Juno spacecraft enters orbit around Jupiter

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5 July 2016

NASA's Juno spacecraft successfully entered orbit around the planet Jupiter late last night (US Eastern Time), making it the eighth mission to visit Jupiter and the second to orbit the solar system's largest planet. In order to achieve orbit, Juno fired its main engines for 35 minutes to slow down enough to be captured by the planet's gravity and begin commissioning its instruments.

Juno will spend the next fifteen weeks orbiting Jupiter in two 53 day orbits as initial observations are taken to calibrate its instruments in the Jovian environment. In particular, researchers need to confirm these instruments aboard the spacecraft will operate as expected in the high radiation environment surrounding Jupiter. Once that phase is complete, the engines will fire again to bring the spacecraft into a 14-day highly elliptical polar orbit. The closest approach of the spacecraft will be a mere 4,300 kilometers above Jupiter's clouds, far closer than any previous mission.

As a result of difficulty in maintaining a polar orbit in Jupiter's immense gravitational field, the mission is expected to last for 37 science orbits over eighteen months. After that time, the spacecraft will be crashed into Jupiter's atmosphere in order to prevent it from crashing into a moon and contaminating it.

Juno, launched on August 5, 2011, is the second spacecraft of NASA's New Frontiers Program. It took five years and a gravity assist from Earth to get it to the Jovian system. It was selected by NASA to be developed in 2005, with an original launch date in June 2009. However, budget cuts forced the project back another two years. The projected total cost of the mission is $1.1 billion, a tenth of the Pentagon's new Gerald R. Ford class aircraft carrier.

The spacecraft is only the second probe to enter orbit around Jupiter. The first was Galileo, which operated from 1995 to 2003. In the intervening years, the only exploration undertaken from anywhere near the planet was a distant Ulysses flyby in 2004 and a Jupiter gravity assist done by New Horizons on its way to Pluto. The next mission to Jupiter will be one focused on looking for liquid water on the moon Europa, which is expected to launch in the mid-2020s.

Unlike the Galileo mission, which took images of various parts of the Jovian system including the moons Europa, Callisto and Ganymede, Juno will focus solely on Jupiter. The mission is particularly centered on how Jupiter formed, which is one of the biggest unknowns regarding the origins and development of the solar system.

Most models of solar system formation have Jupiter forming first, out of the remnants of what made the Sun. To better refine which current concepts are correct, or require entirely new conceptions, astronomers need to measure things currently unknown: how much water and other chemicals beyond hydrogen and helium are in Jupiter's atmosphere, what is the planet's internal structure and what is the nature of Jupiter's magnetic field near the poles.

To begin answering these questions, Juno is equipped with a suite of nine instruments. The Gravity Science instrument will track the spacecraft's velocity as it orbits Jupiter, looking for deviations in the orbit caused by changes in the planet's gravitational field, in turn giving researchers on Earth an idea of Jupiter's deep internal structure and the mass of its core. The Magnetometer will probe Jupiter's inner structure by making a three-dimensional picture of the planet's magnetic field, providing a second way to understand the composition of the matter below Jupiter's cloud layers.

The Microwave Radiometer is the primary instrument for studying Jupiter's atmosphere. It will be able to pierce 550 kilometers below what has hitherto been seen and gather data on the amounts of water and ammonia in the Jovian atmosphere. The Infrared

Auroral Mapper will obtain high resolution imagery of Jupiter's atmosphere in infrared wavelengths, mapping the planet's atmosphere and providing more insight into its chemical composition. It will also provide insight into the formation and continued existence of the centuries old storm, the Great Red Spot, a Jovian hurricane twice the diameter of Earth.

Two other instruments, Waves and UVS, will study Jupiter's aurora by looking at radio and plasma waves as well as taking images with ultraviolet light. These instruments will work alongside the JADE and JEDI particle detectors, two instruments that will look at the energies of particles trapped by Jupiter's magnetic field. Together with the Magnetometer, they will provide the most complete understanding to date of how Jupiter's magnetic field interacts with that of the Sun.

Lastly, JunoCam is a visible light telescope/camera that will provide images of Jupiter's poles, giving much needed context for the other observations. At the spacecraft's closest approach to Jupiter, the images taken will be eight times the resolution of those taken by Hubble.

The Juno spacecraft itself is an impressive technological feat. Rather than being powered by a radioactive core, which were aboard all previous spacecraft to the outer solar system, Juno is the first outer solar system mission to be powered by solar panels. Sunlight is so dim at Jupiter's orbit that the spacecraft and its instruments operate on less power than put out by a standard microwave.

Other issues arise when considering Jupiter's radiation belts and magnetic fields. Unlike in orbits around Earth, the radiation surrounding the solar system's largest planet can degrade cameras and instruments in a matter of weeks. Even though great pains have been taken to ensure that Juno's orbit only passes through the radiation belts for a limