488766 and http://photojournal.jpl.nasa.gov/mission/Juno

NASA Television
NASA Television is carried on the Web and on an MPEG-2 digital signal accessed via satellite AMC-6, at 72 degrees west longitude, transponder 17C, 4040 MHz, vertical polarization. It is available in Alaska and Hawaii on AMC-7, at 137 degrees west longitude, transponder 18C, at 4060 MHz, horizontal polarization. A Digital Video Broadcast compliant Integrated Receiver Decoder is required for reception. For NASA TV information and schedules on the Web, visit www.nasa.gov/ntv.

Live NASA TV programming on NASA's public channel is available on the web at www.nasa.gov/ntv and at http://www.ustream.tv/nasahdtv. The NASA TV media channel is available live at http://www.ustream.tv/channel/nasa-media-channel. Archived NASA TV programming is available soon after it airs at www.youtube.com/nasatelevision.

On-Site Media Logistics
News media representatives covering the Jupiter Orbit Insertion in person must be accredited through the Jet Propulsion Laboratory Media Relations office. Registration for media ended June 2, 2016. Journalists may call (818) 354-5011 for information and to request interviews.

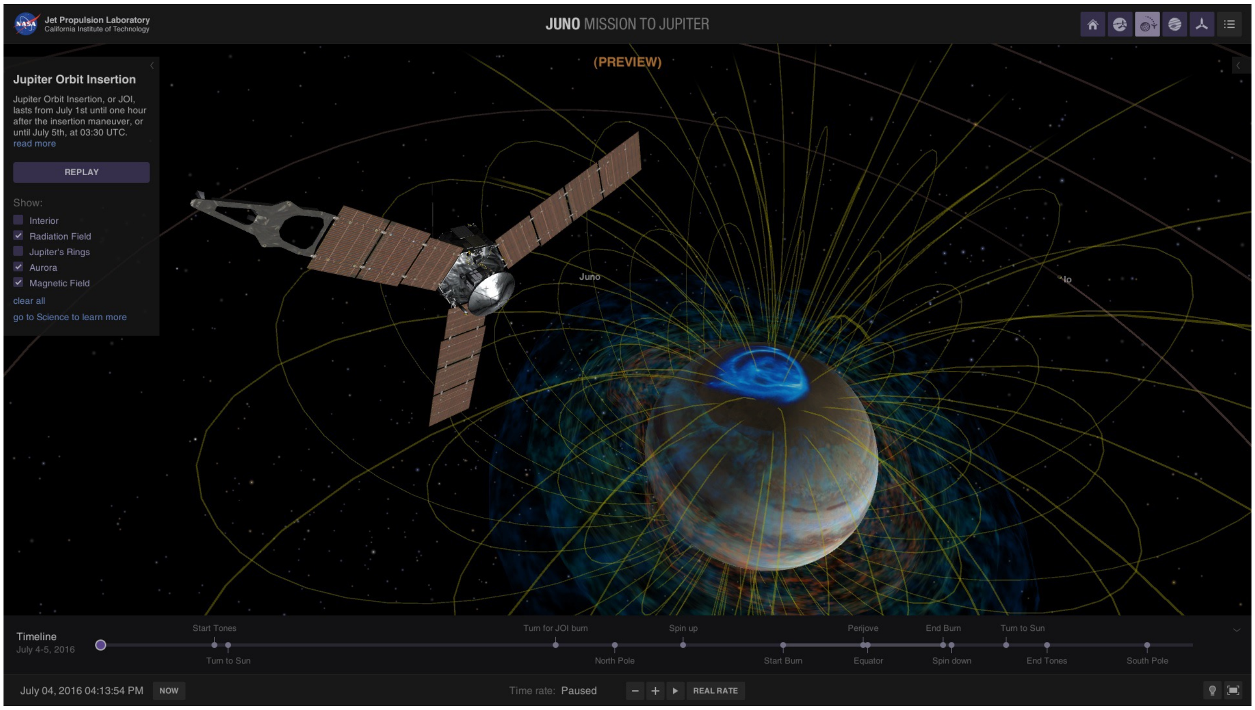
Juno on the Web
Juno information -- including an electronic copy of this press kit, news releases, fact sheets, mission details and background, status reports and images — is available on the web at http://www.nasa.gov/juno and http://missionjuno.swri.edu.

Mission updates are also available on Twitter (@NASAJuno), Facebook (www.facebook.com/NASAJuno, Tumblr (nasajunocam.tumblr.com) and YouTube (youtube.com/NASAJuno).

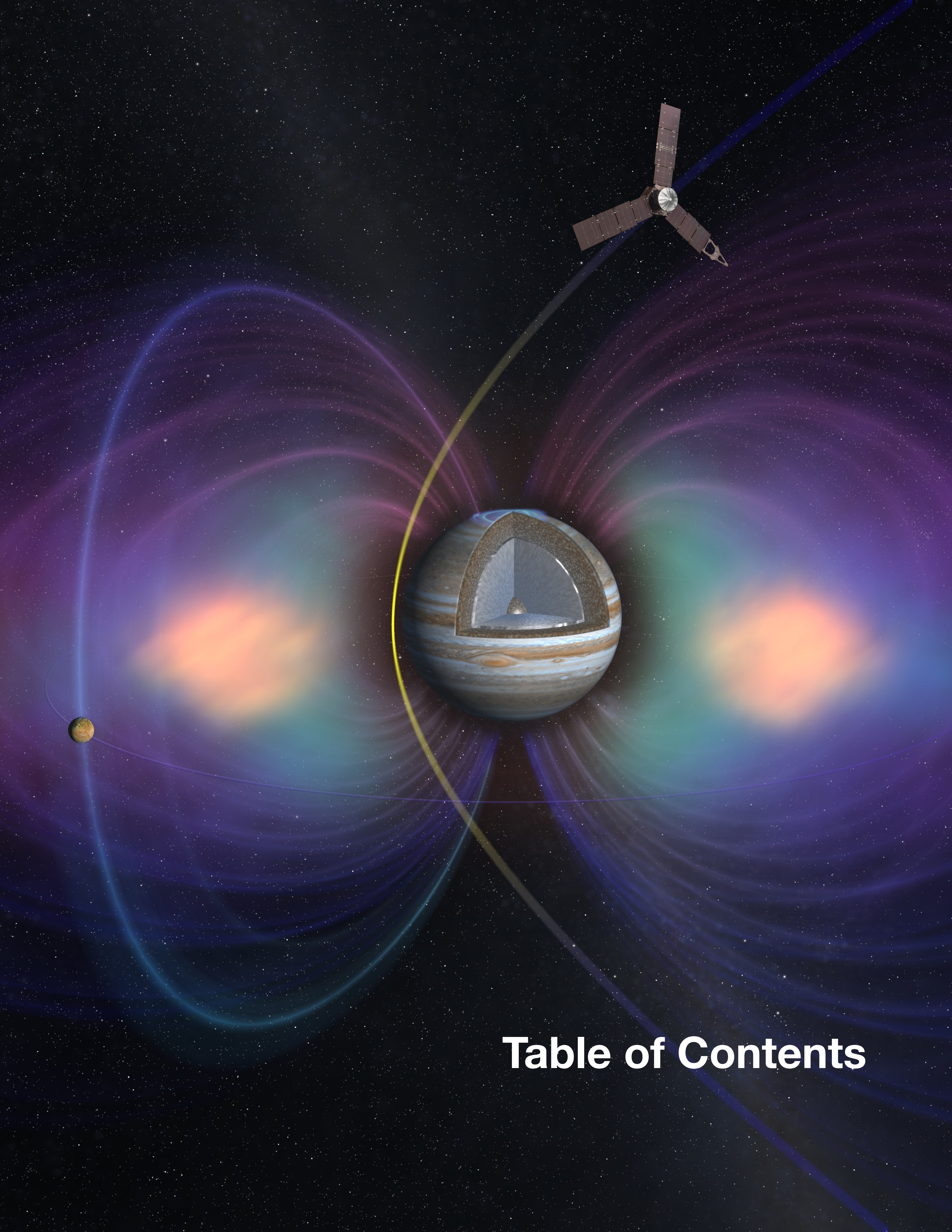
Eyes on the Solar System

If you can't be at the Jet Propulsion Laboratory – or in orbit around Jupiter – for Jupiter Orbit Insertion, the next best place to be might be in front of your computer watching NASA's Eyes on the Solar System app. Or, you could be watching NASA TV commentary on July 4 – which not only includes interviews and live views from mission control – but has a presentation about Eyes on the Solar System.

Eyes On The Solar System has developed a module dedicated to the Juno mission to Jupiter. In this online, interactive visualization, you can ride along with the Juno spacecraft in real-time as it arrives at Jupiter on the 4th of July, or travel backward or forward in time from launch to its planned fiery end of mission in February of 2018.



Go to: http://eyes.nasa.gov/juno



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Quick Facts

Mission Name

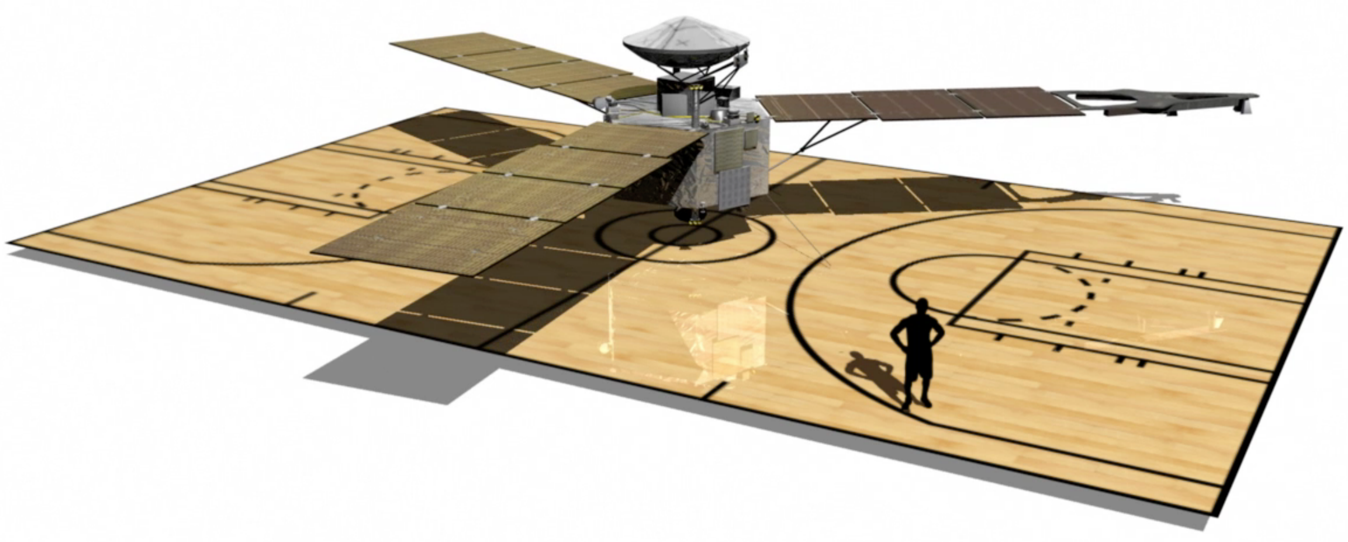
The Juno spacecraft will, for the first time, see below Jupiter's dense cover of clouds. This is why the mission was named after the Roman goddess, who was Jupiter's wife, and who could also see through clouds.

Spacecraft

Dimensions: 11.5 feet (3.5 meters) high, 11.5 feet (3.5 meters) in diameter.

Solar Arrays: length of each solar array 29.5 feet (9 meters) by 8.7 feet (2.65 meters).
Total surface area of solar arrays: more than 650 feet (60 meters) squared.
Total number of individual solar cells: 18,698.
Total power output (Earth distance from sun): approximately 14 kilowatts; (Jupiter distance from sun): approximately 500 watts.

Weight: 7,992 pounds (3,625 kilograms) total at launch, consisting of 3,513 pounds (1,593 kilograms) of spacecraft, 2,821 pounds (1,280 kilograms) of fuel and 1,658 pounds (752 kilograms) of oxidizer.



This artist rendering illustrates the size of Juno relative to a basketball court. Credit: NASA/JPL-Caltech (video available at: https://youtu.be/EOZtqcOMx-A)

At the beginning of the Jupiter Orbit Insertion burn, Juno carries about 1,232 kilograms of fuel (810 kilograms of hydrazine and 422 kilograms of oxidizer). At the end of a nominal 35 minutes Jupiter Orbit Insertion burn, Juno will have about 447 kilograms of fuel (241 kilograms of hydrazine and 206 kilograms of oxidizer).

Launch Vehicle

Type: Atlas V551 (Atlas first stage with five solid rocket boosters, Centaur upper stage)

Height with payload: 197 feet (60 meters)

Launch location: Pad SLC-41, Cape Canaveral Air Force Station, Florida

Mass of rocket (with spacecraft) fully fueled: 1,265,255 pounds (573,910 kilograms)

NASA's Juno spacecraft awaits launch from inside the payload fairing atop a United Launch Alliance Atlas V-551 launch vehicle. Image credit: NASA/KSC

Mission Milestones and Distances Traveled

Launch date/time: August 5, 2011, 9:25 a.m. PDT (12:25 p.m. EDT)

Earth–Jupiter distance at time of launch: 445 million miles (716 million kilometers)

Time it took light to travel from Earth to Jupiter on Aug. 5, 2011: 39 minutes, 50 seconds

Earth gravity assist flyby: October 9, 2013

Distance Juno traveled launch to Earth gravity assist: 994 million miles (1,600 million kilometers)

Juno's attitude over Earth's surface at closest point during gravity assist: 311 miles (500 kilometers)

Jupiter arrival: July 4, 2016
The Jupiter Orbit Insertion (JOI) burn begins at 8:18 p.m. PDT (Earth Receive Time). The burn is scheduled to end at 8:53 p.m. PDT (Earth Receive Time)

One-way speed-of-light time from Jupiter to Earth on July 4, 2016: 48 minutes, 19 seconds

Distance of Jupiter to Earth at time of Jupiter orbit insertion: 540 million miles (869 million kilometers)

Total distance traveled, launch to Jupiter orbit insertion: 1,740 million miles (2,800 million kilometers)

End of mission (deorbit): February 20, 2018

Distance traveled in orbit around Jupiter: 348 million miles (560 million kilometers)

Total distance, launch through Jupiter impact: 2,106 million miles (3,390 million kilometers)

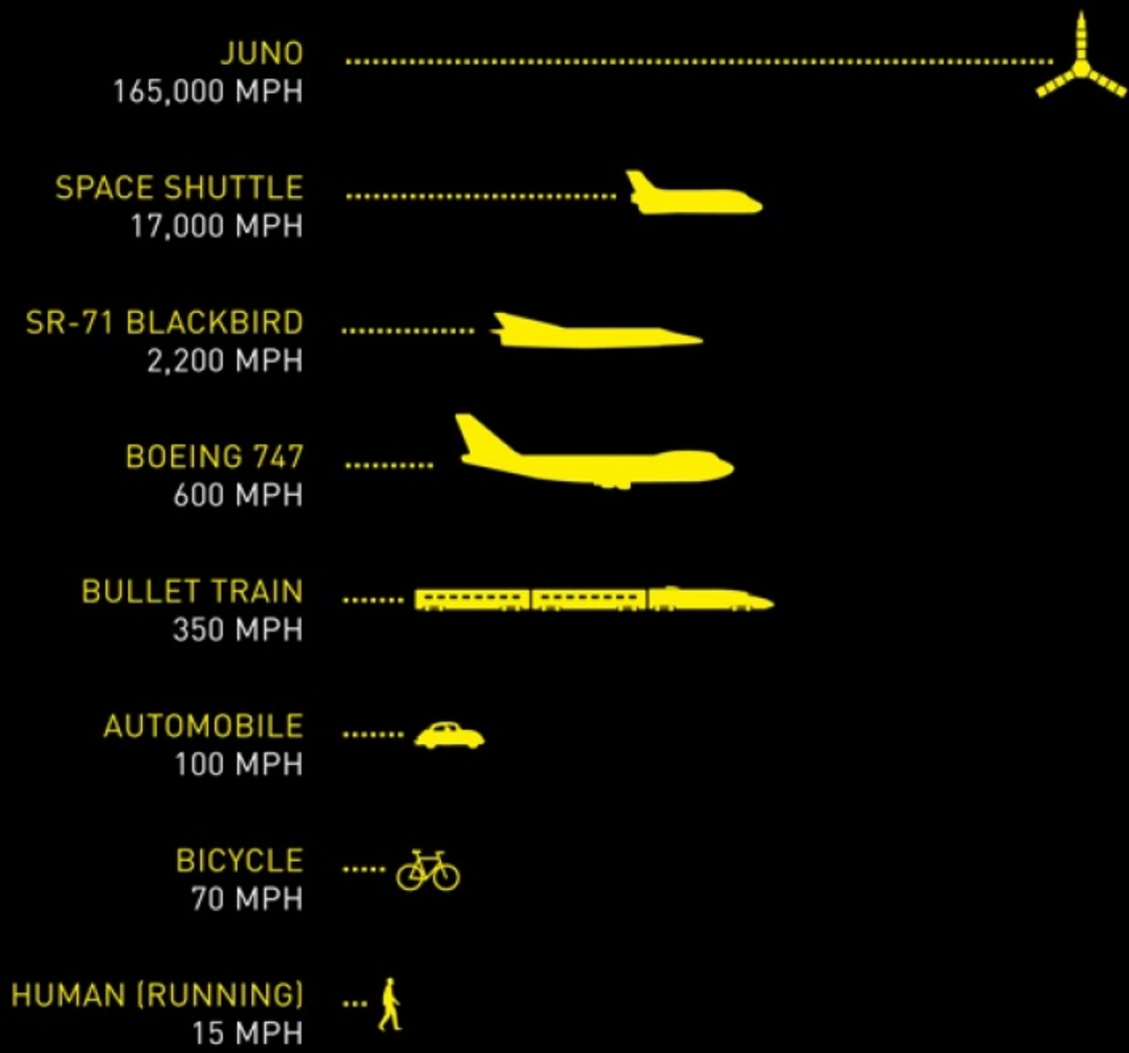
Program

The Juno mission investment is $1.13 billion in total. This cost includes spacecraft development, science instruments, launch services, mission operations, science data processing and relay support for 78 months.

A Mission of Many Firsts:

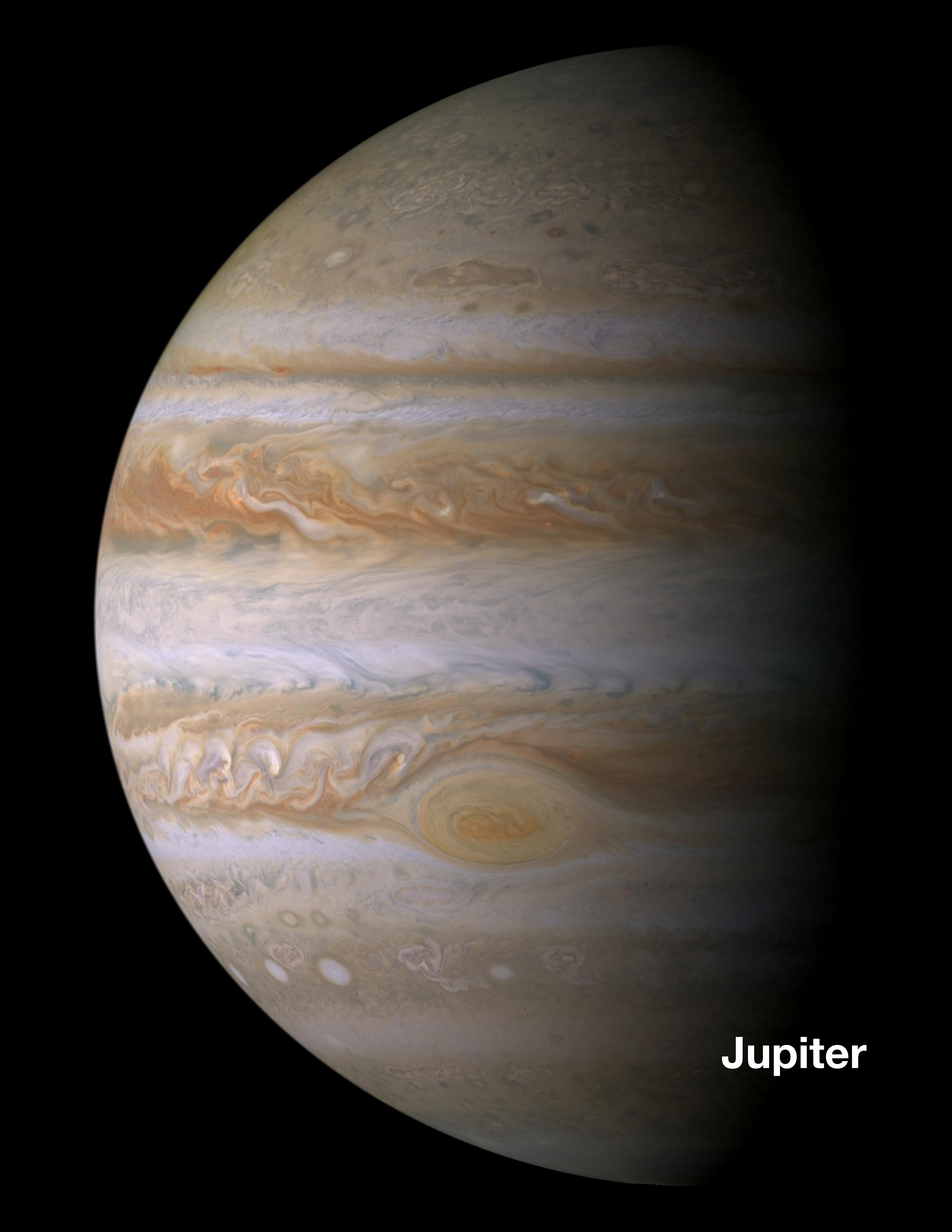
- First space mission to operate a solar-powered spacecraft at Jupiter
- Farthest solar powered spacecraft from Earth
- First space mission to orbit an outer-planet from pole to pole
- First space mission to fly as close as 2,600 miles to Jupiter's cloud tops
- First mission to be designed to operate in the heart of Jupiter's radiation belts
- First mission to carry a titanium radiation vault to protect the spacecraft's most-sensitive instruments from a planet's intense belts of radiation
- First spacecraft to fly 3D-printed titanium parts (Waveguide brackets)
- Will be the fastest spacecraft to enter orbit around a planet, at 130,000 mph (129,518 mph/57.9 km/s) relative to Earth
- Will take the highest-resolution images of Jupiter in history

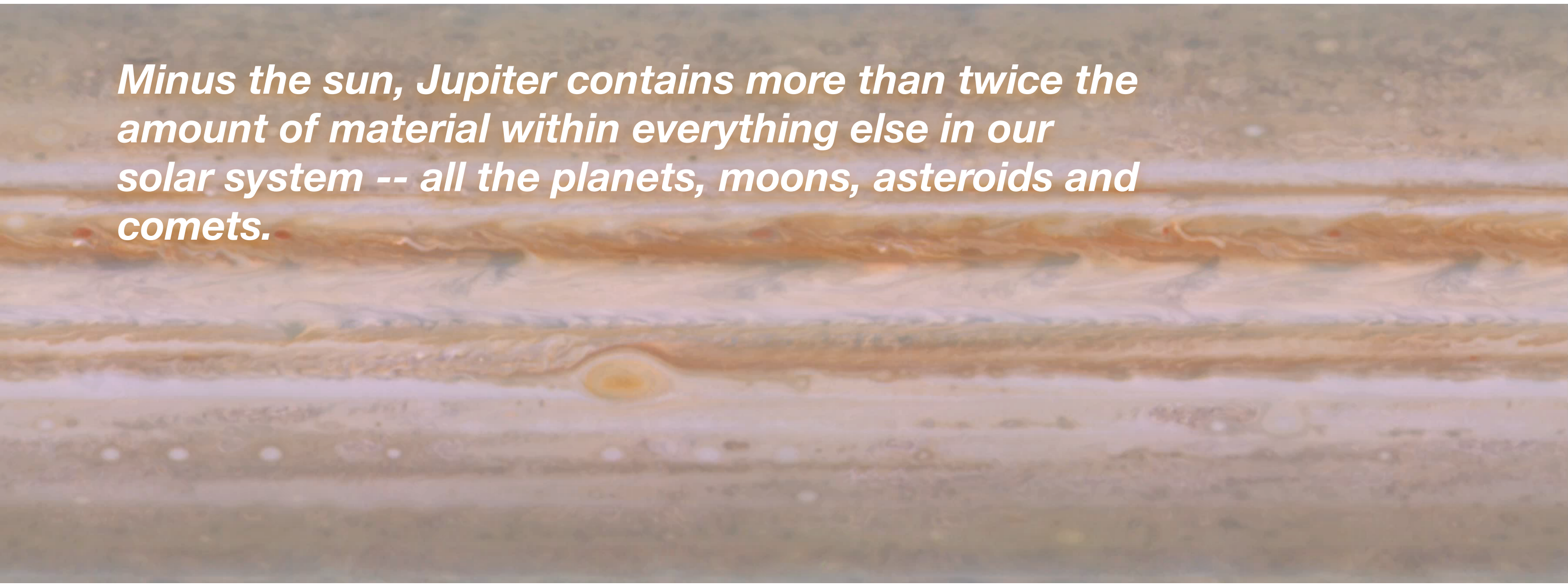
HOW FAST CAN JUNO GO?



When arriving at Jupiter, the planet's gravity pulls in Juno faster and faster until the spacecraft reaches a speed over 250,000 kilometers per hour (150,000 miles per hour) with respect to Earth – making it one of the fastest human-made objects ever. When it arrives at Jupiter, it slams on the brakes, firing its main engine in reverse. After slowing down, Juno can then enter Jupiter orbit.

Juno will cover 2.8 billion kilometers (nearly 1.8 billion miles) during its long, looping voyage. That's 19 times farther than the distance between Earth and the Sun, and 15 times farther than the closest distance between Earth and Jupiter. If Juno were to fly at the speed of a commercial jet, it would take 342 years to complete its journey!


Jupiter



Jupiter is a giant ball of gas 11 times wider than Earth, 300 times more massive than our planet and five times farther from the sun. The giant world takes 12 years to orbit the sun, but rotates so fast that its day is only 10 hours long.

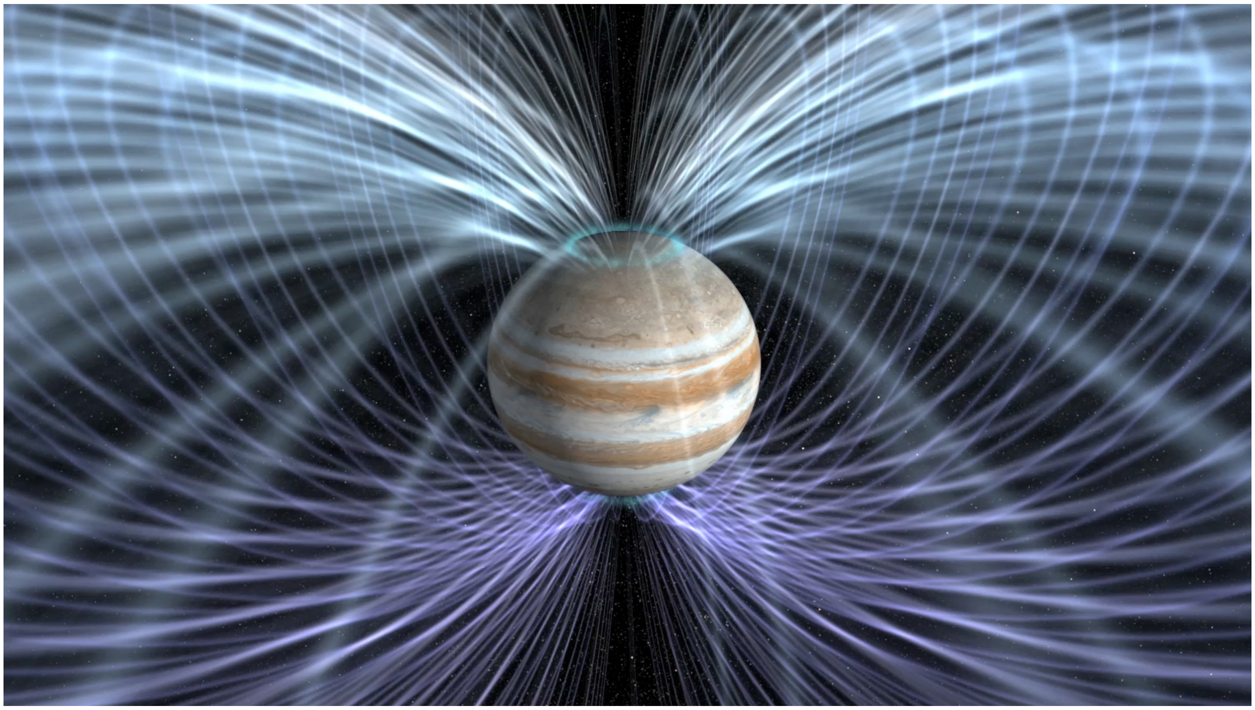
As the most massive world in our solar system, orbited by four large moons and many smaller ones, Jupiter forms its own solar system in miniature. Jupiter resembles a star in composition, and if it had been about 80 times more massive, it would have become a star rather than a planet.

Jupiter's appearance is a tapestry of beautiful colors and swirling atmospheric features. Most of its visible clouds are composed of ammonia and hydrogen sulfide. Water clouds exist deep below and can sometimes be seen through clear spots in the higher cloud layers. Jupiter's "stripes" are created by strong east-west winds in the planet's upper atmosphere. Within these belts and zones are storm systems that can rage for years. The most notable of these long-lived features is the Great Red Spot, a giant, crimson-colored vortex twice as wide as Earth, which has been observed for at least a couple hundred years. In recent years, the Great Red Spot has appeared to be shrinking in its east-west width.

The composition of Jupiter is similar to that of the sun — mostly hydrogen and helium. Its composition and great size imply that it was the first planet to form, incorporating most of the leftover gas not incorporated into the sun.

Deep in the atmosphere, the pressure and temperature increase, compressing the hydrogen gas into a liquid. At depths of about a third of the way down, the hydrogen becomes a liquid that conducts electricity like a metal. Scientists think Jupiter's powerful magnetic field is generated by electrical currents in this giant, swirling ocean of liquid metallic hydrogen, driven by Jupiter's fast rotation. At the planet's center, the temperature is several times hotter than the surface of the sun, and the pressure is tens of millions of times the air pressure on Earth. A dense core of heavy elements, larger than Earth, may exist in this extreme environment.

Jupiter's enormous magnetic field is nearly 20,000 times as powerful as Earth's field. The field dominates a vast area of space called the magnetosphere, where it traps swarms of charged particles -- electrons and ions. Some of these particles become trapped in an intense radiation belt near the planet, creating a hazard for visiting spacecraft. The Jovian magnetosphere has a tadpole shape, ballooning outward 600,000 to 2 million miles (1 to 3 million kilometers) toward the sun and tapering into a long tail that extends more than 600 million miles (1 billion kilometers) outward from Jupiter, to as far as Saturn's orbit.



Artist’s rendering of the invisible lines of Jupiter’s magnetic field. Credit:NASA/JPL-Caltech

Jupiter's magnetic field also channels charged particles into the upper atmosphere near the poles, creating brilliant auroras -- northern and southern lights. Unlike Earth's auroras, which are produced largely through the interaction of our planet's magnetic field and the solar wind, Jupiter's auroras are dominated by the planet's own rotation.

Jupiter has four large moons -- Io, Europa, Ganymede and Callisto -- and more than 60 smaller, confirmed moons. Like the other three giant planets in our solar system, Jupiter also has a system of rings, although they are much fainter than the rings of Saturn. Unlike the icy rings of Saturn, Jupiter's rings are composed largely of dust particles, likely kicked up as micrometeoroids smash into the planet's four small inner moons.

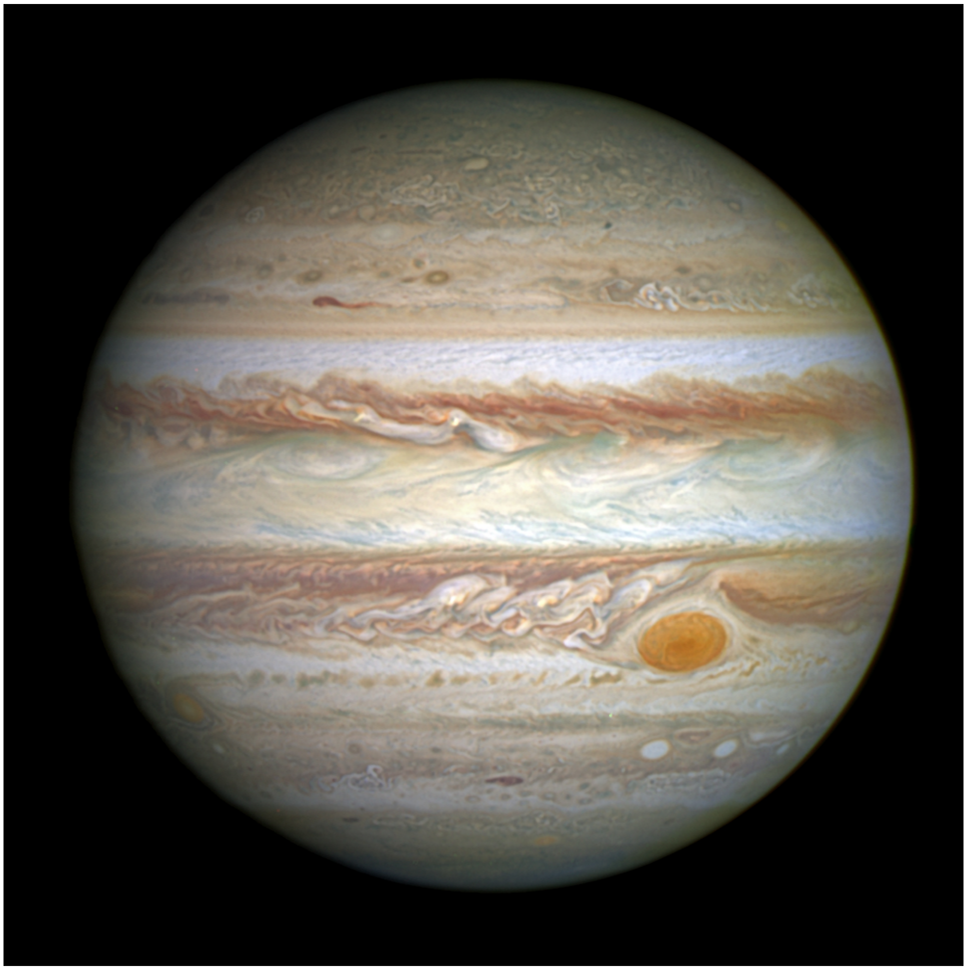


Image of Jupiter taken by the Hubble Space Telescope in 2014. Credit:NASA,ESA, and A.Simon

EXPLORING JUPITER

This timeline explores the key events and discoveries that shaped our understanding of Jupiter over the 400 years since Galileo Galilei's first observations of the gas giant.

2015 Images of Jupiter from Hubble reveal a rare wave not seen since Voyager 2's visit and continued shrinking of the Great Red Spot.

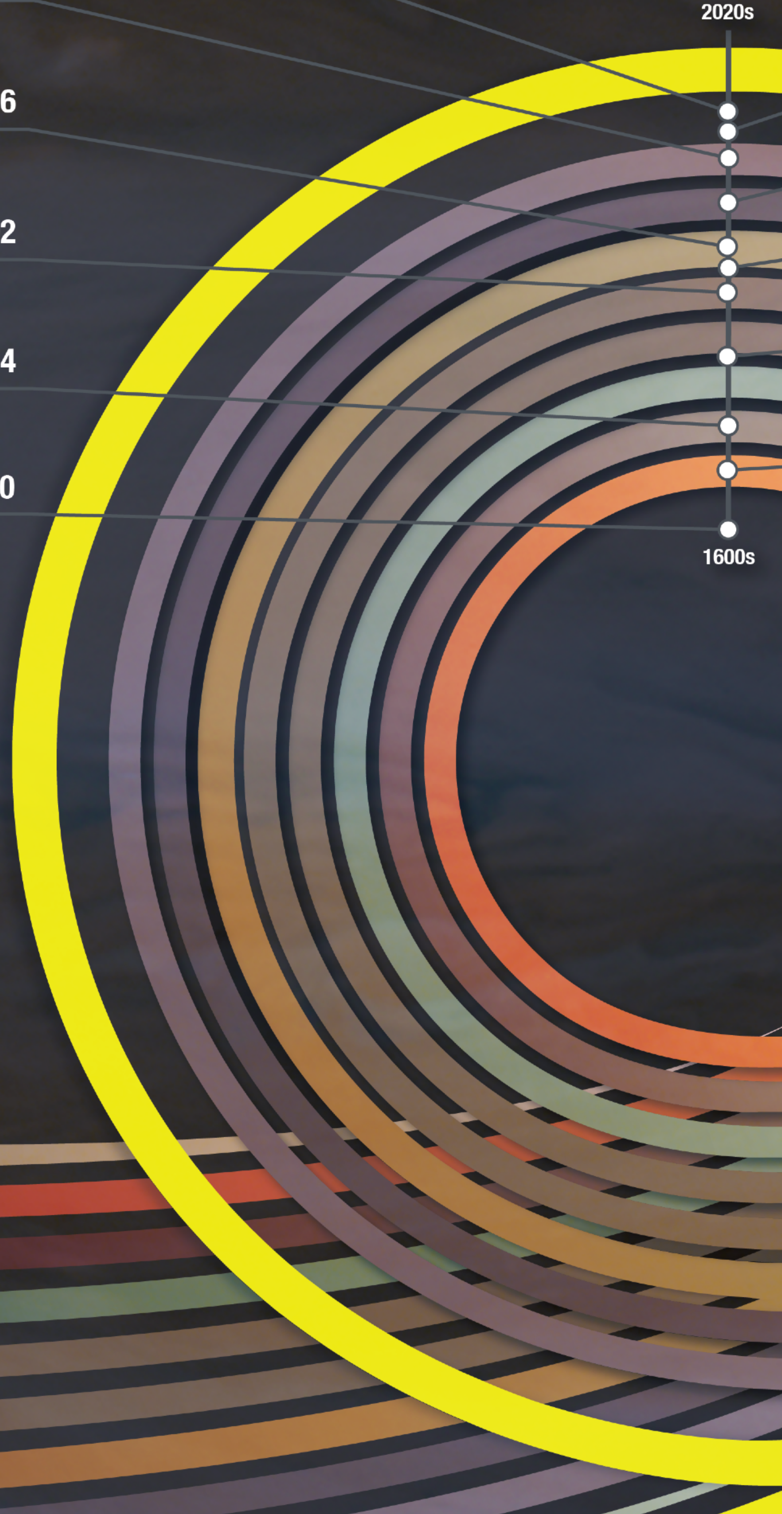
2007 On its way to Pluto, the New Horizons spacecraft flies by Jupiter and captures new perspectives on the planet's clouds and rings.

1996 Galileo measures Jupiter's intense radiation belt while becoming the first spacecraft to orbit the planet and drop a probe below the clouds.

1992 While using Jupiter's gravity to slingshot into its final orbit around the sun, Ulysses collects data about Jupiter's influential magnetic field.

1974 On its way to Saturn, Pioneer 11 flies by Jupiter, getting three times closer than Pioneer 10 and returning the first images of Jupiter's poles.

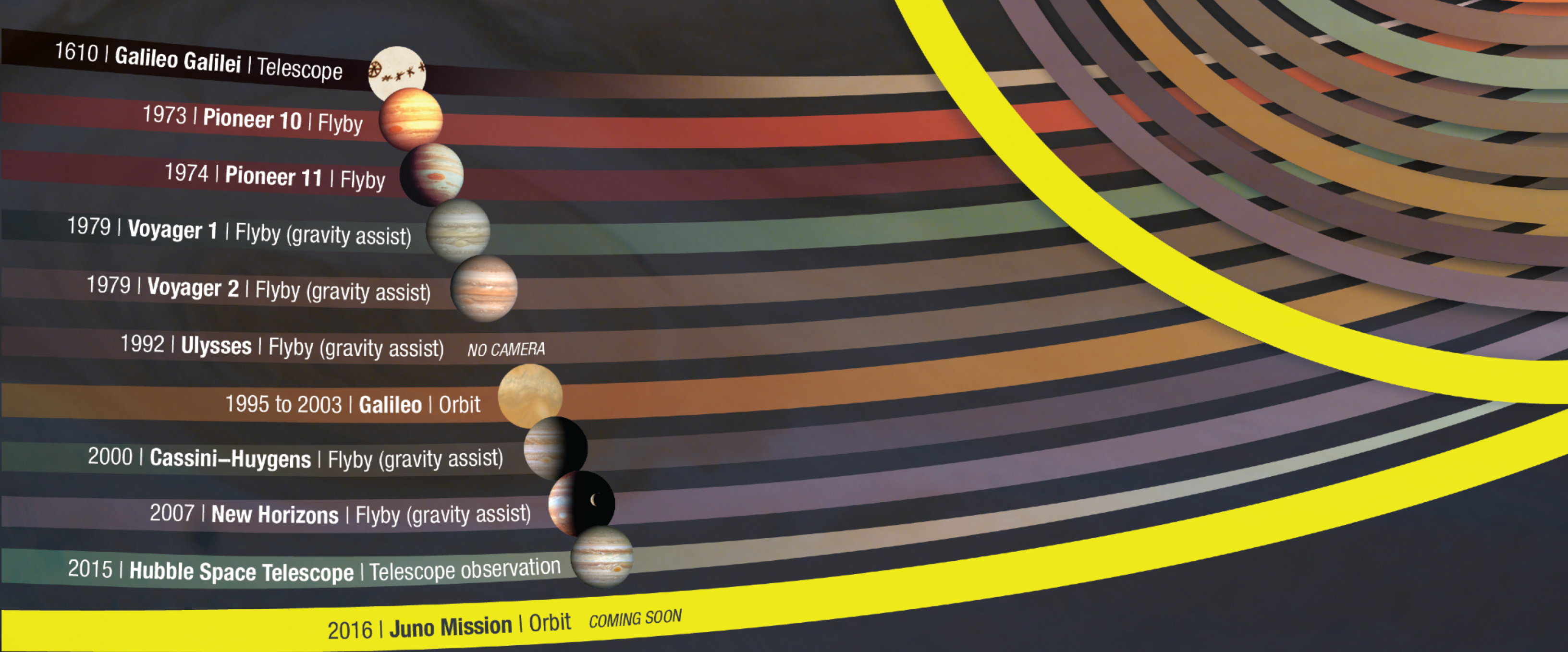
1610 Astronomer Galileo Galilei makes a momentous discovery that challenges the Earth-centric view of the universe: four moons orbiting Jupiter.



VISUALIZING JUPITER

This visualization represents our evolving view of Jupiter. The color spectra are sampled from images taken by the nine spacecraft that visited the gas giant since 1973, as well as the Hubble Space Telescope.

TELESCOPE OBSERVATION FLYBY ORBIT



National Aeronautics and
Space Administration

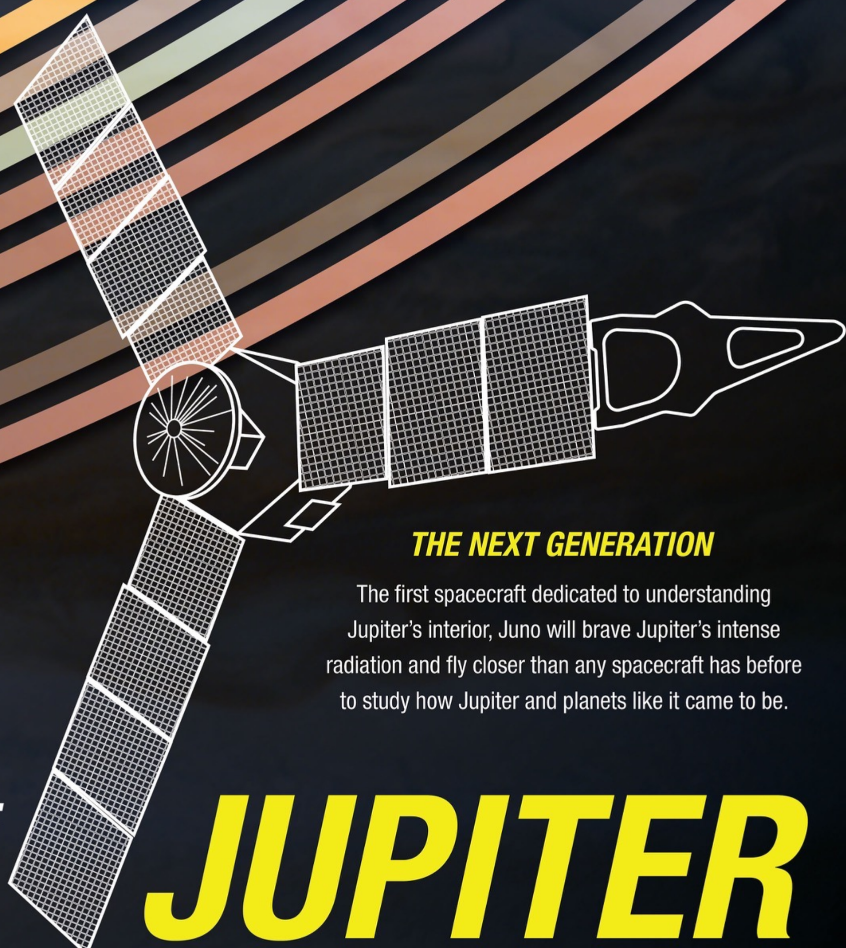
2009 A comet estimated to be as big as several football fields slams into Jupiter, creating a dark bruise on the planet the size of the Pacific Ocean.

2000 The Cassini spacecraft makes new discoveries about the behavior and properties of Jupiter's storms while flying by on its way to Saturn.

1994 The Galileo spacecraft, still on its way to Jupiter, and the Hubble Space Telescope capture the action as pieces of a comet collide with Jupiter.

1979 Voyagers 1 and 2 find faint rings around Jupiter, evolving clouds and storms, plus volcanoes on Io that influence the entire Jovian system.

1973 Pioneer 10 is the first spacecraft to cross the asteroid belt and fly past Jupiter, making the first up-close observations of the gas giant.



THE NEXT GENERATION

The first spacecraft dedicated to understanding Jupiter's interior, Juno will brave Jupiter's intense radiation and fly closer than any spacecraft has before to study how Jupiter and planets like it came to be.

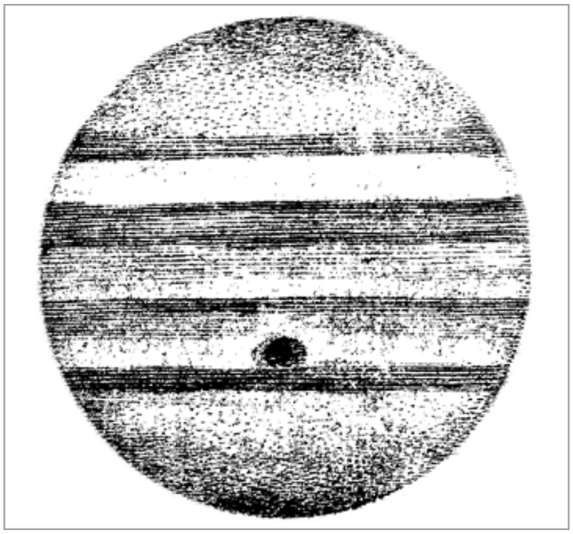
A HISTORY OF EXPLORATION: JUPITER

Observing Jupiter

Jupiter viewing in June and July 2016

During June, look to the western sky after sunset. Jupiter will be visible until midnight. On June 11, Jupiter appears very close to the moon. On July 4, Jupiter appears a little lower in the western sky than in June, and still lower by month's end. On July 9, the moon and Jupiter again appear close to one another.

Jupiter dominates the evening sky January through August this year. Lost from view in September, when it passes behind the sun, it reappears in the morning skies in October 2016. To the naked eye, the planet appears like an extremely bright, unflickering star. Through binoculars or a small telescope, the planet's four large moons and some features in its atmosphere can be glimpsed.



Drawing of Jupiter by Giovanni Cassini.

In 1667, Giovanni Domenico Cassini observed a great spot on Jupiter -- which he called "the Permanent Spot" -- and many cloud bands. Earlier in that century, in 1610, Galileo Galilei observed the planet's four large moons over several weeks, charting their movement around the planet for the first time.

Today's stargazers will be amazed to see these distinct features for themselves, using even the most modest equipment. Jupiter is so bright that it's easily seen from even the brightest city at night. NASA's Night Sky Network can help members of the public find nearby astronomy clubs, and astronomy events are frequently held by local museums, nature centers and university astronomy programs.

Jupiter observing resources:

Night Sky Network http://nightsky.jpl.nasa.gov/

NASA Museum Alliance https://informal.jpl.nasa.gov/museum/Visit

Juno JunoCam Citizen Science program https://www.missionjuno.swri.edu/media-gallery/junocam

What's Up in the Night Sky video series http://solarsystem.nasa.gov/news/category/whatsup

Why Juno?

The primary motivation for the Juno mission is to improve our understanding of the history of our solar system.

Jupiter was likely the first of the planets to form around our sun because it contains a lot of the same light gases that the sun is made of -- hydrogen and helium. After the first few million years in the sun's life, an intense solar wind was generated that blew away most of the light gases remaining from the original stellar nursery. For Jupiter to be primarily composed of hydrogen and helium, it must have formed while there were still a lot of those light gases around -- when the solar system was young.

Artist's rendering of a solar system like our own, early in the process of formation.
Credit: NASA/JPL-Caltech

Since Jupiter is mainly made of the same material as the original solar nebula, the gas giant is thought to hold clues about the solar system's early history. Although people have been studying Jupiter for hundreds of years, many basic questions about the gas giant planet remain.

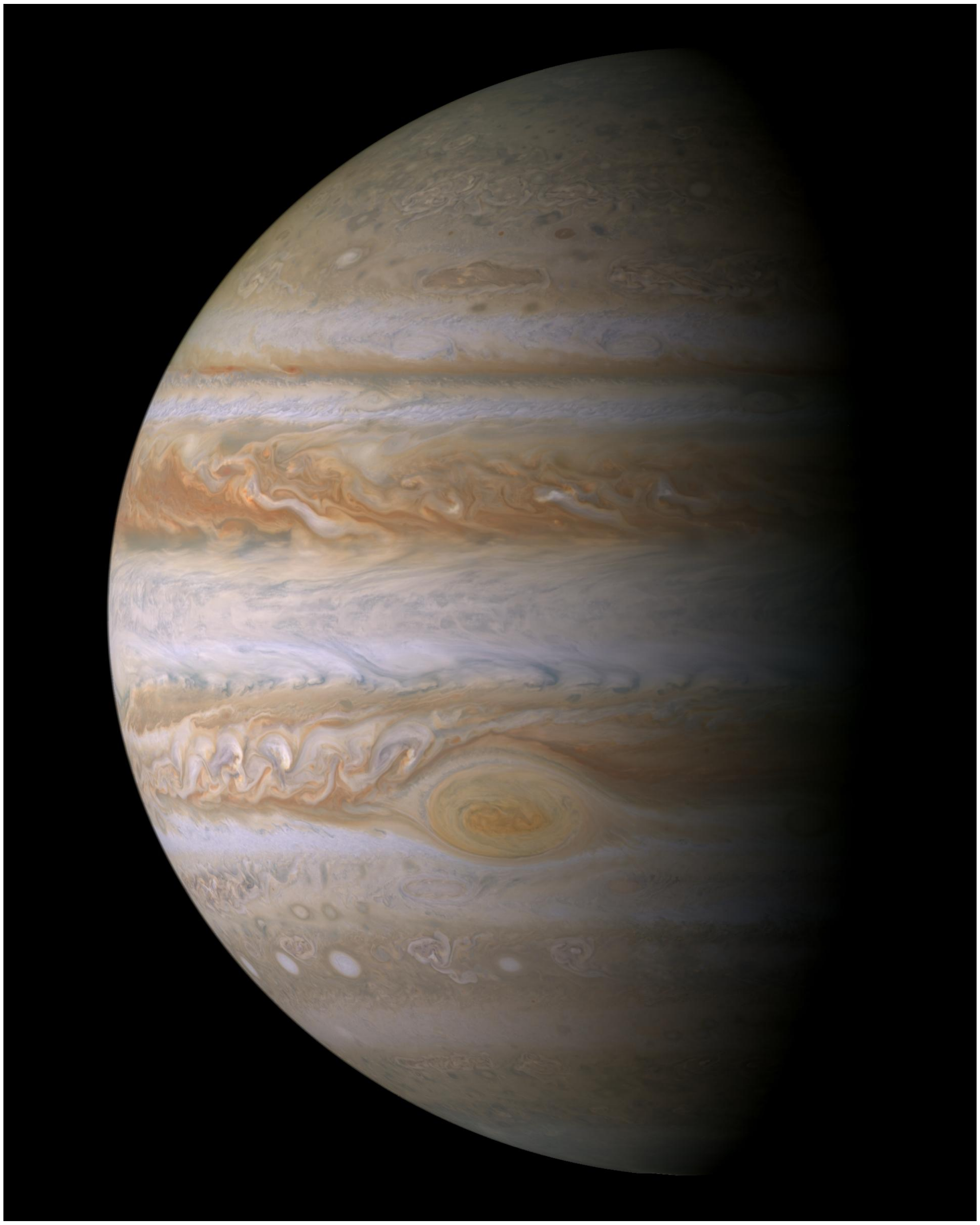
In 1995, NASA's Galileo mission made the voyage to Jupiter. One of its jobs was to drop a probe into Jupiter's atmosphere. The data returned from that probe showed us that Jupiter's composition was different than scientists thought, indicating that our theories of planetary formation were wrong. Even with all the things we learned from Galileo and other studies over the past couple of decades, Jupiter still hides many mysteries beneath its swirling clouds:

- How did Jupiter form?
- How much water (and therefore oxygen) is in Jupiter?
- How is Jupiter arranged on the inside? What is its deep structure?
- Does Jupiter rotate as a solid body, or is the deep interior moving at a different speed than the outside?
- Is there a dense core, and if so, how massive is it?
- How and where is its vast and powerful magnetic field generated?
- How are atmospheric features like the Great Red Spot related to the movement of the deep interior?
- What physical processes power the auroras -- Jupiter's northern and southern lights?
- What do the poles look like up close?

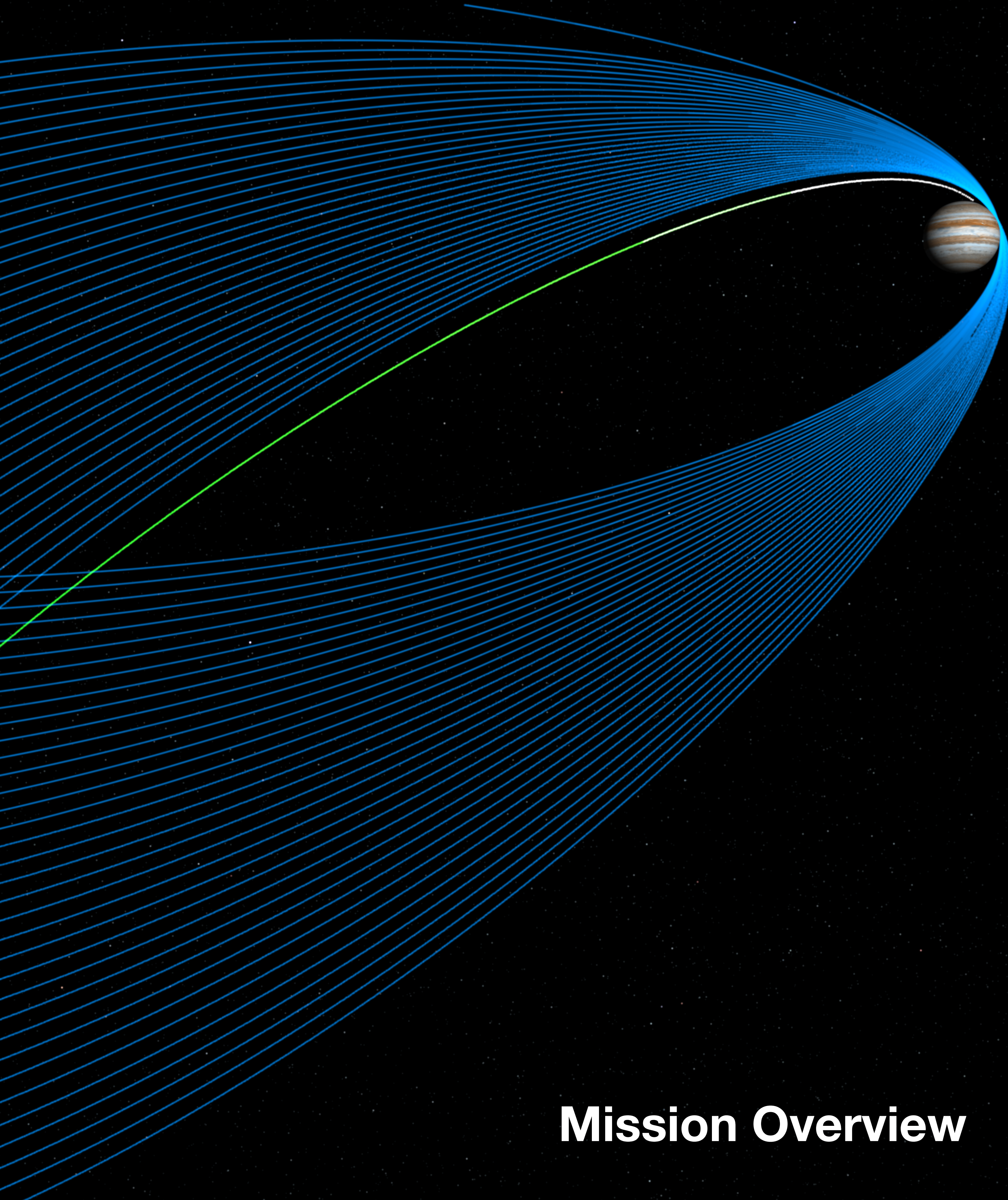
Juno's primary goal is to reveal the story of Jupiter's formation and evolution. The spacecraft will observe the planet's gravity and magnetic fields, atmospheric dynamics and composition, and the complex coupling between the interior, atmosphere and magnetosphere that determines the planet's properties and drives its evolution. In addition to vastly improving our knowledge of Jupiter itself, as the archetype of gas giant planets, Jupiter will provide the knowledge to help us understand the origins of planetary systems around other stars.

Juno's Mythical Connection

In Roman mythology, Jupiter -- king of the gods -- drew a veil of clouds around himself to hide his mischief. It was Jupiter's wife, the goddess Juno, who was able to peer through the clouds and reveal Jupiter's true nature. The Juno spacecraft will look beneath the planet Jupiter's clouds to see what the secretive world is up to….not seeking signs of misbehavior, but helping us understand the gas giant's structure and history.



The largest image mosaic of Jupiter yet produced, from NASA's Cassini spacecraft.
Credit: NASA/JPL-Caltech/Space Science Institute

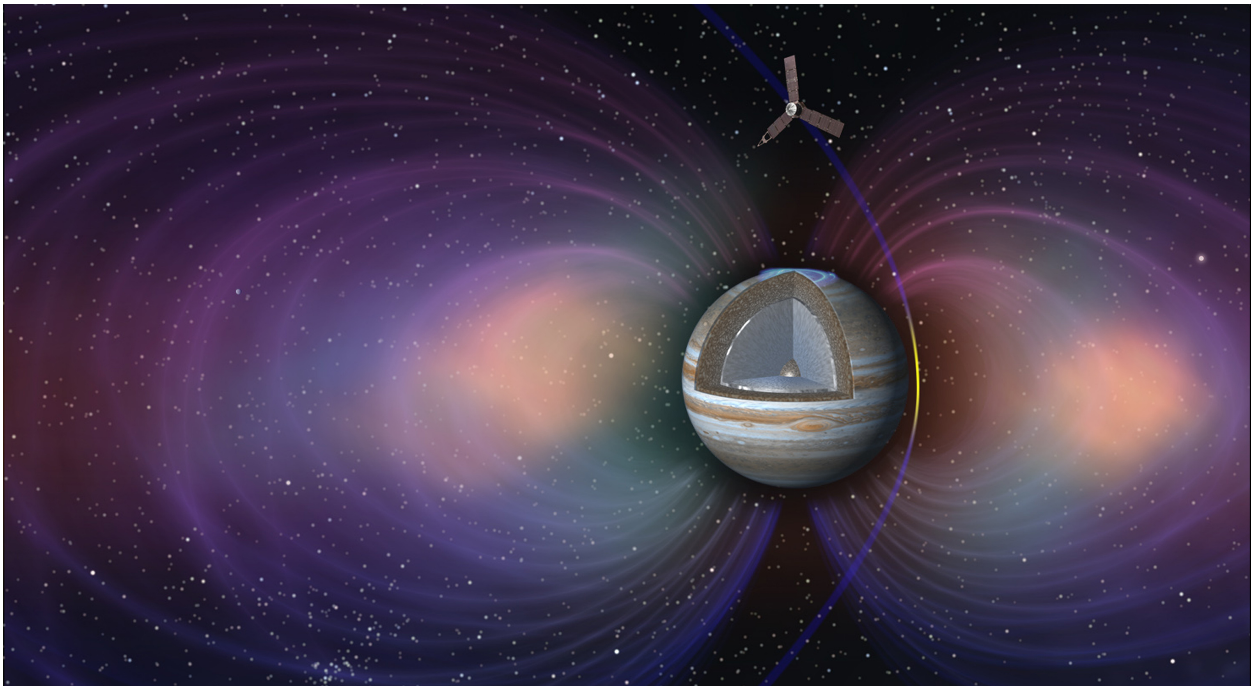


Mission Overview

Mission Overview

The Juno spacecraft launched aboard an Atlas V551 rocket from Cape Canaveral, Florida, on August 5, 2011. It will go into orbit around Jupiter on July 4, 2016.

As of June 16, 2016, the Juno team has executed two deep space maneuvers (using Juno's main engine) and seven trajectory correction maneuvers (which utilized the spacecraft's altitude control system to provide its propulsive thrust). These planned burns refined the spacecraft's trajectory towards Jupiter. An Earth flyby 26 months after launch provided a boost of spacecraft velocity, placing it on a trajectory for Jupiter.



To accomplish its science objectives, Juno will orbit over Jupiter's poles and pass very close to the planet. Juno needs to get extremely close to Jupiter to make the very precise measurements the mission is after. This orbital path carries the spacecraft repeatedly through hazardous radiation belts, while avoiding the most powerful (and hazardous) radiation belts. Jupiter's radiation belts are analogous to Earth's Van Allen belts -- but far more deadly.

The spacecraft will orbit Jupiter 37 times, with de-orbit into Jupiter at the end of the last orbit. During the almost one-and-a-half-year science phase of the mission, the spacecraft will execute a close flyby above the planet's cloud tops every 14 days.

Mission Phases

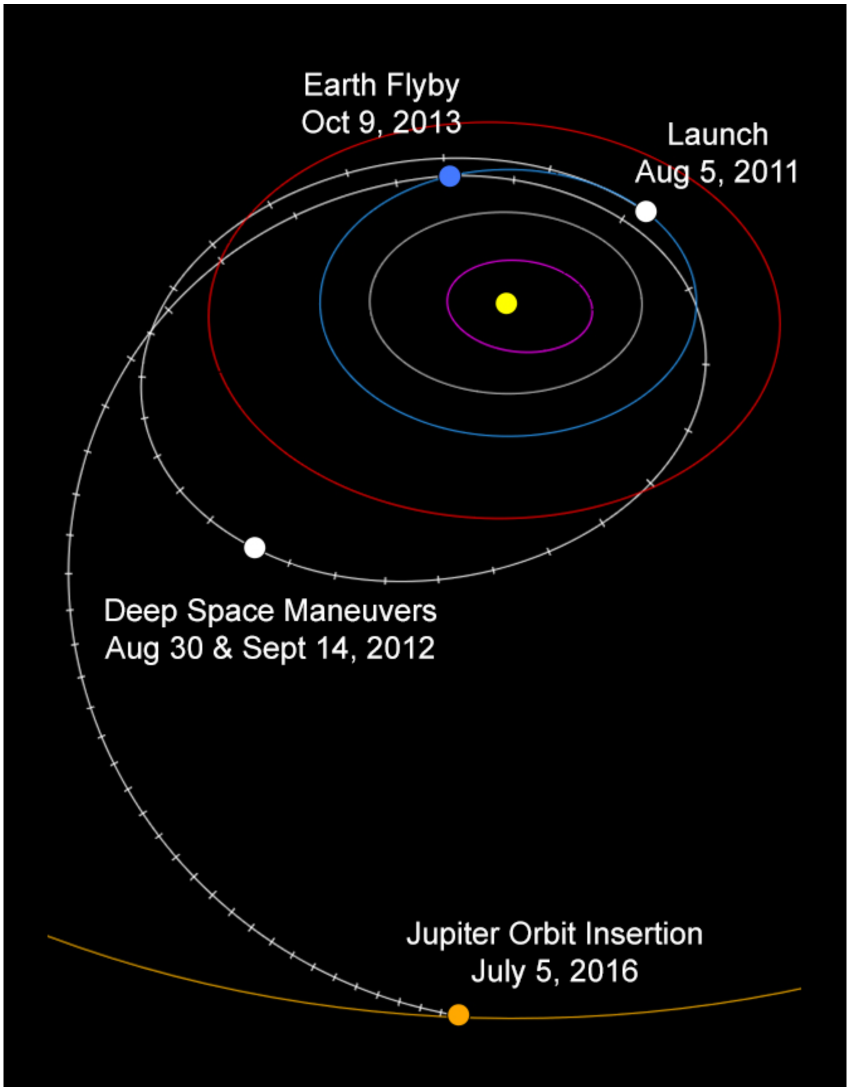
Thirteen mission phases have been defined to describe the different periods of activity during Juno's travels. These phases are: Pre-Launch, Launch, Inner Cruise 1, Inner Cruise 2, Inner Cruise 3, Outer Cruise, Jupiter Approach, Jupiter Orbit Insertion, Capture Orbit, Period Reduction Maneuver, Orbit 2-3, Science Orbits and Deorbit.

Phase 1 - Pre-Launch

The Pre-Launch mission phase lasts from spacecraft power-up at Launch-minus (L-) 3 days to final spacecraft configuration at L-45 minutes.

Phase 2 – Launch

The Atlas V rocket carrying the Juno spacecraft lifted off from Cape Canaveral Air Force Station in Florida on August 5, 2011 at 9:25 a.m. PDT (12:25 p.m. EDT). The Atlas V551 is a two-stage launch vehicle that uses a standard Atlas booster with five solid rocket boosters in the first stage and a Centaur upper stage for the second. The Centaur upper stage had a restartable engine and was three-axis stabilized.



Juno required a gravity assist from Earth in order to reach Jupiter, which necessitated a path that spiraled out beyond Mars and back, before continuing toward its destination. Credit: NASA/JPL-Caltech

Cruise Phases

Juno’s trajectory to Jupiter consists of five phases over five years and one-and-a-half loops of the sun. During cruise, the spacecraft is usually oriented so that its high-gain antenna is Earth-pointed. However, close to the sun there are times where thermal and power requirements did not allow for Earth-pointing of the antenna. At those times, the spacecraft was pointed off-sun in such a way that thermal requirements could be met.

Inner Cruise Phase 1

Transition from the Launch Phase to the Cruise Mission Phase occurred three days after launch. The Inner Cruise 1 phase spanned the interval from L+3 to L+66 days. It was characterized by initial spacecraft and instrument checkouts, deployment of the Waves instrument antenna and Juno’s first trajectory correction maneuver.

Inner Cruise Phase 2

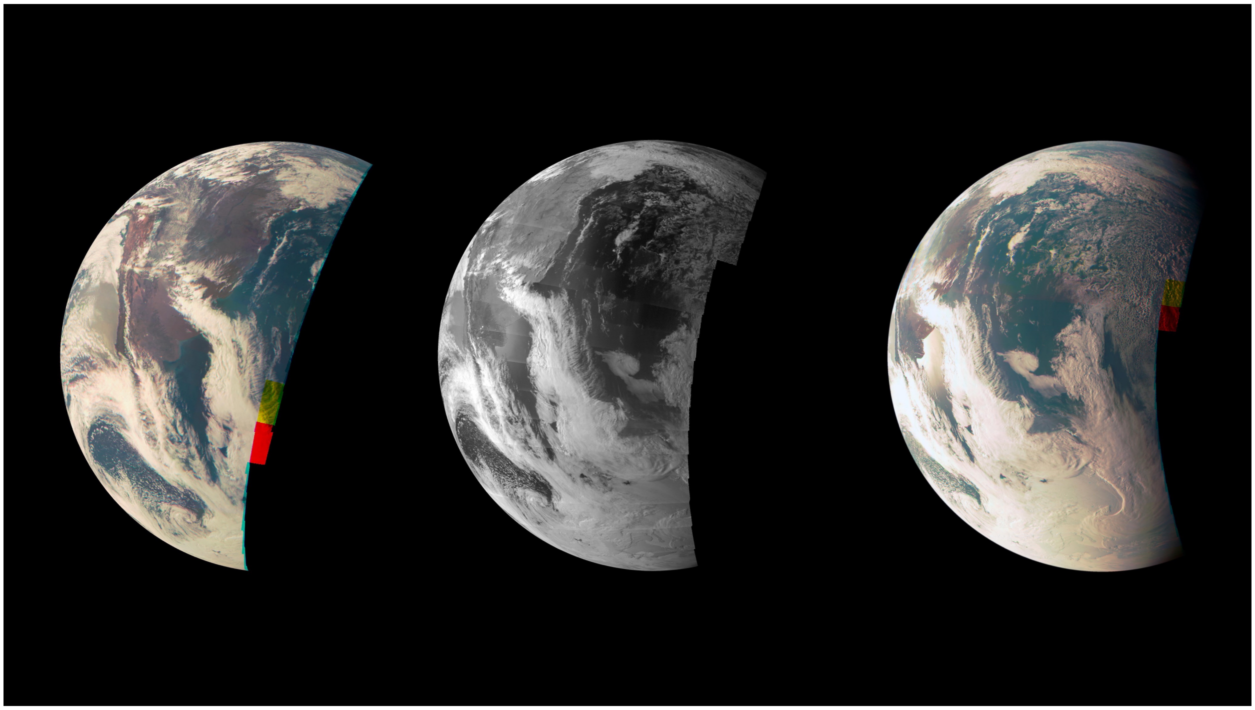
The Inner Cruise 2 phase spanned the period from L+66 days until L+663 days (1.6 years in length). The mission’s two deep space maneuvers occurred during this phase, prior to the spacecraft’s one Earth flyby. The dates for the deep space maneuvers were Aug. 30, 2012, and Sept. 14, 2012. The Deep Space Maneuvers were planned and conducted to minimize the number of first-time events at Jupiter Orbit Insertion. The Deep Space Maneuvers featured the use of the main engine, telemetry downlink (tones) from spacecraft to Earth via toroidal antenna, simultaneous coverage of the burns by two 70-meter antennas of NASA's Deep Space Network, and burns lasting approximately 30 minutes.

Other spacecraft activities during the Inner Cruise 2 phase included calibrations and alignments associated with using the high-gain antenna for the first time. The spacecraft’s science instruments were also checked out again.

Inner Cruise Phase 3

The Inner Cruise 3 phase spans the interval from L+663 days to L+823 days. During this time, the Juno flight team focused on performing the required maneuvers, as well as an integrated operations exercise around Earth flyby.

The Earth flyby occurred as the spacecraft was completing its first elliptical orbit around the sun. It boosted Juno’s velocity by 16,330 mph (about 7.3 kilometers per second), placing the spacecraft on its final trajectory for Jupiter. Closest approach to Earth occurred on Oct. 9, 2013, at an altitude of 310 miles (500 kilometers).



Views of Earth from JunoCam during the Earth flyby gravity assist maneuver in Oct. 2013. Credit: NASA/JPL-Caltech/MSSS

During the flyby, Juno passed behind Earth as seen from the sun, causing an interval when Earth blocked the sun's rays from reaching the spacecraft's solar panels. The time in eclipse was about 19 minutes and represented the only time after Launch Phase when Juno did not receive direct sunlight. Six of Juno's eight instruments collected data during Earth flyby.

Outer Cruise Phase

The Outer Cruise phase took place between L+822 days until the start of Jupiter Approach at six months to Jupiter Orbit Insertion. During the Outer Cruise phase, which lasted for 26 months, the spacecraft steadily increased its distance from the sun. A few months after Earth Flyby, the spacecraft passed the orbit of Mars, then crossed the main asteroid belt, and then started to approach Jupiter's orbit.

Jupiter Approach Phase

The Jupiter Approach phase lasts the final 6 months of cruise before Jupiter Orbit Insertion and is an opportunity for final checkouts of the spacecraft's flight systems and instruments, as well as the commencement of some limited science observations of the planet. At the beginning of this phase, the project increased its staffing in preparation for Jupiter Orbit Insertion and more than a year of science orbits. The Approach Phase ends four days prior to Jupiter Orbit Insertion (June 30), which is the start of the critical sequence that will result in the spacecraft orbiting Jupiter.

Spacecraft activities during the Jupiter Approach phase include spacecraft subsystem calibrations and maintenance activities, as well as flight software updates and hardware checks in preparation for Jupiter Orbit Insertion. There was also an emphasis on satisfying navigation requirements for trajectory correction maneuvers on the way to Jupiter Orbit Insertion, as well as preparing the Flight System for orbit insertion shortly after the end of this phase.

Calibrations and science observations performed during this phase will help validate instrument performance in the Jupiter environment, testing the data processing pipeline, and preparing the Juno team for successfully returning Jupiter science data once it begins its science mission in Orbit 3.

Jupiter Orbit Insertion Phase

The Jupiter Orbit Insertion Phase encompasses the critical sequence of activities that will result in Juno obtaining orbit around Jupiter.

The Jupiter Orbit Insertion Phase begins 4 days before the start of the orbit insertion maneuver and ends about 2.5 hours after the start of the insertion maneuver. The burn (insertion maneuver) occurs at the spacecraft's closest approach to Jupiter, and slows it enough to be captured by the giant planet's gravity into a 53.5-day orbit. The spacecraft saves fuel by executing a burn that places Juno in a capture orbit with a 53.5-day orbit instead of going directly for the 14-day orbit that will occur during the mission's primary science collection period. Deep Space Network coverage is continuous during this phase.

Jupiter Orbit Insertion is a critical event and is performed as part of a critical sequence. If the Jupiter Orbit Insertion burn fails to insert the spacecraft into orbit around Jupiter, there will be no science mission. To increase the probability that the burn will take place as planned, certain features of the onboard computer's fault protection will be disabled. This decreases the probability that a computer restart or other anomaly could occur during the sequence, interrupting the critical main engine burn. In the event of such an interruption, the sequence is designed such that the spacecraft will quickly reboot and re-start the sequence in order to continue with a successful Jupiter Orbit Insertion burn.

Jupiter Orbit Insertion Timeline

Time relative to beginning of JOI burn	Activity
-14 days	Open main engine cover; Main engine auto-restart enabled
-7 days	Open main engine propellant valves
-6 days	Pressurize propulsion system
-5 days	Science instruments turned off
-4 days	Spacecraft computer begins running JOI command sequence
-125 minutes	Begin transmitting tones; Switch telecom to Medium Gain Antenna
-122 minutes	Begin slow, first turn of 15 degrees away from the sun, toward the JOI attitude
-50 minutes	Begin fast, large turn to JOI attitude
-37 minutes	Switch to Toroidal Low Gain Antenna
-33 minutes	Begin "nutation damping" activity to remove remaining wobble
-28 minutes	Begin fine-tune adjustment of the JOI attitude
-22 minutes	Begin approx. 5-minute spin-up from 2 RPM to 5 RPM
0	Start 35-minute main engine burn
+35 minutes	Close propulsion pressurant valves
+37 minutes	Begin approx. 5-minute spin-down from 5 RPM to 2 RPM; (Items below may begin earlier, if the spin down and/or turn complete sooner)
+49 minutes	Begin turn to sun-pointed attitude
+53 minutes	Switch telecom to Medium Gain Antenna (tones no longer received)
+58 minutes	Begin transmitting telemetry (team expects it will take 20 minutes or more to lock onto Juno's telemetry signal)

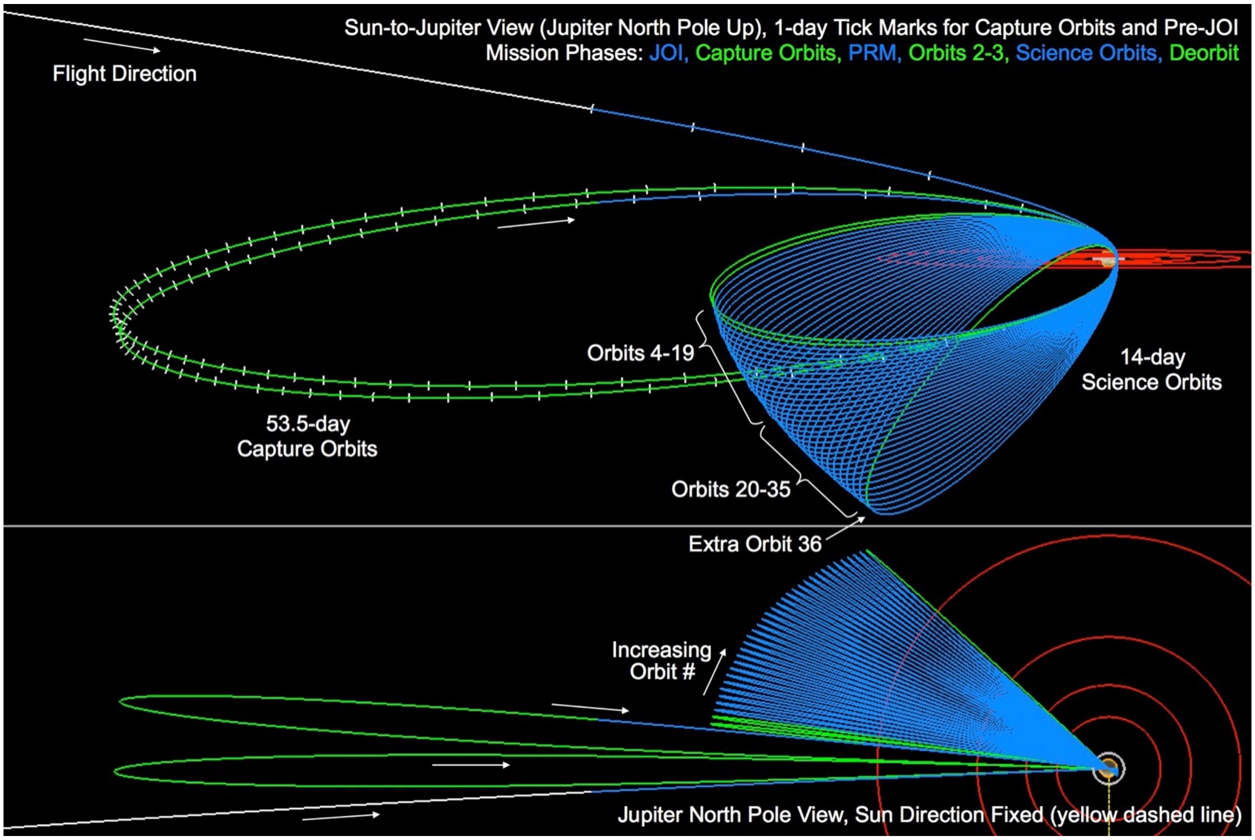
Jupiter Orbit Insertion is performed on the main engine (the third large main engine burn of the mission). Thirty-five minutes in length, the burn will impart a mean change in velocity of 1,212 mph (542 meters a second) on the spacecraft. The burn is performed in view of Earth, allowing its progress to be monitored by the mission teams at NASA JPL and Lockheed Martin Space Systems via signal reception by 70-meter Deep Space Network antennas in Goldstone, California, and Canberra, Australia (arrayed with 34-meter antennas in the same locations). The total time off sun-point (where Juno's solar panels are pointed directly into sun) is 103 minutes.

Juno fires its main engine during orbit insertion. Credit: NASA/JPL-Caltech

No science observations are planned during the Jupiter Orbit Insertion burn due to the criticality of the event (all instruments are off). All science instruments will be off from about Jupiter Orbit Insertion minus 5 days to Jupiter Orbit Insertion plus 50 hours.

Capture Orbit Phase

The Capture Orbit phase starts at Jupiter Orbit Insertion plus 2.5 hours and ends October 14 -- five days before the Period Reduction Maneuver, which will place Juno in its 14-day science orbit around Jupiter. All science instruments are expected to be turned on at some point in the Capture Orbit Phase. Calibrations and science observations performed during this phase will help



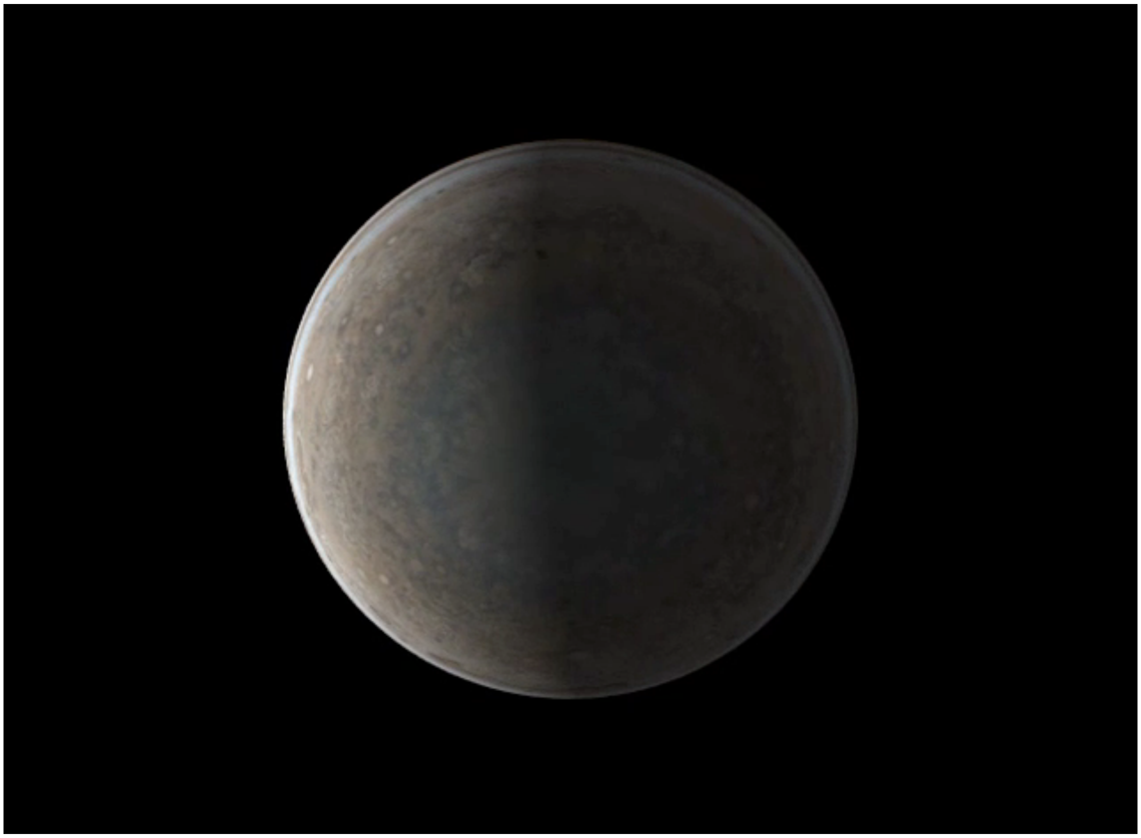
validate instrument performance in the Jupiter environment, test the data processing pipeline, and prepare the Juno team to successfully acquire Jupiter science data during the first planned science orbit -- Orbit 3.

Using the spacecraft's attitude control system, the mission will execute a short "cleanup maneuver" during the Capture Orbit Phase. This short rocket burn is designed to refine the spacecraft's trajectory around the planet without affecting its 53.5-day orbital period.

Period Reduction Maneuver Phase

During the Period Reduction Maneuver phase, Juno transitions from an orbit that takes 53.5 days to circumnavigate Jupiter to one that takes only 14 days. The phase starts 5.25 days before the maneuver and concludes 50 hours after the maneuver is complete. At about 22 minutes in length, this is the shortest (and last) burn scheduled for Juno's main engine.

Three science instruments are scheduled to be on during the Period Reduction Maneuver Phase to explore unique scientific opportunities. The Microwave Radiometer instrument will take advantage of the unique attitude and spin rate that occurs during the Period Reduction Maneuver to scan across Jupiter longitudes at a high rate. Juno's Advanced Stellar Compass instrument will also exploit a unique opportunity for imaging Jupiter's north polar region and darkened hemisphere at low light levels and high time resolution. Juno's Flux Gate Magnetometer can take additional science data that will be useful in constructing the global magnetic field map, potentially filling in holes that could occur later in the mission.



This animation simulates Juno's view of Jupiter over one of its science orbits, which take two weeks apiece. (The apparent speed of the video slows during closest approach to Jupiter.) Credit: NASA/JPL-Caltech (Video available at https://youtu.be/UZ_2DqtO-ik and http://www.jpl.nasa.gov/video/details.php?id=1011)

Apojoves and Perijoves and Orbit Numbering

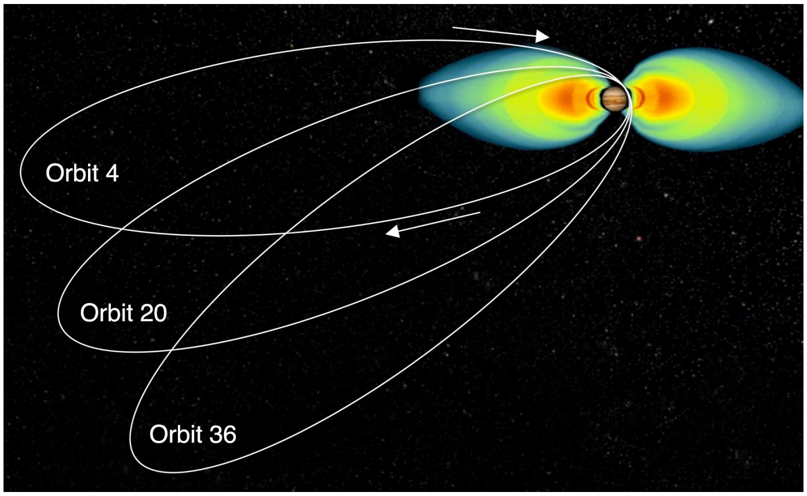
'Perijove' is defined as the point in a spacecraft's orbit where the spacecraft is closest to Jupiter. An 'apojove' is exactly the opposite -- it is the location in a spacecraft's orbit where the spacecraft is farthest from Jupiter. The Juno mission team begins marking perijoves and apojoves with its first close encounter with the planet on July 4 – 'Perijove 0.'

Now about counting the mission's orbits. Juno's 'Orbit 0' starts with its first perijove (again at the moment of closest approach to the planet during Jupiter Orbit Insertion -- July 4). 'Apojove 0' occurs on July 27 -- when Juno for the first time reaches its most distant point in its orbit from Jupiter. At the moment Juno reaches this first apojove, Juno is considered to be entering 'Orbit 1.' Everything that occurs between Apojove 0 and Apojove 1 is part of Orbit 1. Later, when Juno reaches apojove again, it will begin Orbit 2 -- and so on.

Orbits 2-3 Phase

The Orbits 2-3 Phase starts 50 hours after the October 19 scheduled Period Reduction Maneuver burn. This phase ends one day before Perijove 4. The Orbits 2-3 phase includes most of the last half of Orbit 2 and all of Orbit 3. Instrument checkouts and science observations are planned during this phase.

Science Orbits Phase



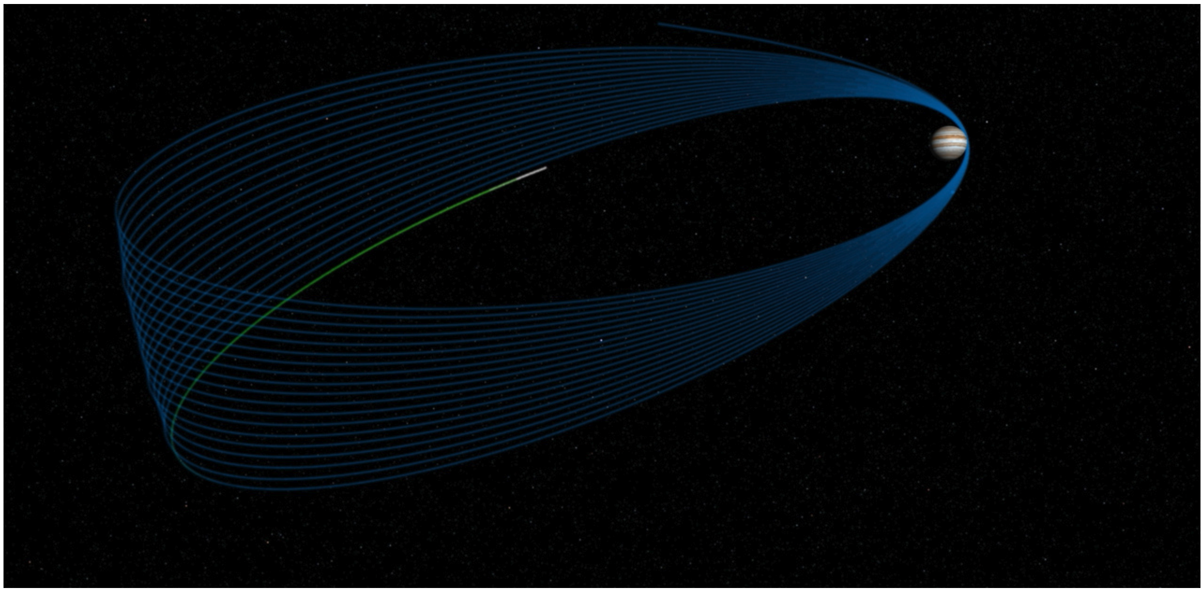
The tilt of Juno's orbit relative to Jupiter changes over the course of the mission, sending the spacecraft increasingly deeper into the planet's intense radiation belts. Credit: NASA/JPL-Caltech

The Science Orbit Phase goes from Orbit 4 to Orbit 36. During the phase, the bulk of the science collection for the mission occurs. Small orbit trim maneuvers (each less than 18 mph, 8 meters per second) are planned about four hours after each perijove pass. These orbit trim maneuvers are required so that Juno will achieve the correct longitudinal track over Jupiter during its next perijove pass. This phase also includes one spare orbit (37).

Juno’s Highly Elliptical Polar Orbits

For many of the instruments to do their job, the spacecraft has to get closer to Jupiter than any previous mission. To avoid the highest levels of radiation in the belts surrounding Jupiter, mission navigators have designed a highly elongated orbit that approaches the gas giant from the north. Flying from north to south, the spacecraft’s point of closest approach above the cloud tops varies with each flyby -- coming as close as about 2,600 miles (4,200 kilometers) and as far out as 4,900 miles (7,900 kilometers). As Juno exits over the south pole, its orbit carries it far beyond even the orbit of the Jovian moon Callisto.

Orbiting Jupiter around the poles carries Juno repeatedly over every latitude. As the planet rotates beneath the spacecraft, the entire surface can be covered by Juno’s suite of instruments. Each orbit of Jupiter is about 50 minutes less than about 14 days long on average (or 13.965 days long). This orbit allows Juno to be viewable at every perijove from NASA’s Deep Space Network antennas at Goldstone. This orbit, along with Jupiter’s rotation period of about 9.925-hours, also allows even coverage of Jupiter by Juno’s instruments over the mission’s 32 science orbits.



Artist's rendering illustrating Juno’s elliptical orbit. Image credit: NASA/JPL-Caltech (video available at: https://youtu.be/3liQOvj8LPE)

Juno’s elliptical orbit around Jupiter has another benefit. It allows the spacecraft’s three massive solar panels to be constantly bathed in sunlight. This is important because the amount of sunlight that reaches Jupiter is only 1/25th that which reaches Earth. To keep the spacecraft’s instruments and operating systems powered requires the solar panels to have an almost constant exposure to the available sunlight.

MWR Science Orbits vs. Gravity Science Orbits

All of Juno's science instruments will be on during all 32 science orbits. However, all Juno science orbits are not created equal. Some orbits will find Juno flying past the planet in an orientation that best highlights Juno's Microwave Radiometer (MWR) instrument. Other orbits have Juno flying past Jupiter in an orientation that favors Juno's gravity science (GRAV) experiment.

During an MWR orbit, Juno's Infrared imager/spectrometer (JIRAM) and JunoCam will be collecting their best data of the mission because during those orbits, the spacecraft spin axis is oriented to get the best view of the planet directly below (nadir). The gravity science experiment during MWR orbits will still operate, although only with the X-Band instrument. The Ka-band Translator (KaT) that is part of the gravity experiment is turned off during MWR orbits because it requires the spacecraft to be in an Earth-pointed orientation.

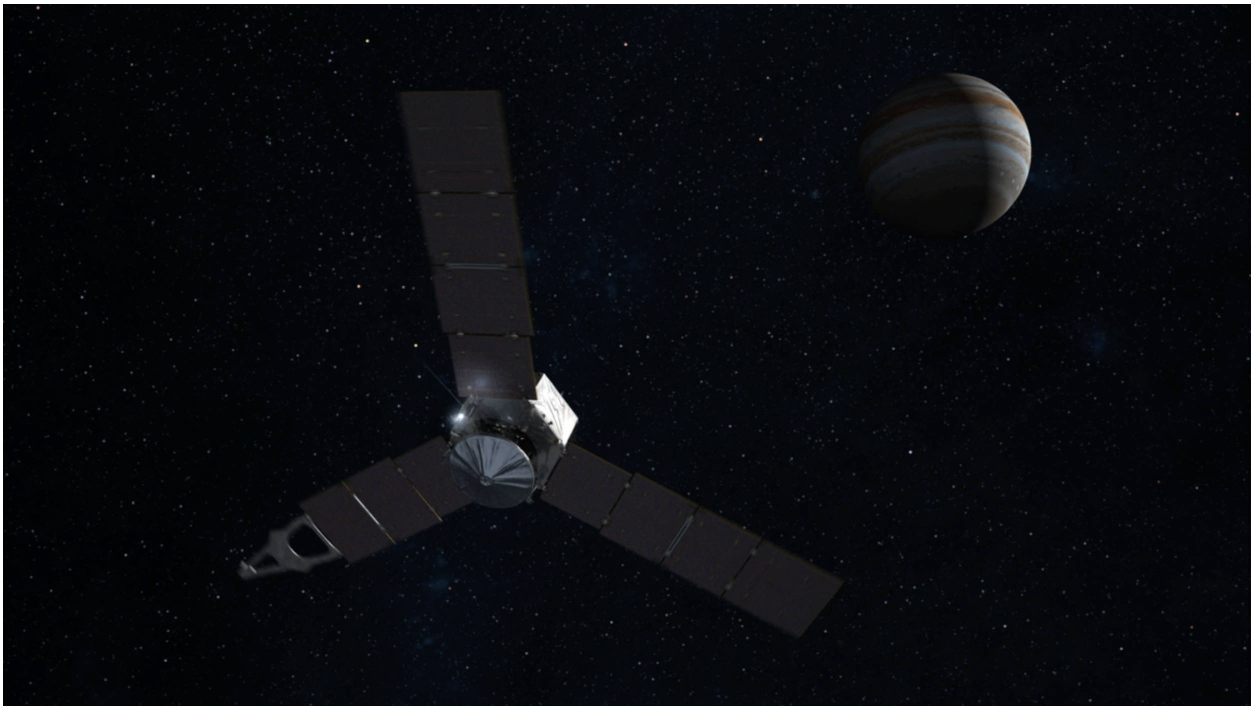
During orbits that highlight gravity experiments (GRAV), Juno is in an Earth-pointed orientation that allows the Ka-Band Translator to downlink data in real-time to Earth. However, this Earth-pointed orientation reduces the quantity of MWR, JIRAM and JunoCam data collection.

Deorbit Phase

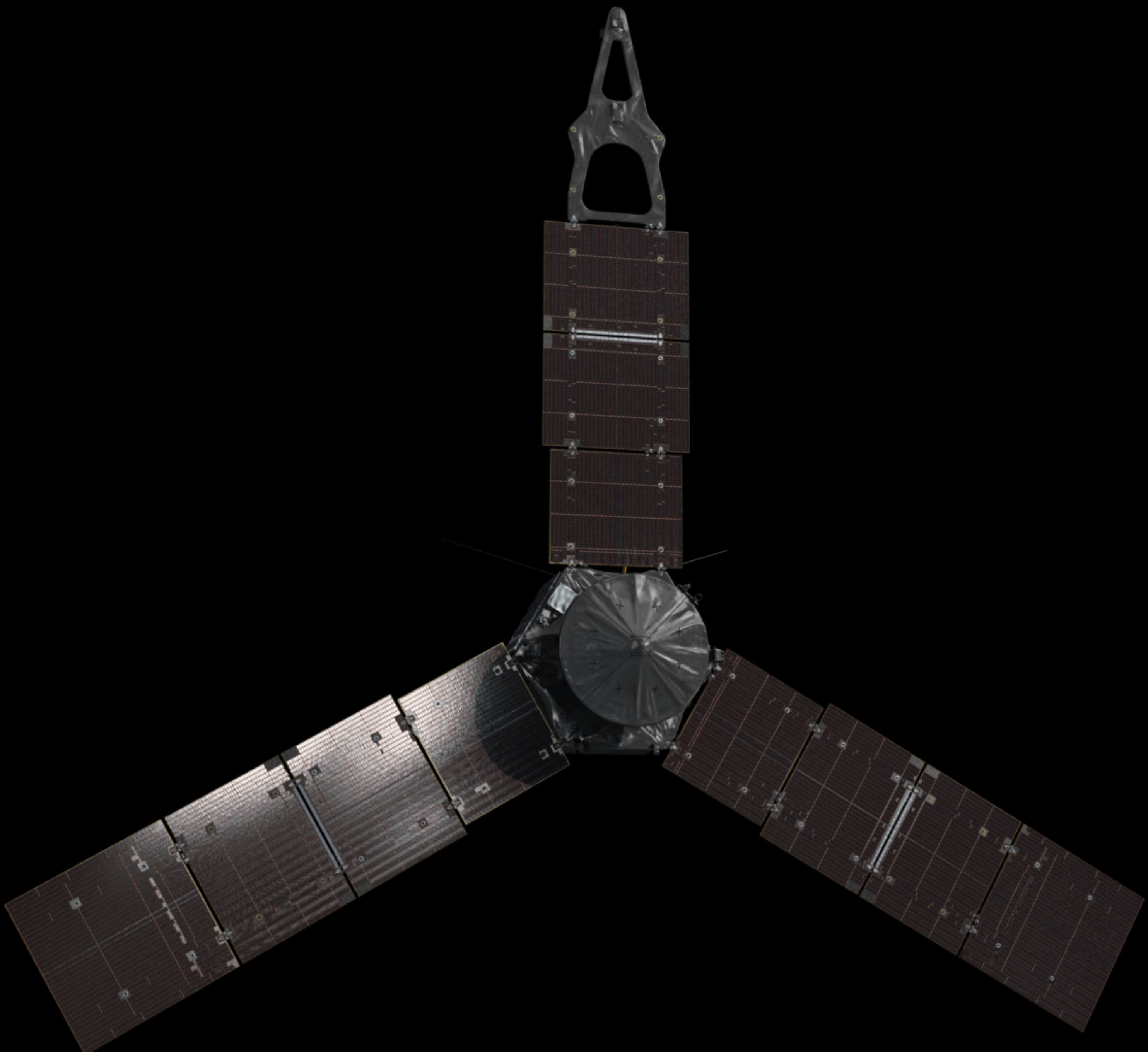
The final mission phase is the Deorbit phase, which occurs during the final orbit of the mission. The 5.5-day phase starts several days after the Orbit 37 science pass. It ends with Juno's impact into Jupiter.

The deorbit maneuver was designed to satisfy NASA's planetary protection requirements and ensure that Juno does not impact the Jovian moons Europa, Ganymede and Callisto.

By orbit 37, a deorbit burn will be executed, placing the spacecraft on a trajectory that will reset its point of closest approach to the planet to an altitude that is below the cloud tops at 34 degrees North Jupiter latitude on February 20, 2018. Juno is not designed to operate inside an atmosphere and will burn up.



This artist's rendering shows NASA's Juno spacecraft initiating a deorbit burn. Image credit: NASA/JPL-Caltech

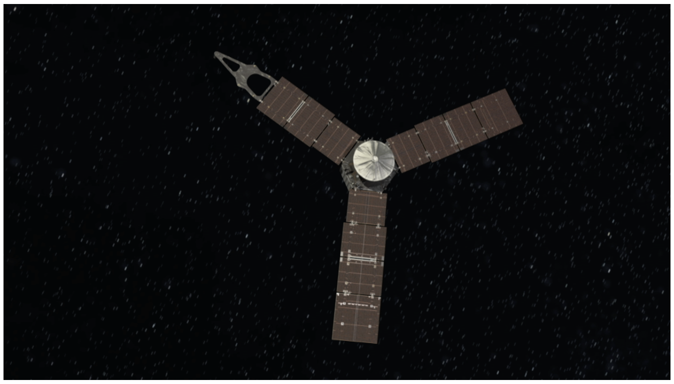


Spacecraft

Spacecraft

Juno uses a spinning, solar-powered spacecraft in a highly elliptical polar orbit that avoids most of Jupiter's high-radiation regions. The designs of the individual instruments are straightforward, and the mission did not require the development of any new technologies.

Why A Rotating Spacecraft



This artist's rendering shows the Juno spacecraft rotating as it orbits. Image credit: NASA/JPL-Caltech (video available at: https://youtu.be/dKP28_VgMtU)

For Juno, like NASA's earlier Pioneer spacecraft, spinning makes the spacecraft's pointing extremely stable and easy to control. Just after launch, and before its solar arrays are deployed, Juno will be spun up by rocket motors on its still-attached second-stage rocket booster. Juno's planned spin rate varies during the mission: 1 RPM for cruise, 2 RPM for science operations, and 5 RPM for main engine maneuvers.

To simplify and decrease weight, all instruments are fixed. While in orbit at Jupiter, the spinning spacecraft will sweep the fields of view of its instruments through space once for each rotation. At two rotations per minute, the instruments' fields of view sweep across Jupiter about 240 times in the two hours it takes Juno to fly from pole to pole.

Structure

The spacecraft's main body measures 11.5 feet (3.5 meters) tall and 11.5 feet in diameter.

The spacecraft's hexagonal two-deck structure uses composite panel and clip construction for decks, central cylinder and gusset panels. Polar mounted off-center spherical tanks provide spinning spacecraft designs with high stability.

Propulsion System

For weight savings and redundancy, Juno uses a dual-mode propulsion subsystem, with a bi-propellant main engine and mono-propellant reaction control system thrusters.

The Leros-1b main engine is a 645-Newton bi-propellant thruster using hydrazine–nitrogen tetroxide. Its engine bell is enclosed in a micrometeoroid shield that opens for engine burns. The engine is fixed to the spacecraft body firing aft and is used for major maneuvers and flushing burns.

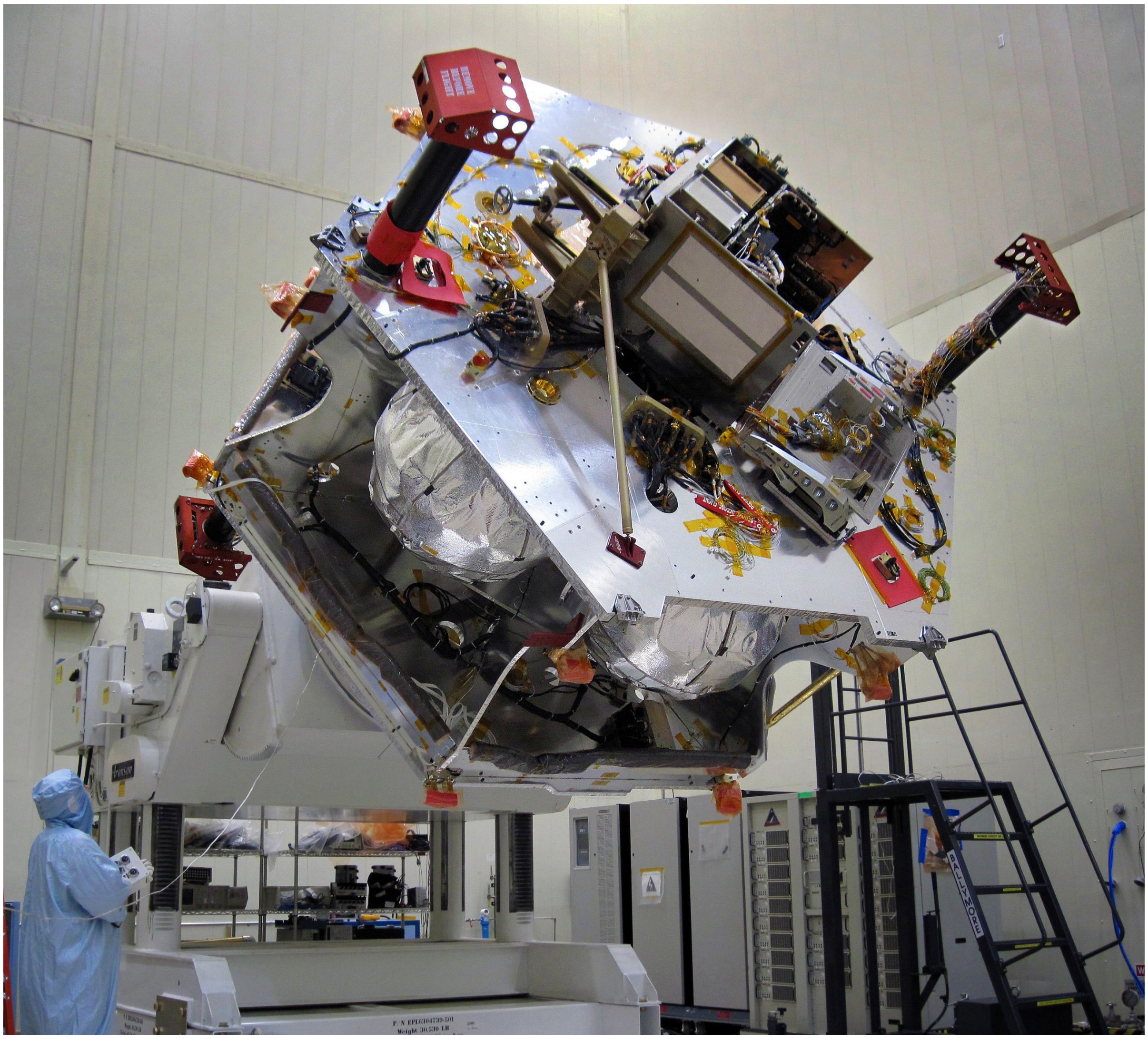
The 12 reaction control system thrusters are mounted on four rocket engine modules. They allow translation and rotation around three axes. They also are used for most trajectory correction maneuvers.

Command and Data Handling

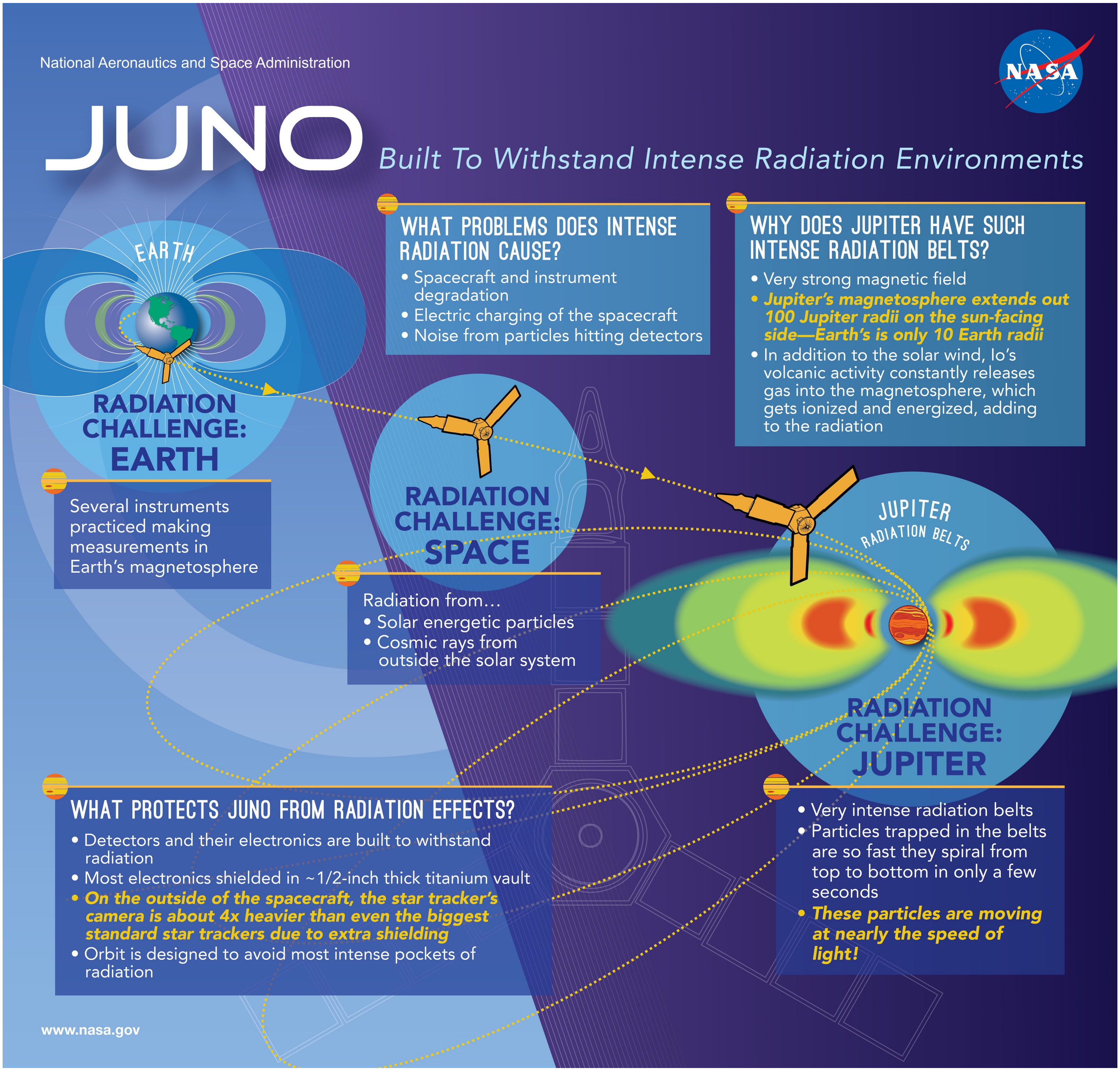
Command and data handling includes a RAD750 flight processor with 256 megabytes of flash memory and 128 megabytes of DRAM local memory. It provides 100 Mbps total instrument throughput, more than enough for payload requirements.

Electronics Vault

To protect sensitive spacecraft electronics, Juno carries the first-of-its-kind radiation-shielded electronics vault, a critical feature for enabling sustained exploration in such a heavy radiation environment. Each of the titanium cube's eight sides measures nearly 9 square feet (a square meter) in area, about a third of an inch (1 centimeter) in thickness, and 40 pounds (18 kilograms) in mass. This titanium box -- about the size of an SUV's trunk -- encloses Juno's command and data handling box (the spacecraft's brain), power and data distribution unit (its heart), and about 20 other electronic assemblies. The whole vault weighs about 400 pounds (200 kilograms).



Juno's specially designed radiation vault protects the spacecraft's electronic brain and heart from Jupiter's harsh radiation environment. Credit: NASA/JPL-Caltech/LMSS



Credit: NASA's Goddard Space Flight Center

Power

Juno's Electrical Power Subsystem manages the spacecraft power bus and distribution of power to payloads, propulsion, heaters and avionics. The power distribution and drive unit monitors and manages the spacecraft power bus, manages the available solar array power to meet the spacecraft load and battery state of charge, and provides controlled power distribution.

Power generation is provided by three solar arrays consisting of 11 solar panels and one MAG boom. Two 55 amp-hour lithium-ion batteries provide power when Juno is off-sun or in eclipse, and are tolerant of the Jupiter radiation environment. The power modes during science orbits are sized for either data collection during an orbit emphasizing microwave radiometry or gravity science.

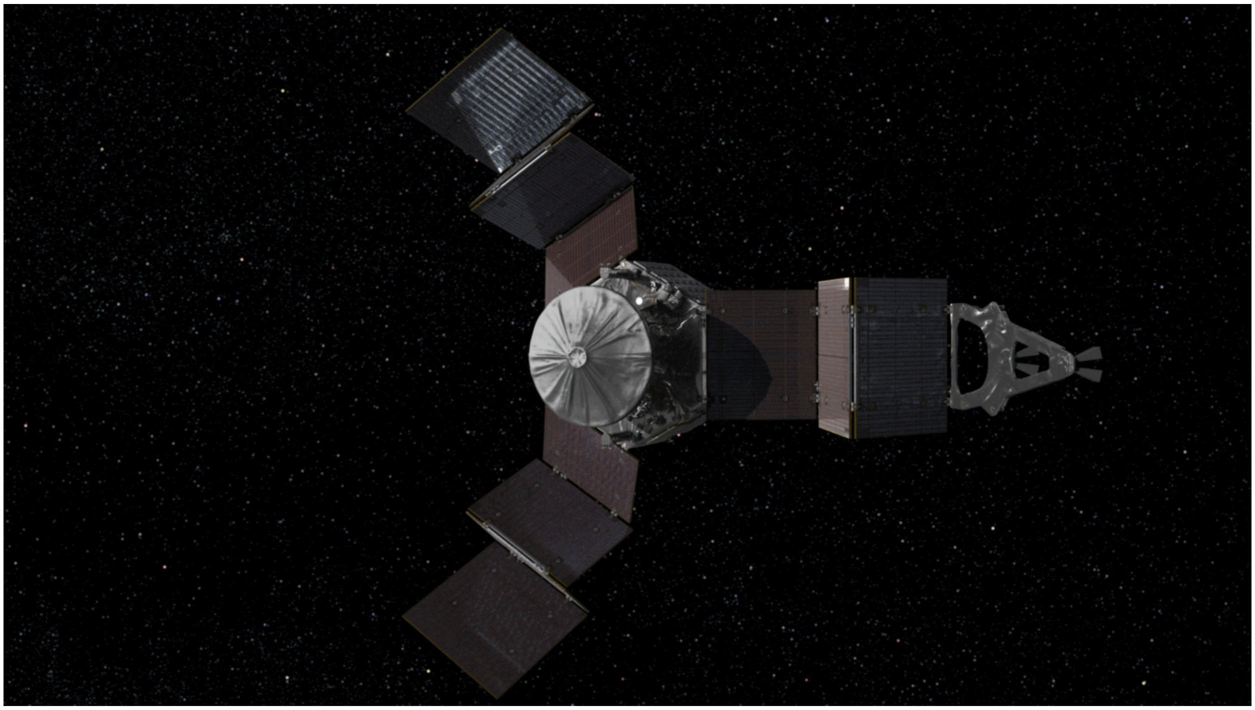
Technicians test Juno's solar arrays in preparation for launch at NASA's Kennedy Space Center. Credit: NASA

Solar Power

Jupiter's orbit is five times farther from the sun than Earth's orbit, and the giant planet receives 25 times less sunlight than Earth. Juno will be the first solar-powered spacecraft designed to operate at such a great distance from the sun, which means the surface area of solar panels required to generate adequate power is quite large.

Juno benefits from advances in solar cell design with modern cells that are 50 percent more efficient and radiation-tolerant than silicon cells available for space missions 20 years ago. The mission's power needs are modest. Juno has energy-efficient science instruments. Solar power is possible on Juno due to the energy-efficient instruments and spacecraft, a mission design that can avoid Jupiter's shadow, and a polar orbit that minimizes the total radiation.

The spacecraft's three solar panels extend outward from Juno's hexagonal body, giving the overall spacecraft a span of more than 66 feet (20 meters). The solar panels will remain in sunlight



This artist rendering illustrates Juno deploying its solar arrays. Credit: NASA/JPL-Caltech

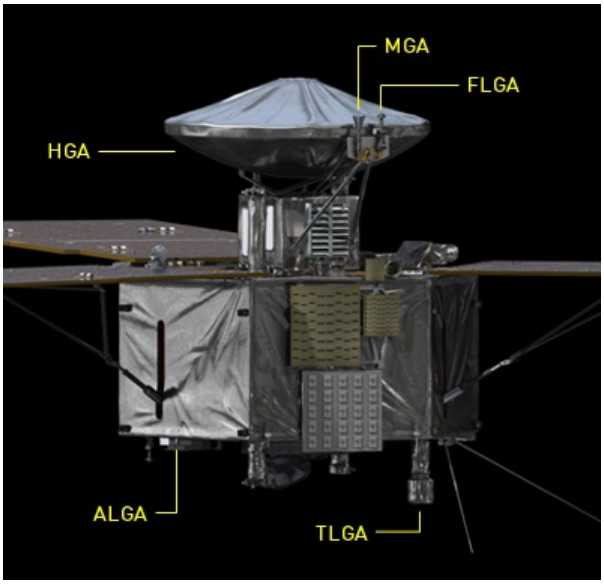
continuously from launch through end of mission, except for a few minutes during the Earth flyby. Before deployment in space, the solar panels are folded into four-hinged segments so the spacecraft can fit into the launch vehicle's payload fairing.

Thermal Control

Juno’s thermal control subsystem uses a passive design with heaters and louvers. The main component of the thermal control subsystem consists of an insulated, louvered electronics vault atop an insulated, heated propulsion module. This design accommodates all mission thermal environments from Earth orbit to Jupiter orbital operations. During cruise, while the spacecraft is close to the sun, the high-gain antenna is used as a heat shield to protect the vault avionics.

Most instrument electronics are contained within the radiation vault and are thermally managed as part of the vault thermal control system. Science sensors are externally mounted to the deck and are individually blanketed and heated to maintain individual temperature limits.

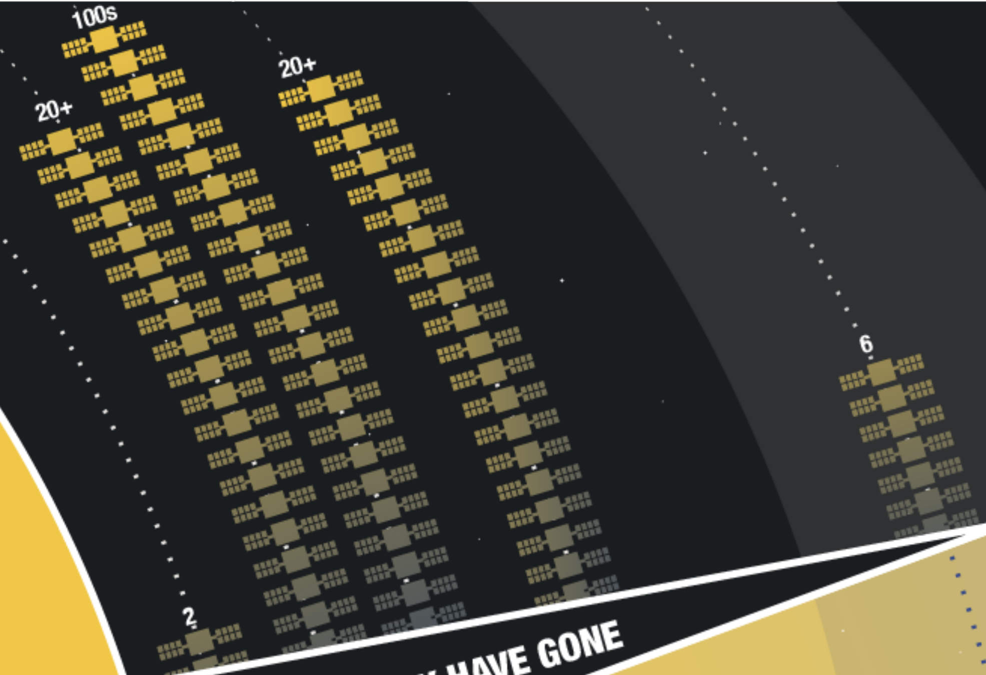
Thermal blankets being installed on Juno's magnetometer boom. Credit: NASA



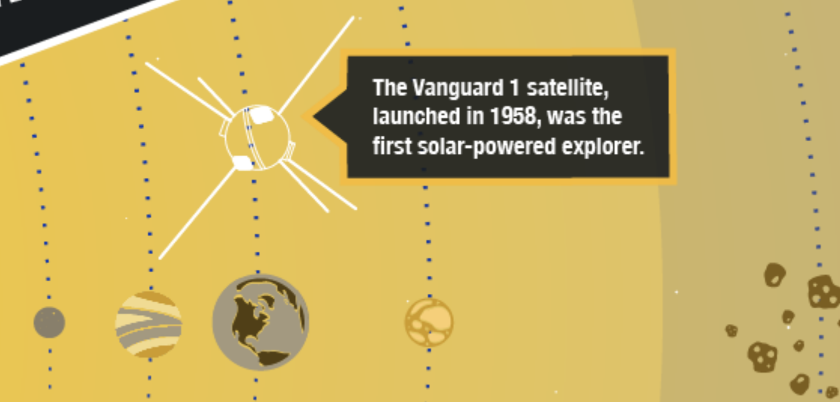
Juno's telecom antennas consist of a large high-gain antenna, a medium gain antenna, forward and aft low gain antennas and a toroidal low gain antenna. Credit: NASA/JPL-Caltech

Telecommunications

The gravity science and telecom subsystem provides X-band command uplink and engineering telemetry and science data downlink for the entire post-launch, cruise and Jupiter orbital operations. The subsystem also provides for dual-band (X- and Ka-band) Doppler tracking for gravity science at Jupiter.



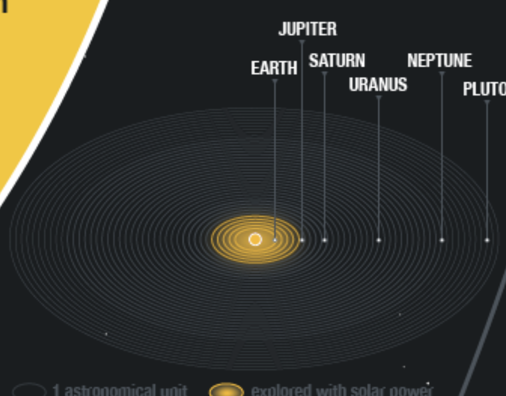
WHERE THEY HAVE GONE



SOLAR POWER EXPLORERS

The sun powers spacecraft to Earth orbit, Mars and beyond. Here's how NASA's Juno mission to Jupiter became the most distant solar-powered explorer and influenced the future of space exploration powered by the sun ▸

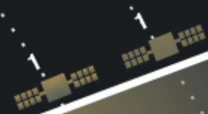
WHERE THEY WILL GO

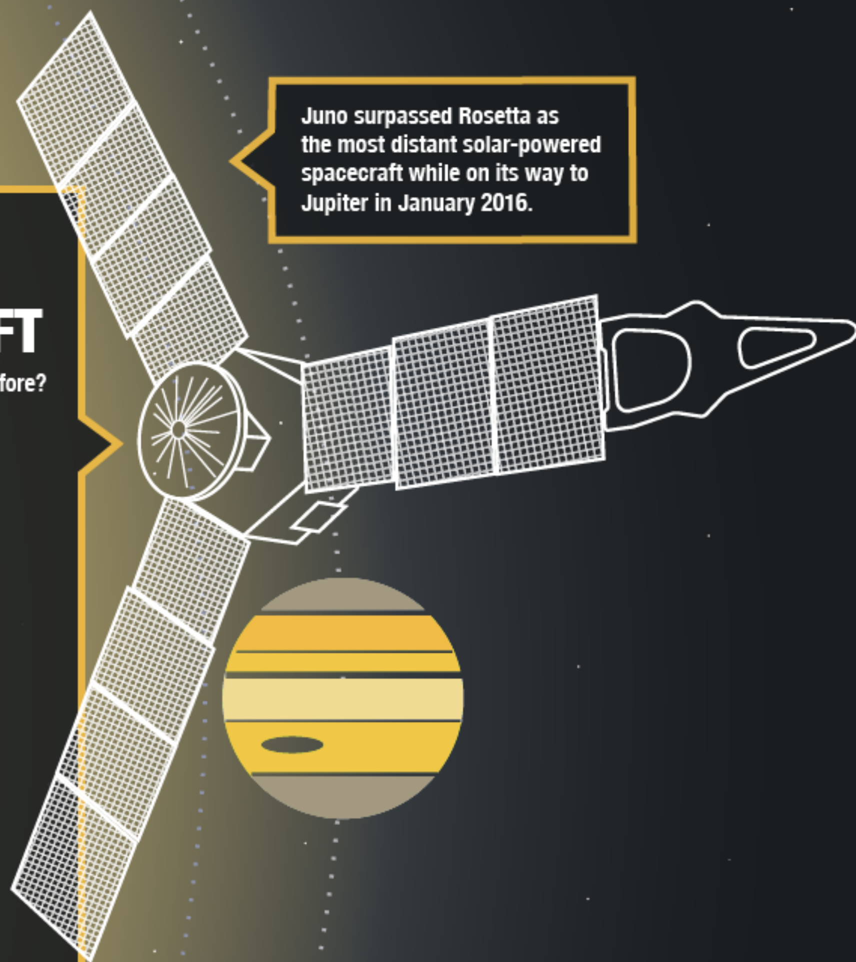


Today's solar technology can power spacecraft out to Jupiter, about 508 million mi (817 million km) from the sun, but no farther.

Juno's state-of-the-art solar panels were nearly too massive to launch and at their best can convert 20% of sunlight into power.

NASA's Juno and the European Space Agency's Rosetta are the only spacecraft to operate beyond the asteroid belt on solar power.





Juno surpassed Rosetta as the most distant solar-powered spacecraft while on its way to Jupiter in January 2016.

GOING THE DISTANCE
NASA'S JUNO SPACECRAFT

How did Juno go where no solar-powered spacecraft has gone before?

1 Biggest Solar Panels in the Universe

It would take 1,200+ sheets of letter-size paper to cover the surface of Juno's three solar arrays, which are each **261 square feet** (24 square meters).

2 No Cell Left Unchecked

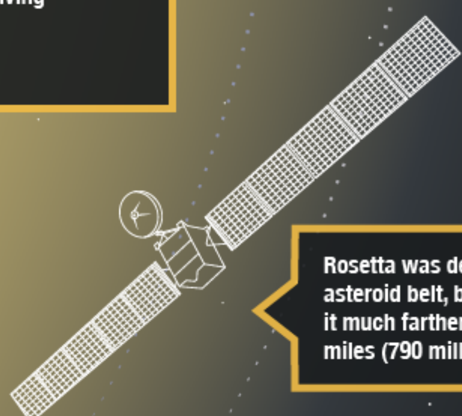
All **19,000 solar cells** (the material that makes up a solar panel) on the spacecraft were inspected to guarantee Juno performs at its best.

3 Dial It Up

Juno can dial down or up on power depending on its distance from the sun so it doesn't overload when close to the sun or become underpowered far from the sun.

4 Rainbow Power

Similar to the tint on sunglasses, the material in Juno's solar panels picks up different kinds of light – giving them more power than average solar panels.



Rosetta was designed to go to the asteroid belt, but its solar panels took it much farther: 5.29 AU, 490 million miles (790 million km) from the sun.

To reach Saturn and beyond, solar panels of the future will need to be lighter and more efficiently convert sunlight into power. NASA's mission to Jupiter's moon Europa may be the first to use such technology.

The Hitchhiker's Guide to Jupiter

Along with the spacecraft subsystems and science gear, the Juno spacecraft carries some very special guests on board.

Juno carries the 1.5-inch likeness of Galileo Galilei, the Roman god Jupiter and his wife Juno. The inclusion of the three mini-statues, or figurines, is part of a joint outreach and educational program developed as part of the partnership between NASA and the LEGO Group to inspire children to explore science, technology, engineering and mathematics.

In Greek and Roman mythology, Jupiter drew a veil of clouds around himself to hide his mischief. From Mount Olympus, Juno was able to peer through the clouds and reveal Jupiter's true nature. Juno holds a magnifying glass to signify her search for the truth, while her husband holds a lightning bolt. The third LEGO crew member, Galileo Galilei, made several important discoveries about Jupiter, including the four largest satellites of Jupiter (named the Galilean moons in his honor). Of course, the miniature Galileo has his telescope with him on the journey.

The Juno LEGO minifigures, from left to right: Galileo, Juno and Jupiter. Credit: NASA/JPL-Caltech/LEGO

A plaque dedicated to Galileo Galilei is also carried aboard Juno. The plaque, which was provided by the Italian Space Agency, measures 2.8 by 2 inches (71 by 51 millimeters), is made of flight-grade aluminum and weighs 0.2 ounces (6 grams). It was bonded to Juno's propulsion bay with a spacecraft-grade epoxy. The graphic on the plaque depicts a self-portrait of Galileo. It also includes -- in Galileo's own hand -- a passage he made in 1610 of observations of Jupiter, archived in the Biblioteca Nazionale Centrale in Florence.

Galileo's text included on the plaque reads as follows: "On the 11th it was in this formation -- and the star closest to Jupiter was half the size than the other and very close to the other so that during the previous nights all of the three observed stars looked of the same dimension and among them equally afar; so that it is evident that around Jupiter there are three moving stars invisible till this time to everyone."

Among his many achievements, Galileo Galilei discovered that moons orbited Jupiter in 1610. These Galilean moons, as they are now called, are Io, Europa, Ganymede and Callisto.

Science Instruments aboard Juno

The Juno spacecraft carries a payload of 29 sensors, which feed data to nine onboard instruments. Eight of these instruments (MAG, MWR, Gravity Science, Waves, JEDI, JADE, UVS, JIRAM) are considered the science payload. One instrument, JunoCam, is aboard to generate images for education and public outreach.

Primary science observations are obtained within three hours of closest approach to Jupiter, although calibrations, occasional remote sensing and magnetospheric science observations are planned throughout the science orbits around Jupiter.

Juno is spin-stabilized. Because of the spacecraft mission design and the fact that its science instruments were all developed together, there is no need for a scan platform to point instruments in different directions. Gravity science and microwave sounding of the atmosphere observations are obtained through orientation of the spacecraft's spin plane. All other experiments utilize ride-along pointing and work in either one or both orientations. This design allows for very simple operations.


Juno Spacecraft
JunoCam
Ultraviolet Spectrograph (UVS)
Jovian Infrared Auroral Mapper (JIRAM)
Plasma Waves Instrument (WAVES)
SPACECRAFT DIMENSIONS
Diameter: 66 feet (20 meters)
Height: 15 feet (4.5 meters)
Gravity Science
For more information:
missionjuno.swri.edu &
www.nasa.gov/juno
Jovian Auroral Distributions Experiment (JADE)
Microwave Radiometer (MWR)
Jupiter Energetic-particle Detector Instrument (JEDI)
National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California
www.nasa.gov

[redacted]

Juno's Instruments

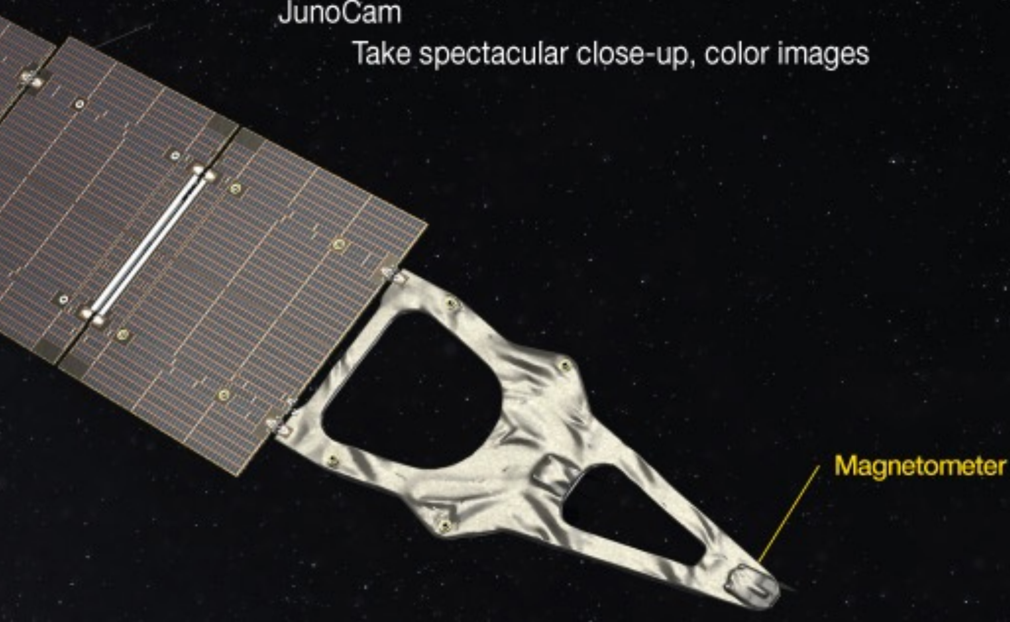
Gravity Science and Magnetometers
: Study Jupiter's deep structure by mapping the planet's gravity field and magnetic field

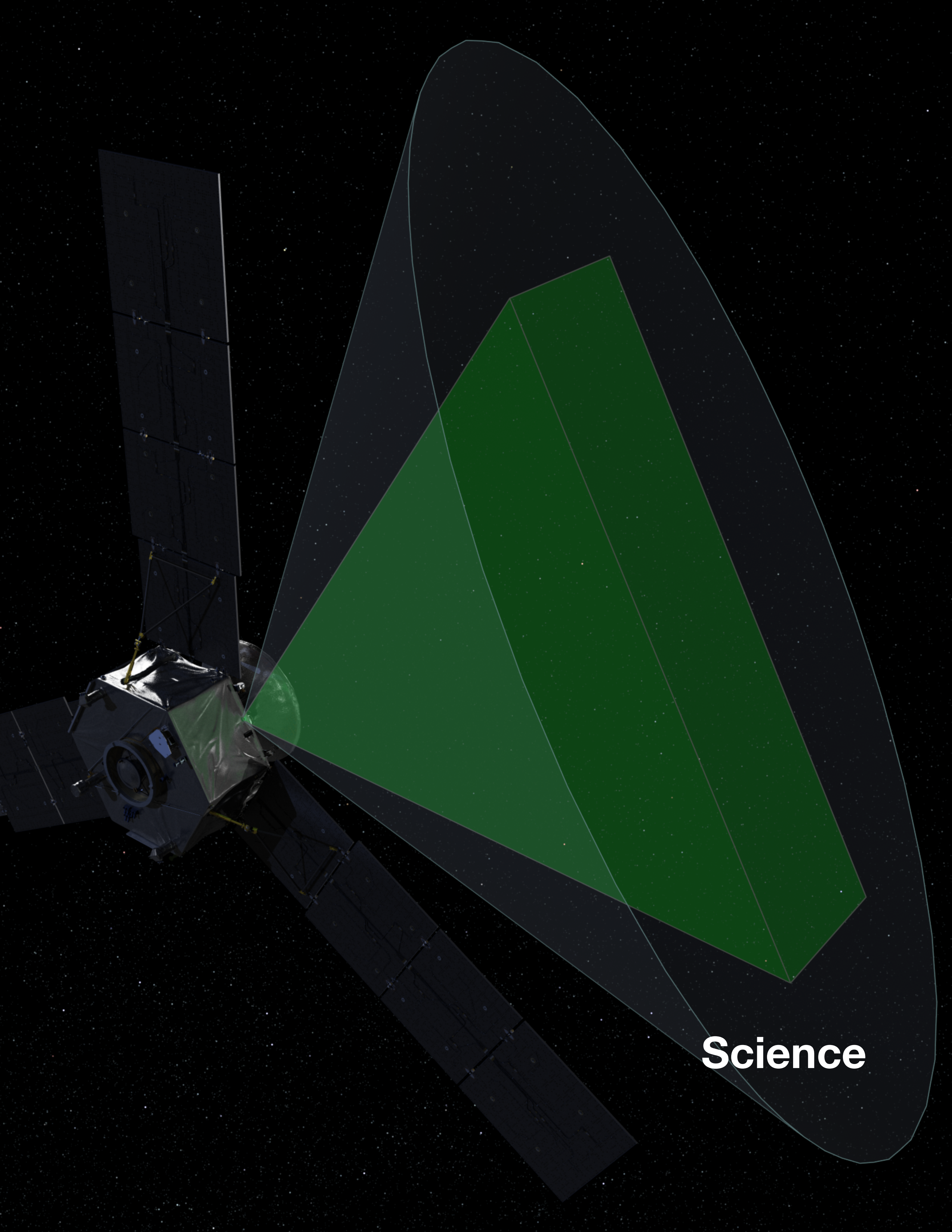
Microwave Radiometer
: Probe Jupiter's deep atmosphere and measure how much water (and hence oxygen) is there

JEDI, JADE and Waves
: Sample electric fields, plasma waves and particles around Jupiter to determine how the magnetic field is connected to the atmosphere, and especially the auroras (northern and southern lights)

UVS and JIRAM
: Using ultraviolet and infrared cameras, take images of the atmosphere and auroras, including chemical fingerprints of the gases present

JunoCam
: Take spectacular close-up, color images




Science

The Giant Planet Story is the Story of the Solar System

The principal goal of NASA's Juno mission is to understand the origin and evolution of Jupiter. Underneath its dense cloud cover, Jupiter safeguards secrets about the fundamental processes and conditions that governed our solar system during its formation. As our primary example of a giant planet, Jupiter can also provide critical knowledge for understanding the planetary systems being discovered around other stars.

With its suite of science instruments, Juno will investigate the existence of a possible solid planetary core, map Jupiter's intense magnetic field, measure the amount of water and ammonia in the deep atmosphere, and observe the planet's auroras.

Juno will let us take a giant step forward in our understanding of how giant planets form and the role these titans played in putting together the rest of the solar system.

Jupiter's Origins and Interior

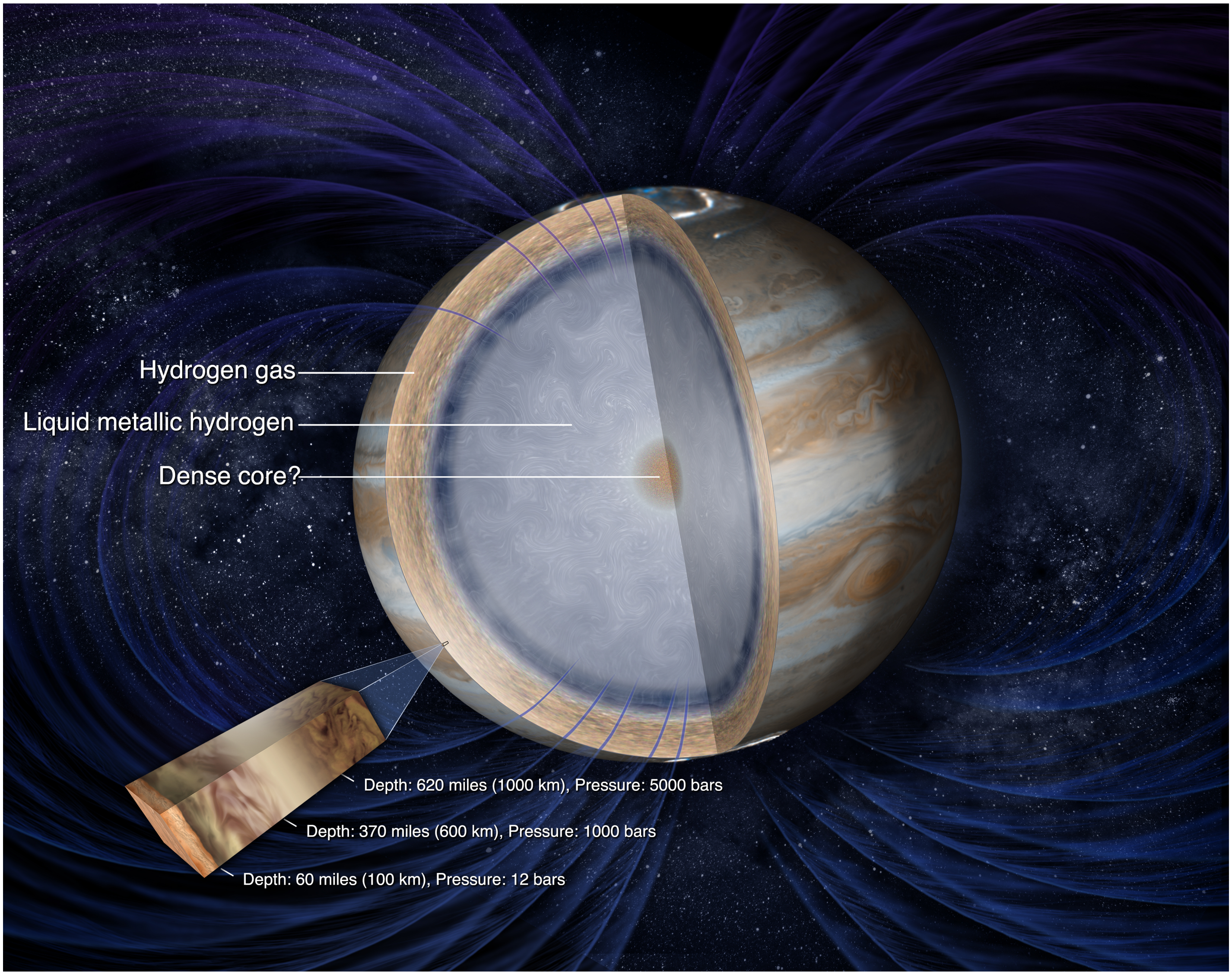
Theories about solar system formation all begin with the collapse of a giant cloud of gas and dust, or nebula, most of which formed the infant sun, our star. Like the sun, Jupiter is mostly hydrogen and helium, so it must have formed early, capturing most of the material left after our star came to be. How this happened, however, is unclear. Did a massive planetary core form first and capture all that gas gravitationally, or did an unstable region collapse inside the nebula, triggering the planet's formation? Differences between these scenarios are profound.

Even more importantly, the composition and role of icy planetesimals, or small protoplanets, in planetary formation hangs in the balance — and with them, the origin of Earth and other terrestrial planets. Icy planetesimals likely were the carriers of materials like water and carbon compounds that are the fundamental building blocks of life.

Unlike Earth, Jupiter's giant mass allowed it to hold onto its original composition, providing us with a way of tracing our solar system's history. Juno will measure the amount of water and ammonia in Jupiter's atmosphere and help determine if the planet has a core of heavy elements, constraining models on the origin of this giant planet and thereby the solar system. By mapping Jupiter's gravitational and magnetic fields, Juno will reveal the planet's interior structure and measure the mass of the core.

Atmosphere

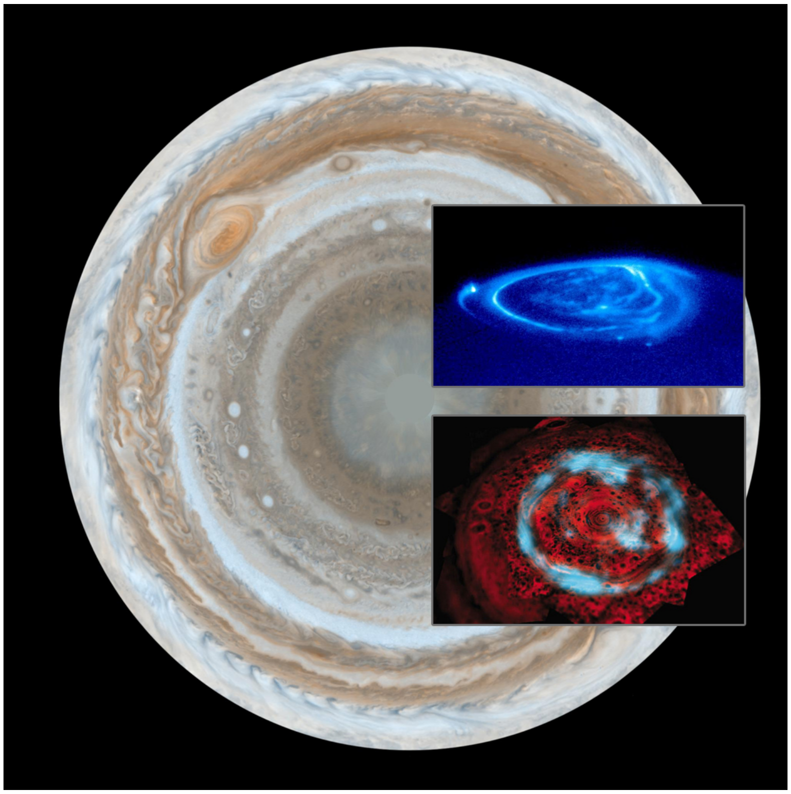
How deep Jupiter's colorful zones, belts and other features penetrate is one of the most outstanding fundamental questions about the giant planet. Juno will determine the global structure and motions of the planet's atmosphere below the cloud tops for the first time, mapping variations in the atmosphere's composition, temperature, clouds and patterns of movement down to unprecedented depths.



Jupiter illustrated with labeled interior layers. Credit: NASA/JPL-Caltech

Magnetosphere

Deep in Jupiter's atmosphere, under great pressure, hydrogen gas is squeezed into a fluid known as metallic hydrogen. At these enormous pressures, the hydrogen acts like an electrically conducting metal, which is believed to be the source of the planet's intense magnetic field. This powerful magnetic environment creates the brightest auroras in our solar system, as charged particles precipitate down into the planet's atmosphere. Juno will directly sample the charged particles and magnetic fields near Jupiter's poles for the first time, while simultaneously observing the auroras in ultraviolet light produced by the extraordinary amounts of energy crashing into the polar regions. These investigations will greatly improve our understanding of this remarkable phenomenon, and also of similar magnetic objects, like young stars with their own planetary systems.



Juno will provide the first close look at Jupiter's poles, probing forces in the magnetosphere that connect the giant, fast-rotating planet's exterior with its deep interior. (Background image from Cassini; top inset: Jupiter auroras from the Hubble Space Telescope; bottom inset: Cassini at Saturn) Credit NASA/JPL-Caltech

Juno Science Objectives

The primary science objectives of the mission are as follows:

Origin
Determine the abundance of water and place an upper limit on the mass of Jupiter's possible solid core to decide which theory of the planet's origin is correct.

Interior
Understand Jupiter's interior structure and how material moves deep within the planet by mapping its gravitational and magnetic fields.

Atmosphere
Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes.

Magnetosphere
Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

The overall goal of the Juno mission is to improve our understanding of the solar system by understanding the origin and evolution of Jupiter. It addresses science objectives central to three NASA Science divisions: Solar System (Planetary), Earth–Sun System (Heliophysics), and Universe (Astrophysics).

Juno's primary science goal of understanding the formation, evolution, and structure of Jupiter is directly related to the conditions in the early solar system, which led to the formation of our planetary system. The mass of Jupiter's possible solid core and the abundance of heavy elements in the atmosphere discriminate among models for giant planet formation. Juno constrains the core mass by mapping the gravitational field, and measures through microwave sounding the global abundances of oxygen (water) and nitrogen (ammonia).

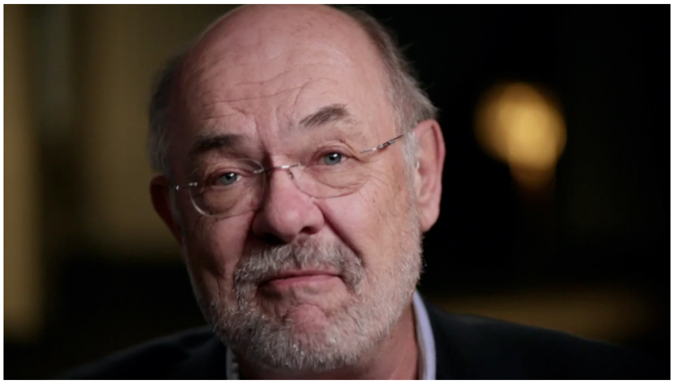
Juno reveals the history of Jupiter by mapping the gravitational and magnetic fields with sufficient resolution to constrain Jupiter's interior structure, the source region of the magnetic field, and the nature of deep convection. By sounding deep into Jupiter's atmosphere, Juno determines to what depth the belts and zones penetrate. Juno provides the first survey and exploration of the three-dimensional structure of Jupiter's polar magnetosphere.

Juno's Science Instruments

Microwave Radiometer (MWR)
Juno's Microwave Radiometer instrument will probe beneath Jupiter's cloud tops to provide data on the atmosphere's structure, movement and chemical composition to a depth as great as 1,000 atmospheres — about 342 miles (550 kilometers) below the visible cloud tops. In particular, MWR will determine the amount of water in the planet's atmosphere.

Juno will use its Microwave Radiometer (MWR) instrument to probe Jupiter's deep atmosphere, revealing new insights about its structure and composition. The instrument will make measurements that enable scientists to determine the amount of water in the planet's atmosphere. This information is the missing key to understanding Jupiter's formation.

To see what's under the cloud tops, MWR will measure the microwave radiation emitted from inside the planet. The planet emits radiation across the radio, microwave and infrared ranges, but only microwave frequencies can make it out through the thick clouds. The depth from which the radiation can escape depends on frequency, so by measuring different frequencies of microwave radiation, MWR can study different layers of Jupiter's interior.



Investigation lead: Michael Janssen, NASA-JPL

"It's a completely new capability we've never had before at the outer planets. Being able to see deep into Jupiter from very close, we should have quite a high-resolution view."
--Mike Janssen

Strong radio emission from Jupiter's radiation belts blocks our view of the planet from Earth at the critical microwave frequencies necessary to measure Jupiter's water abundance. Juno avoids this problem by flying close to Jupiter, inside the radiation belts.

MWR consists of six antennas designed to passively sense the microwaves coming from six levels within the clouds. These levels range from the cloud tops, where the pressure is about the same as that on Earth, down to a depth of hundreds of miles, where the pressure is a thousand times greater. The deepest layers (below 100 bars) will reveal Jupiter's water content, which is key to understanding how Jupiter formed. MWR will also allow us to determine how deeply atmospheric features extend into the planet, including the cloud bands and the Great Red Spot.

Five of Juno's six MWR antennas are located on one side of the spacecraft. The largest of Juno's six MWR antennas takes up a full side of the spacecraft.

All six MWR antennas are located on the sides of Juno's hexagonal body, with the largest antenna taking up one whole side. Each antenna is connected by a cable to a receiver, which sits in the instrument vault on top of the spacecraft.

Instrument stats:

Measures microwave brightness temperatures of Jupiter with six passive microwave antennas, sensitive to wavelengths between 1.3 centimeters and 50 centimeters, or frequencies between 0.6 GHz and 22 GHz

Largest antenna is 5.2 feet (1.6 meters) square.

Location: Two sides of the spacecraft, between the solar arrays

Two largest antennas, which sense the lowest frequencies, are "patch arrays," the next three smaller antennas are "slot arrays," the smallest is a "horn" antenna.

The MWR instrument operates during five preselected Juno orbits. During these orbits, Juno is oriented so that the MWR antennas' views sweep across Jupiter directly below the spacecraft. This geometry allows Juno to observe thermal emission from each point along the spacecraft's path over the planet to be observed from multiple angles, helping MWR build up a three-dimensional understanding of how the deep atmosphere is structured.

JPL provided the MWR sub-system components, including the antennas and receivers.

Gravity Science Experiment
Juno's Gravity Science experiment will use the spacecraft's telecommunications system to help us understand Jupiter's inner structure, by very precisely mapping the planet's gravitational field.

The Gravity Science experiment will enable Juno to measure Jupiter's gravitational field and reveal the planet's internal structure. Juno will see how the material inside Jupiter churns and flows, helping to determine whether the planet harbors a dense core at its center.

Variations in Jupiter's inner structure will have tiny effects on its gravitational field, which ever so slightly alters Juno's orbit. The closer Juno gets to Jupiter, the more pronounced the displacements are. These subtle shifts in Juno's motion cause equally subtle shifts in the frequency of a radio signal received from and sent back to Earth. Known as the Doppler effect, it's the same type of frequency shift that happens when the pitch of an ambulance's siren increases when speeding toward you and decreases when speeding away from you.

"We can't get anywhere close to the deep interior of Jupiter, but we can explore it nonetheless, by mapping the planet's gravity."
-- William Folkner

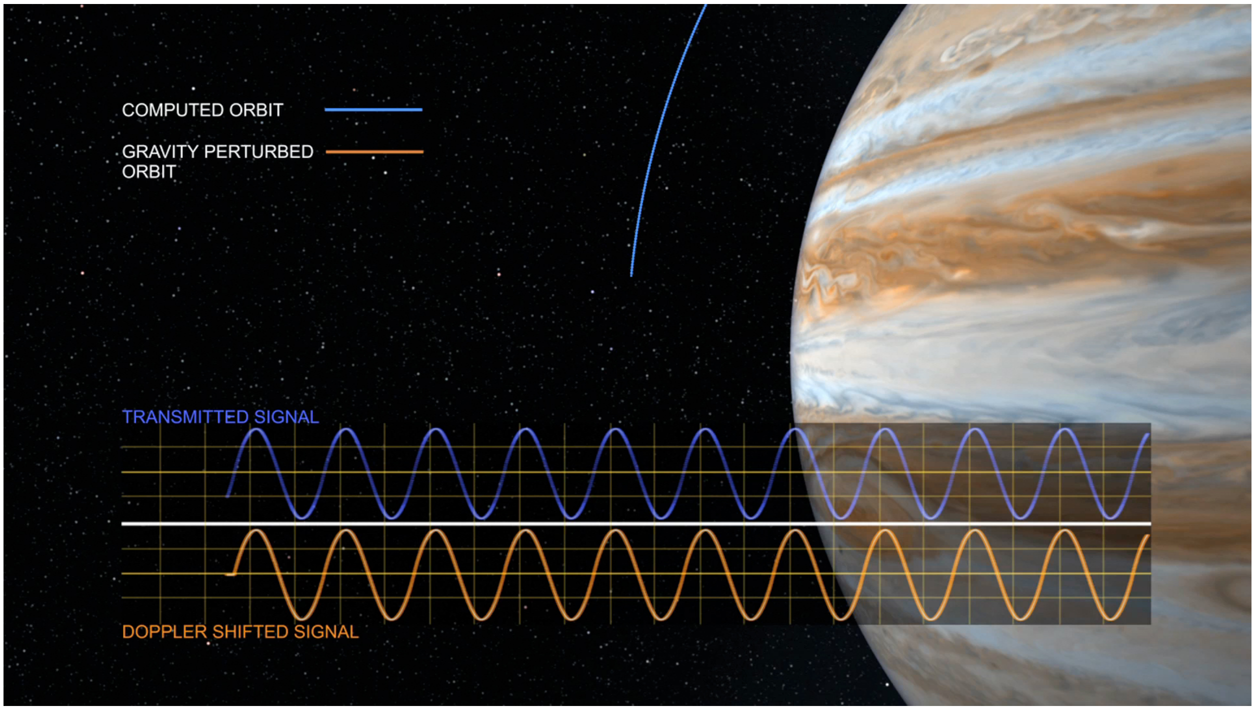
Investigation lead: William Folkner, JPL

To measure these tiny shifts, Juno's telecommunication system is equipped with a radio transponder that operates in the X-band, which are radio signals with a wavelength of three centimeters. The transponder detects signals sent from NASA's Deep Space Network on Earth and immediately sends a signal in return. The small changes in the signal's frequency tell us how much Juno has shifted due to variations in Jupiter's gravity. For added accuracy, the telecommunication system also has a Ka-band translator system, which does a similar job, but at radio wavelengths of one centimeter. One of the antennas of NASA's Deep Space Network located in Goldstone, California, has been fitted to send and receive signals at both radio bands. An instrument called the Advanced Water Vapor Radiometer helps to isolate the signal from interference caused by Earth's atmosphere.

JPL provided the Juno telecom system. The Italian Space Agency contributed the Ka-band translator system.

Instrument stats:
Frequencies used for transmitting gravity data:
X-band and Ka-band

Location: Saucer-shaped high-gain antenna on top of spacecraft and radio transponder within radiation vault



The Doppler shift in Juno's radio signal will allow scientists to map variations in Jupiter's gravity field as the spacecraft falls past the planet during each orbit.

Magnetometer Experiment (MAG)
Juno's magnetometer will visualize Jupiter's magnetic field in 3-D, all around the planet, sensing the deep interior and watching for changes over time.

Using its magnetometer (MAG), Juno will create an extremely accurate and detailed three-dimensional map of Jupiter's magnetic field. This unprecedented study will allow us to understand Jupiter's internal structure and how the magnetic field is generated by the dynamo action inside – the churning of electrically charged material deep below the surface. MAG will also monitor the field for long-term variations, called secular variations, during the entire mission. Measurements of these variations, in combination with the map, will help us determine the depth of the dynamo region. Because Jupiter lacks a rocky crust or continents that complicate the picture as they do at Earth, Juno's observations could be the most detailed look at a planetary dynamo ever.

Investigation lead: Jack Connerney, NASA GSFC

"The primary purpose of our investigation is to map the magnetic field of Jupiter very accurately and try to understand how it's generated."
-- Jack Connerney

Electrical currents can align themselves with the magnetic field, and these so-called Birkeland currents help drive the brilliant auroras around Jupiter's poles. To better understand the auroras, MAG will measure these currents.

MAG consists of two flux gate magnetometers, which will measure the strength and direction of the magnetic field lines, and an advanced stellar compass (ASC) -- a system of four star cameras that will monitor the orientation of the magnetometer sensors.

Juno’s other instruments have their own small magnetic fields, and to avoid contamination, the MAG sensors sit as far from the rest of the spacecraft as possible. They are mounted on the magnetometer boom that sticks out from one of Juno’s solar arrays. As an extra precaution, there are two sets of MAG sensors – one 33 feet (10 meters) from the center of the spacecraft and one 39 feet (12 meters) from the center. By comparing measurements from both sensors, mission scientists can remove from the MAG data any contamination due to the spacecraft itself.

NASA's Goddard Space Flight Center provided the Juno magnetometers. The ASC is provided by Danish Technical University.

Juno's two magnetometers are located on a boom at the end of one of its long solar arrays.

Instrument stats:

Sensors: 2 fluxgate magnetometers, plus four advanced star tracker cameras

Location: Mounted on a boom at the end of one of Juno's solar arrays

Four star tracker cameras help determine the precise orientation of the magnetometers as they sense Jupiter's magnetic field.

Jovian Auroral Distributions Experiment (JADE)
JADE is a set of sensors charged with detecting the electrons and ions that produce Jupiter's auroras.

The JADE instrument will work with some of Juno's other instruments to identify the particles and processes that produce Jupiter's stunning auroras. It will also help create a three-dimensional map of the planet's magnetosphere.

JADE consists of four sensors that share an electronics box. Three of the sensors will detect electrons in the space surrounding Juno, while the fourth will identify positively charged hydrogen, helium, oxygen and sulfur ions. Most of these ions are ejected from the volcanoes on Jupiter's moon Io.

Investigation lead: Phil Valek, SwRI

"We're trying to understand what's the same and what's different between the auroras at Earth and Jupiter so we can understand the processes that create them in detail for the first time. We'll be really successful when we can tell the world how it really works, what particles are involved and why."
-- Phil Valek

When Juno flies directly over Jupiter's auroras, JADE will be able to observe the light show, resolving structures as small as 50 kilometers (30 miles). Considering that the auroras can stretch for tens of thousands of kilometers around the pole, JADE will be able to discern a lot of detail. JADE will also measure the particles that fly to and from Jupiter's poles, spiraling along as they're guided by the magnetic field. JADE is provided by SwRI.

The JADE investigation has two types of sensors to detect the charged particles that create Jupiter's stunning auroras: one for ions and one for electrons.

Instrument stats:

Number of sensors: 4 (3 electron sensors, 1 ion sensor)

Location: upper spacecraft deck

Measures electrons in the energy range from 100 eV to 95 keV

Measures ions in the energy range from 10 eV to 46 keV

Jupiter Energetic-Particle Detector Instrument (JEDI)

JEDI will measure the energetic particles that stream through space and study how they interact with Jupiter's magnetic field.

The Jupiter Energetic Particle Detector Instrument (JEDI) will measure energetic particles that stream through space around Jupiter, studying how they interact with Jupiter's magnetic field. These electrically charged particles -- consisting of electrons and ions -- follow the influence of the magnetic field. Many of them are channeled by the field toward Jupiter's poles, where they crash into the atmosphere and create brilliant auroras.

JEDI will determine the amount of energy these particles carry, their type and the direction in which they're zipping around Jupiter. Working with Juno's other instruments designed to study the magnetosphere -- the bubble created by Jupiter's magnetic field -- JEDI will help us understand how the planet's auroras are produced, as well as the processes by which the magnetic field interacts with charged particles to dump energy into the planet's atmosphere.

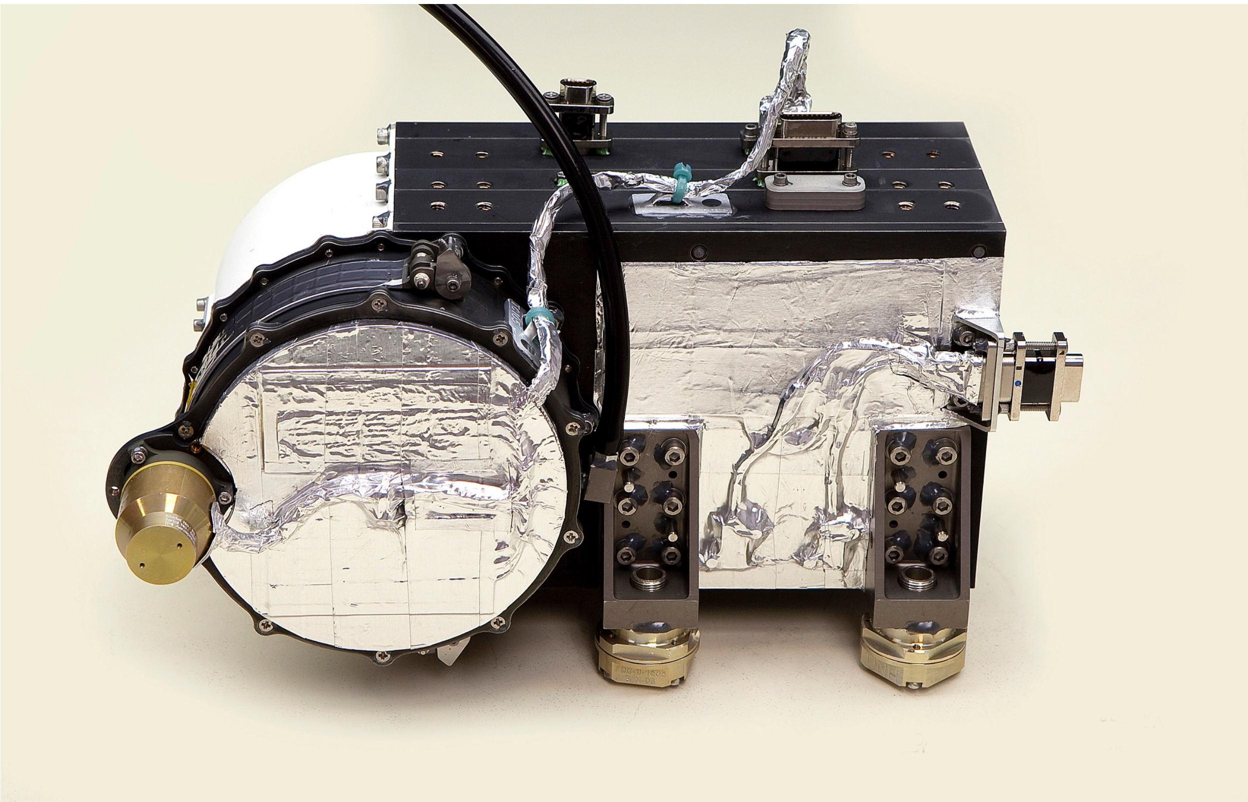
Investigation lead: Barry Mauk, JHU-APL

"The space around Earth is dominated by the sun and solar wind, but Jupiter is different. It rules its own domain. We'll sample material whizzing around Jupiter under the influence of its powerful rotating magnetic field."
--Barry Mauk

JEDI comprises three identical sensor units each with six ion and six electron views. JEDI works in close coordination with the JADE instrument. JEDI measures the higher-energy charged particles in Jupiter's environment, while JADE measures the lower-energy ones. The instrument also works in coordination with the JADE and Waves instruments to investigate Jupiter's polar space environment, with a particular focus on the physics of Jupiter's intense and impressive northern and southern auroral lights.

JEDI uses measurement techniques and technologies demonstrated previously at Jupiter by NASA's Galileo mission, and is similar to the New Horizons Pluto Energetic Particle Spectrometer Science Investigation (PEPSSI).

JEDI is provided by APL.



Each of the three JEDI detectors consists of a disk the size and shape of a hockey puck attached to an electronics box.

Instrument stats:
Number of sensors: 3

Location: Upper spacecraft deck

Measures electrons in the energy range of 25 keV to 800 keV

Measures ion in the energy range of 10 keV to 8000 keV

Jovian Infrared Auroral Mapper (JIRAM)
JIRAM will provide a visual and thermal (infrared) view of Jupiter's aurora.

JIRAM will study Jupiter's atmosphere in and around Jupiter's auroras, providing new insights about the interactions between the auroras, the magnetic field and the magnetosphere. JIRAM will be able to probe the atmosphere down to 30 to 45 miles (50 to 70 kilometers) below the cloud tops, where the pressure is five to seven times greater than on Earth at sea level.

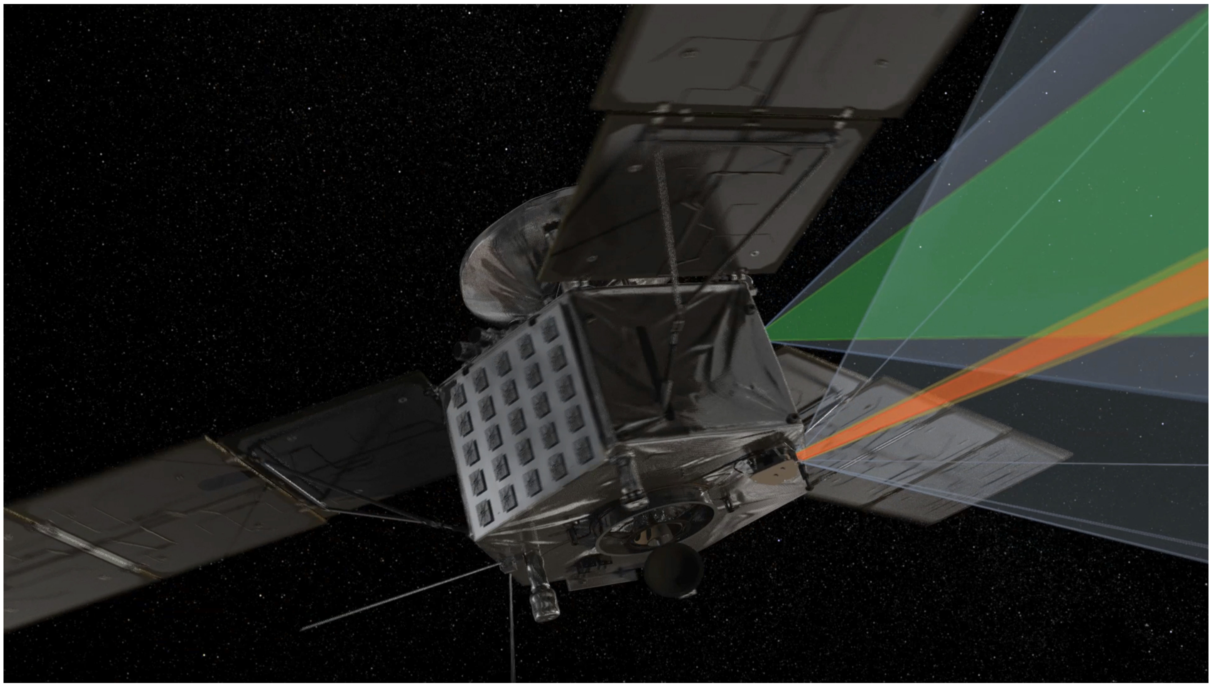
Alberto Adriani, Italian National Institute for Astrophysics (INAF)

"JIRAM will study Jupiter's atmospheric composition and measure the concentration of key gases such as water, ammonia and phosphine. It will also provide maps of the auroras, which show the strong interaction between the planet's magnetic field and surrounding space."
-- Alberto Adriani

JIRAM consists of a camera and a spectrometer, which splits light into its component wavelengths, like a prism. The camera will take pictures in infrared light, which is heat radiation with wavelengths of two to five microns (millionths of a meter) -- three to seven times longer than visible wavelengths. In particular, the instrument will snap photos of auroras at a wavelength of 3.4 microns -- the wavelength of light emitted by excited hydrogen ions in the polar regions. Methane in the atmosphere absorbs light at this same wavelength, darkening the atmosphere behind the auroras. In front of a darkened background, the auroras stand out even more brightly.

The instrument will also try to learn about the structure and origin of voids in Jupiter's atmosphere called hot spots. These spots -- like the one the Galileo probe happened to have dropped into in 1995 -- are windows into the depths of Jupiter's atmosphere. By measuring the heat radiating from Jupiter's atmosphere, JIRAM can determine how water-containing clouds circulate under the surface. It turns out that this sort of motion, called convection, in which hot gas rises and cool gas sinks, reveals the amount of water in these clouds. Certain gases in the atmosphere -- methane, water, ammonia and phosphine, in particular -- absorb particular wavelengths of infrared light. When the spectrometer measures the infrared rainbow emitted by Jupiter, the wavelengths of light absorbed by those gases will be reduced by an amount that indicates the chemical composition of the atmosphere.

JIRAM was developed by the Italian National Institute for Astrophysics and funded by the Italian Space Agency.



The JIRAM instrument is mounted to the aft deck of the Juno spacecraft and looks in the same direction as the other optical instruments, UVS and JunoCam.

Instrument stats:

Spectral range: Sensitive to infrared wavelengths between 2 and 5 microns.

Spectral resolution: 9 nanometers

Location: Mounted to the aft deck of the spacecraft

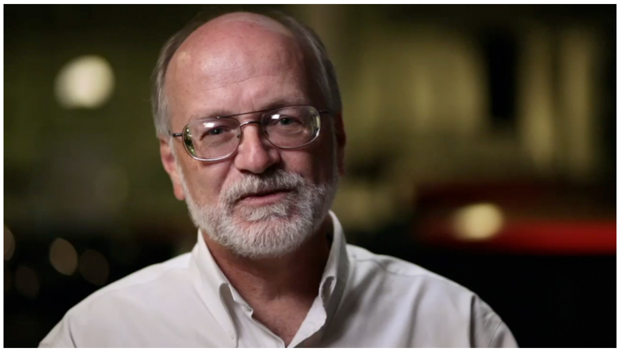
Operating temperature: 100 Kelvin or lower

JIRAM is an infrared spectrometer designed to observe Jupiter's auroras and atmosphere from very close to the planet.

Ultraviolet Imaging Spectrograph (UVS)
UVS will see Jupiter's auroras in UV, which helps us understand Jupiter's upper atmosphere and the particles that slam into it, creating the greatest light show in the solar system.

UVS will take pictures of Jupiter's auroras in ultraviolet light. Working with Juno's JADE and JEDI instruments, which measure the particles that create the auroras, UVS will help us understand the relationship between the auroras, the particles that collide with Jupiter's atmosphere to create them, and the planet's magnetosphere as a whole.

NASA's Hubble Space Telescope has taken impressive images of Jupiter's auroras, but Juno will get an even better view -- looking directly down on them over the north and south poles. UVS includes a scan mirror for targeting specific auroral features. The instrument is sensitive to both

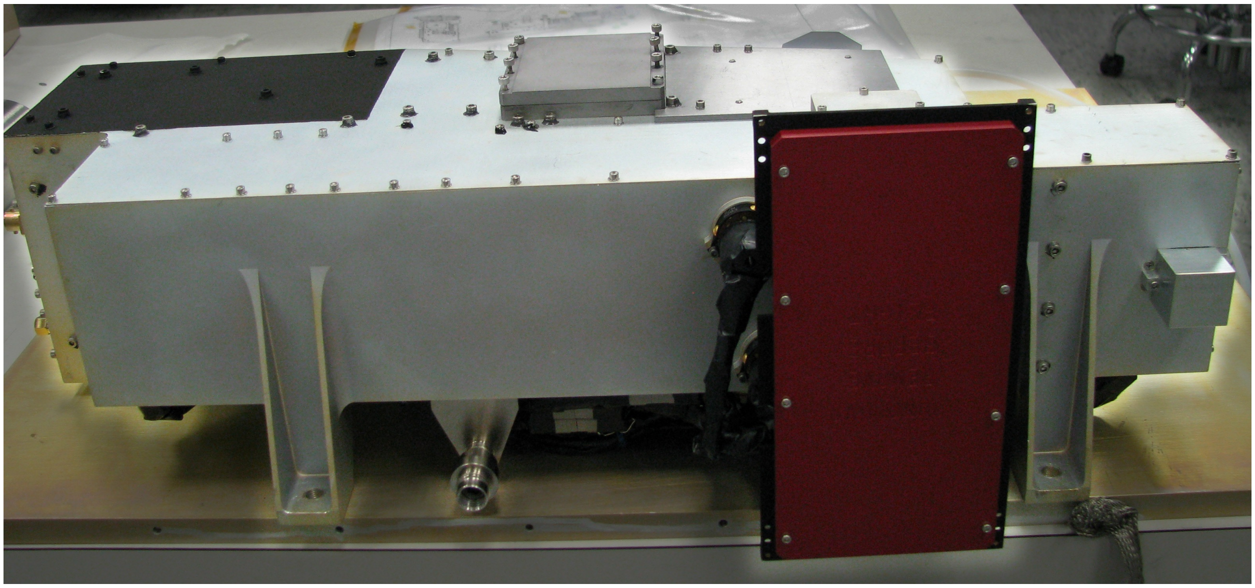


Investigation lead: Randy Gladstone, SwRI

"We'll be able to contrast how auroras work at Earth with how they work at Jupiter. There are a lot of things we've never been able to see at Jupiter that we can see with Juno."
-- Randy Gladstone

extreme and far-ultraviolet light, within a wavelength range of about 70 to 200 nanometers. In comparison, visible light has wavelengths that range from 400 to 700 nanometers.

Southwest Research Institute (SwRI) provided the UVS instrument. CSL/BELSPO (Belgium) contributed the scan mirror.



The UVS instrument observes Jupiter's auroras in ultraviolet light, breaking up the light into its component wavelengths to reveal processes that power the planet's brilliant UV light show.

Instrument stats:
Wavelength range: 68 to 210 nanometers

Spectral resolution: 0.6 to 1.2 nanometers

Location: Mounted to side of spacecraft, between solar arrays

Waves

The Waves instrument will measure radio and plasma waves in Jupiter's magnetosphere, helping us understand the interactions between the planet's magnetic field, atmosphere and magnetosphere. Waves will also pay particular attention to activity associated with auroras.

Jupiter's magnetosphere, an enormous bubble created by the planet's magnetic field, traps plasma, an electrically charged gas. Activity within this plasma, which fills the magnetosphere, triggers waves that only an instrument like Waves can detect.

Because plasma conducts electricity, it behaves like a giant circuit, connecting one region with another. Activity on one end of the magnetosphere can therefore be felt somewhere else, allowing Juno to monitor processes occurring in this entire, giant region of space around Jupiter. Radio

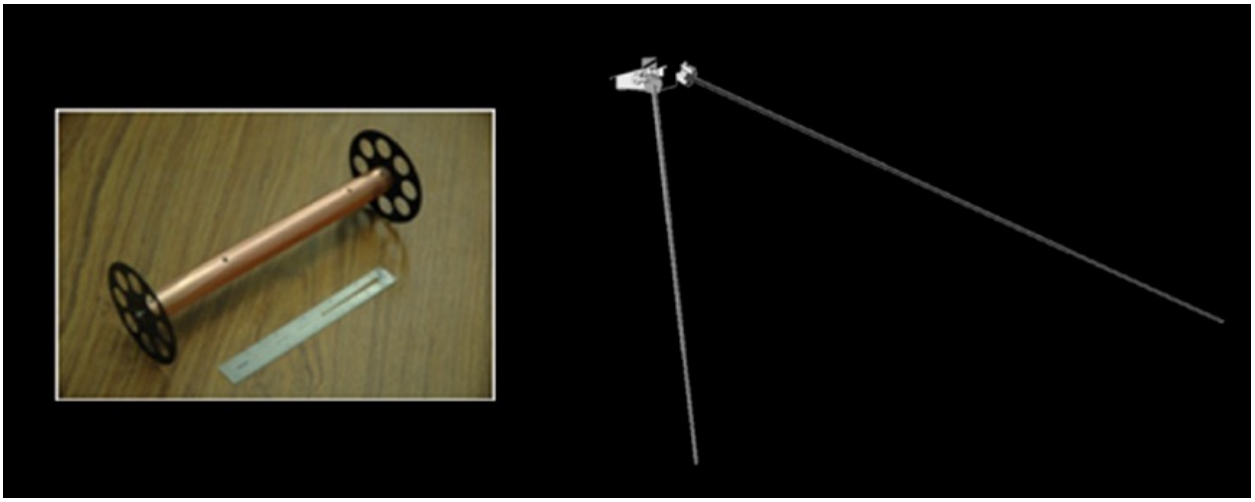
Investigation lead: Bill Kurth, University of Iowa

"We're excited that Juno is going to make the first measurements of an extraterrestrial auroral region in great detail."
--Bill Kurth

and plasma waves move through the space around all of the giant, outer planets, and previous missions have been equipped with similar instruments.

Juno's Waves instrument consists of two sensors; one detects the electric component of radio and plasma waves, while the other is sensitive to just the magnetic component of plasma waves. The first sensor, called an electric dipole antenna, is a V-shaped antenna, four meters from tip to tip -- similar to the rabbit-ear antennas that were once common on TVs. The magnetic antenna -- called a magnetic search coil -- consists of a coil of fine wire wrapped 10,000 times around a 6-inch-long (15-centimeter) core. The search coil measures magnetic fluctuations in the audio frequency range.

The University of Iowa provides the instrument.

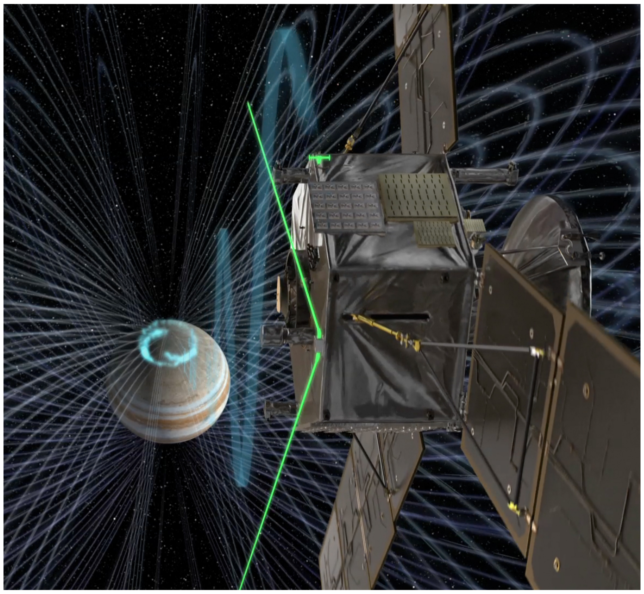


Waves consists of two sensors that monitor radio and plasma waves in echoing through Jupiter's magnetosphere.

Instrument stats:
Sensors: 2 (electric dipole antenna and magnetic search coil)

Frequency range:
50 Hz (near the bottom of the audio frequency range) to ~40 MHz (the limit of Jupiter's radio emissions)

Location: Mounted to the aft deck of the spacecraft



This artist's rendering shows Juno above Jupiter's north pole, with the auroras glowing brightly. Jupiter's magnetic field surrounds the planet. A radio wave from the auroras is shown traveling past the spacecraft, where it is intercepted by the Waves investigation, whose sensors are highlighted in bright green.

JunoCam

JunoCam is Juno's color imaging camera, which will provide close-up views of Jupiter's poles for the first time.

Juno's color, visible-light camera, called JunoCam, is designed to capture remarkable pictures of Jupiter's cloud tops. As Juno's eyes, it will provide a wide view, helping to provide context for the spacecraft's other instruments. JunoCam was included on the spacecraft specifically for purposes of public engagement; although its images will be helpful to the science team, it is not considered one of the mission's science instruments.

Juno rotates twice per minute, so JunoCam's images would be smeared if it were to try to take a complete picture at once. Instead, it is a "push-broom imager," taking thin strips of an image at the same rate that the spacecraft spins. JunoCam then stitches the strips together to form the full picture.

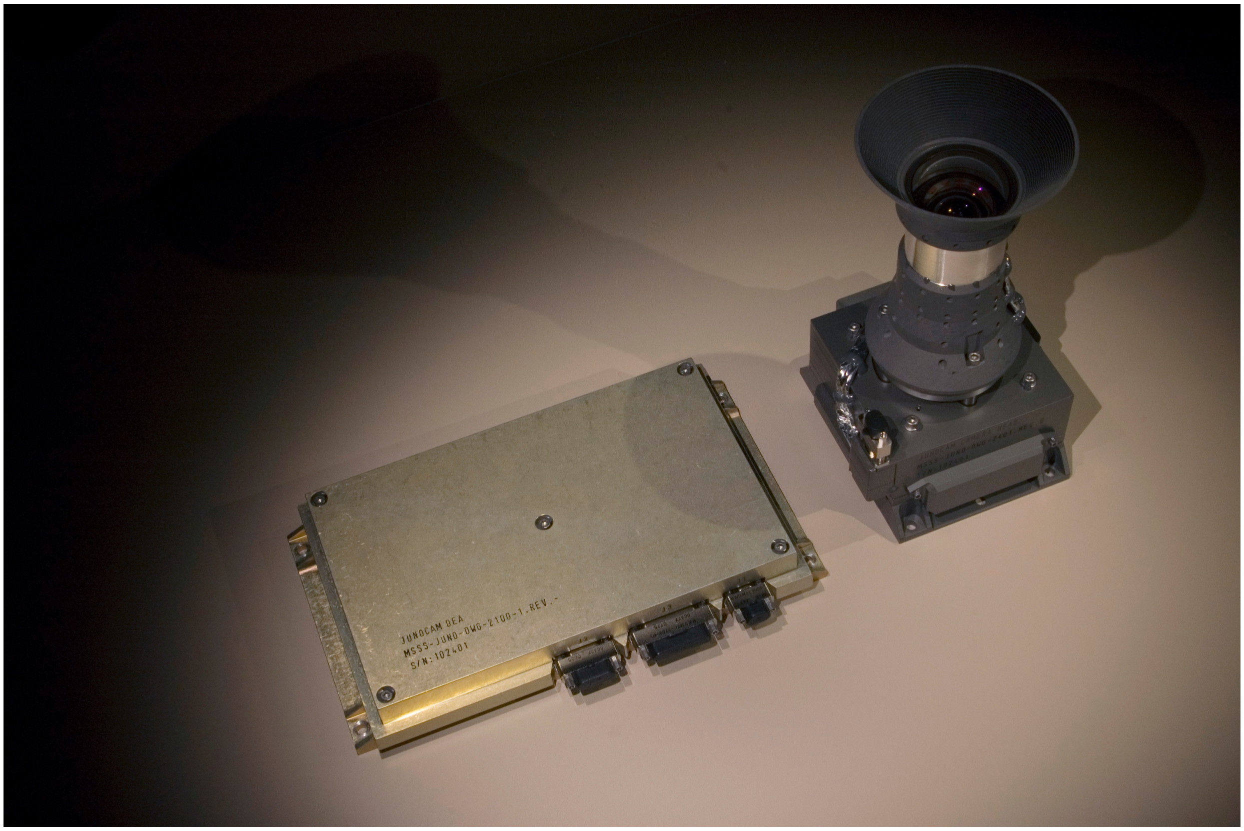
JunoCam takes images mainly during closest approach – about 3,100 miles (5,000 kilometers) above the cloud tops – when it has the best-possible vantage point. Taking pictures with a resolution of up to 25 kilometers (16 miles) per pixel, the wide-angle camera will provide high-quality views of Jupiter's atmosphere. These images will be made available on the Juno mission website for members of the public to process into color views. The public will also help choose targets for JunoCam to image, and members of the amateur astronomy community will provide maps to help in image planning.

Investigation lead: Michael Ravine, Malin Space Science Systems

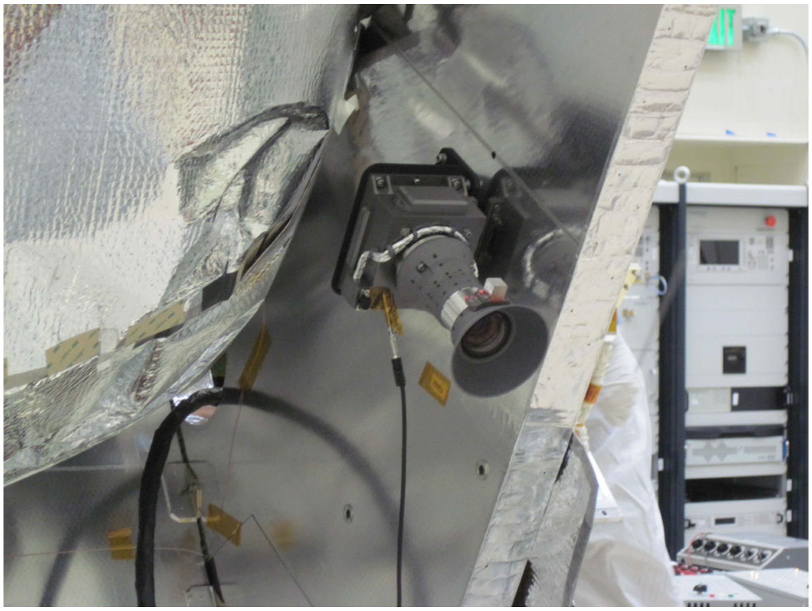
"JunoCam doesn't have the scientific responsibilities of the other Juno instruments, but we took it as a challenge to build the most capable science instrument we could. It's one of the best cameras we've ever built." -- Michael Ravine

The Juno team expects that high-energy particles surrounding Jupiter will eventually damage JunoCam's electronics to a point where the instrument will have to be shut down permanently. The camera is designed to last for at least seven orbits – enough time to take many pictures.

JunoCam's hardware is based on a descent camera, called MARDI, that was developed for NASA's Curiosity Mars rover. Some of its software was originally developed for NASA's Mars Odyssey and Mars Reconnaissance Orbiter spacecraft. JunoCam is provided by Malin Space Science Systems.



JunoCam consists of a camera head and an electronics box (the box is housed in Juno's protective radiation vault).



JunoCam is shown mounted to the spacecraft, prior to launch.

Instrument stats:
Image field of view: 58 degrees; 0.7 mrad/pixel

Spectral range:
400-900 nanometers

Spectral filters: 3 RGB color, 1 methane [878-899 nanometers])

Location: Side of spacecraft

Image size: 1600 x 4800 pixel 3-color image;
800 x 2400 pixel
methane-band image

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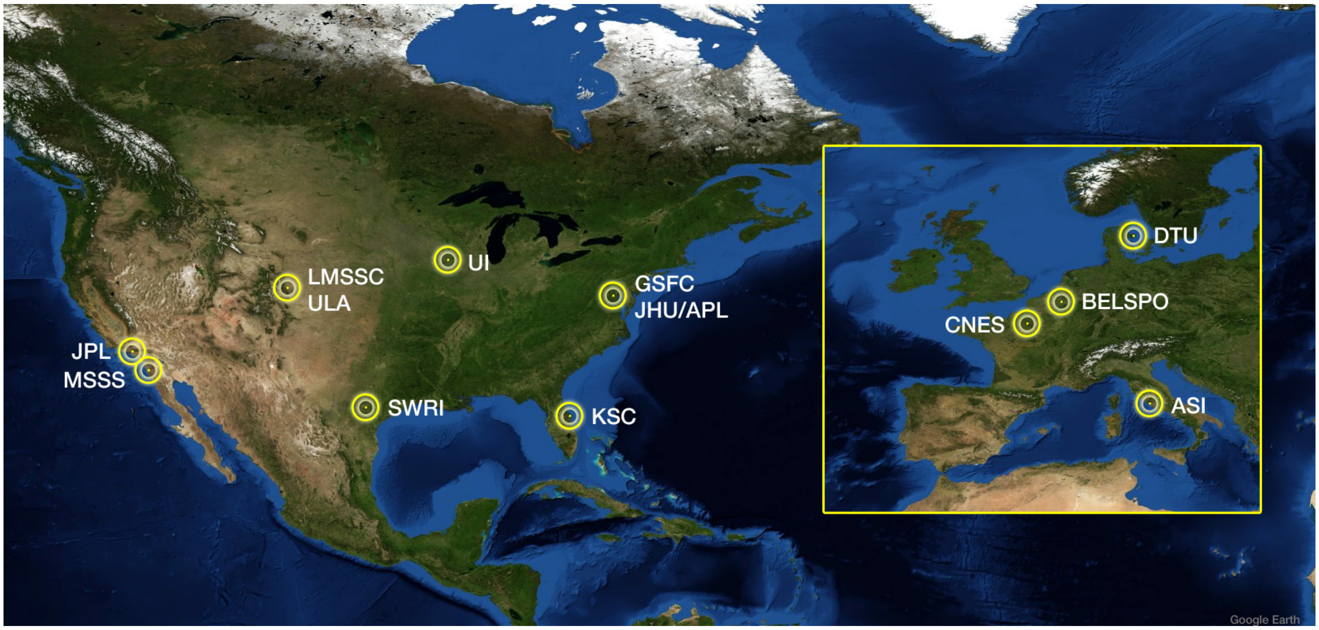
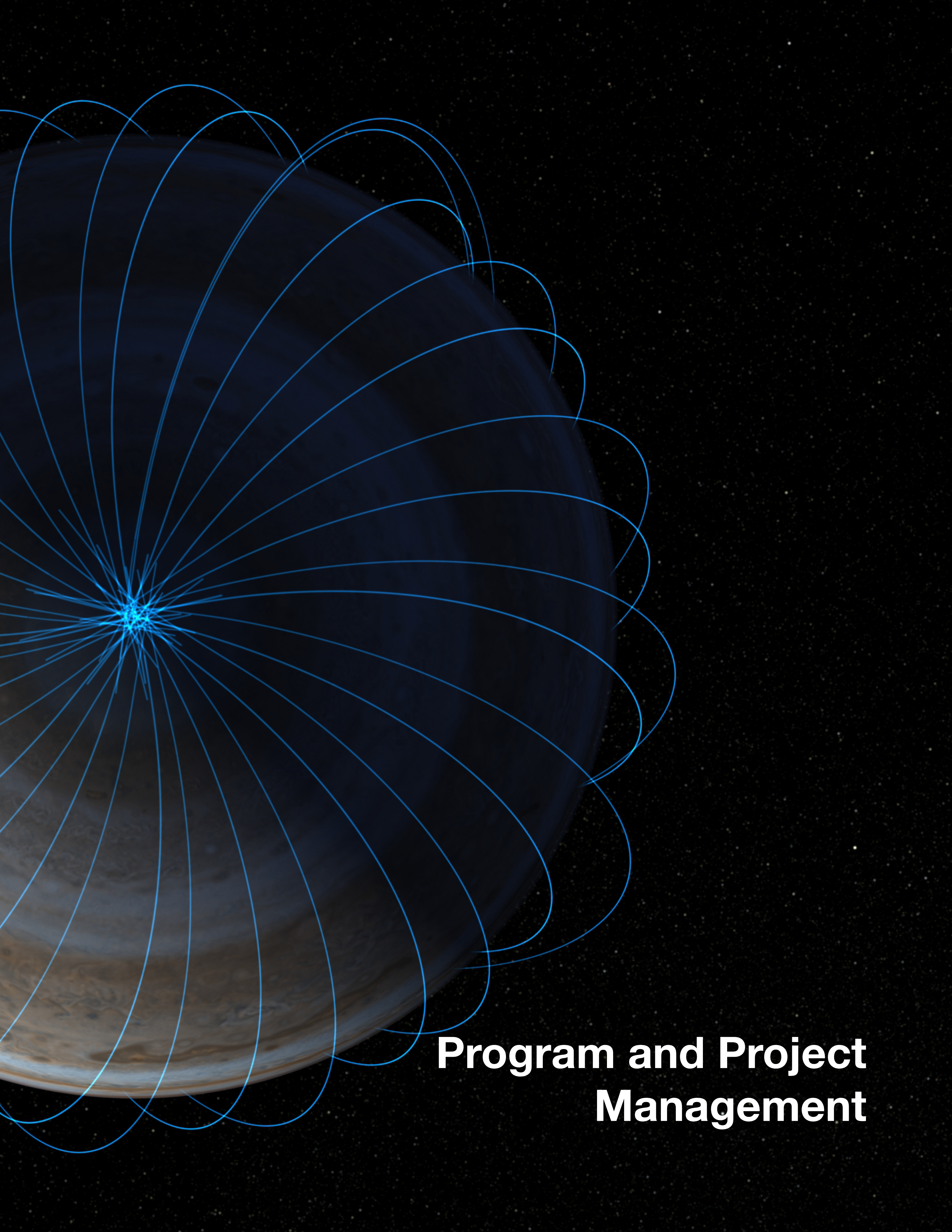
Paul Steffes	Georgia Tech, Atlanta
David Stevenson	California Institute of Technology, Pasadena
Ed Stone	California Institute of Technology, Pasadena
Richard Thorne	University of California Los Angeles
Hunter Waite	Southwest Research Institute, San Antonio



This map shows some key Juno mission partners across the U.S. and Europe. Credit: NASA/JPL-Caltech



Program and Project Management

Juno's principal investigator is Scott Bolton of Southwest Research Institute in San Antonio.

Steve Levin of NASA's Jet Propulsion Laboratory, Pasadena, Calif., is project scientist.

NASA's Jet Propulsion Laboratory, Pasadena, Calif., manages the Juno mission for the principal investigator. JPL is a division of the California Institute of Technology in Pasadena.

Southwest Research Institute in San Antonio, Texas, is home to the Juno principal investigator and several members of the Juno science team.

The Juno mission is part of the New Frontiers Program managed at NASA's Marshall Space Flight Center in Huntsville, Ala.

Lockheed Martin Space Systems, Denver, built the spacecraft.

At NASA Headquarters, Geoff Yoder is associate administrator for the Science Mission Directorate. Jim Green is director of the Planetary Science Division. Allen Bacskay is the manager of the Discovery/New Frontiers Program office, Diane Brown is Juno program executive, and Jared Espley is Juno program scientist.

Geoff Yoder

Jim Green

Allen Bacskay

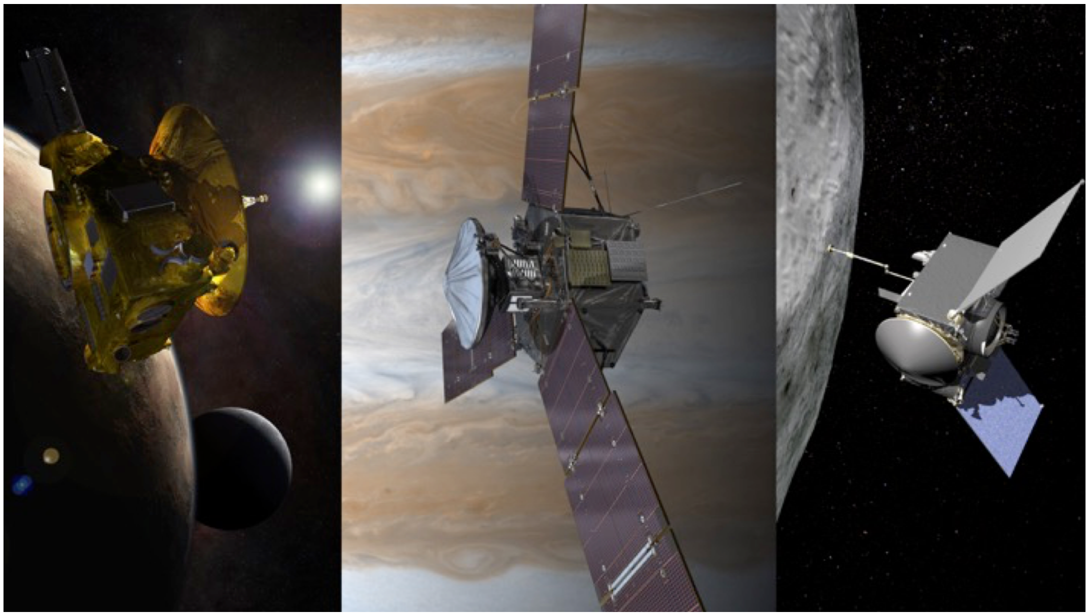
Diane Brown

Jared Espley

NASA's New Frontiers Program

The Juno mission was the second spacecraft designed under NASA's New Frontiers Program. The first was the Pluto New Horizons mission, launched in January 2006 and reached Pluto in the summer of 2015. The third mission will be the Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer, or OSIRIS-Rex — the first U.S. mission to carry materials from an asteroid back to Earth. OSIRIS-Rex is scheduled to launch in September 2016. The program provides opportunities to carry out medium- class missions identified as top priority objectives in the Decadal Solar System Exploration Survey, conducted by the Space Studies Board of the National Research Council in Washington.

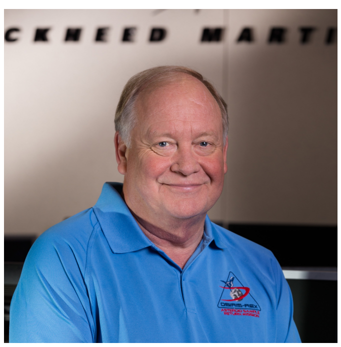
More information is online at: https://discoverynewfrontiers.nasa.gov/



At JPL, Rick Nybakken is project manager. Ed Hirst is mission manager.

Rick Nybakken

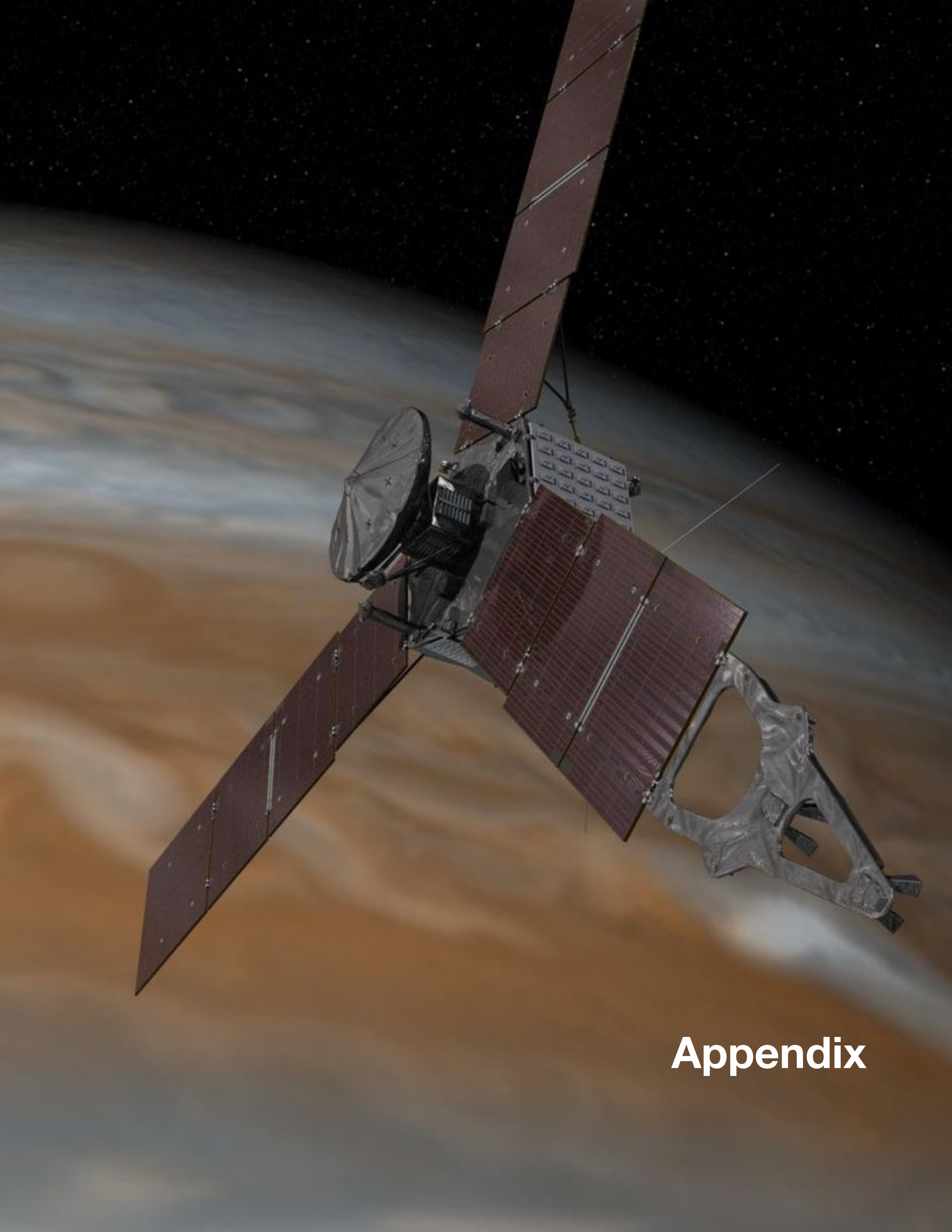
Ed Hirst



Kenneth Starnes

Lockheed Martin Space Systems in Denver designed and built Juno and handles its day-to-day operations. Kenneth Starnes is the company's Juno program manager and leads the Juno flight team.

More information about Juno is online at http://www.nasa.gov/juno and http://missionjuno.swri.edu .



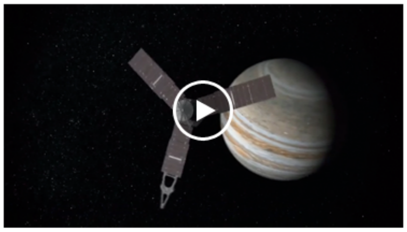
Appendix

Digital Media and Assets

To download videos, images and infographics pertaining to Jupiter Orbit Insertion, please visit the appendix section of the online press kit.

http://www.jpl.nasa.gov/news/press_kits/juno/appendix/

Animation: Jupiter Approach

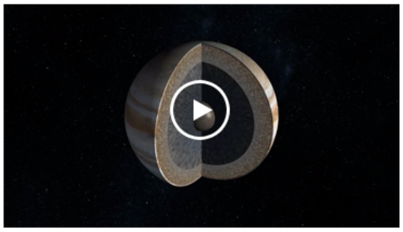


Credit: NASA/JPL-Caltech

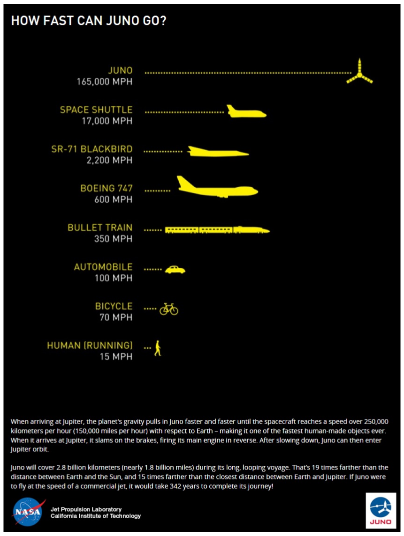
Animation: Jupiter Single Orbit

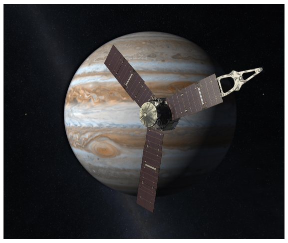
Credit: NASA/JPL-Caltech

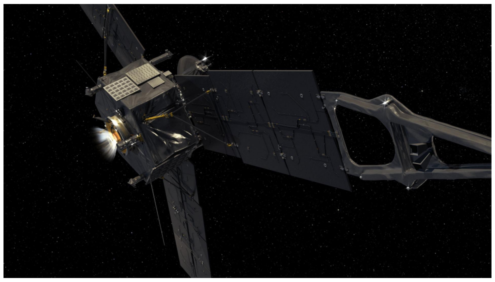
Animation: Jupiter's Interior



Credit: NASA/JPL-Caltech







Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov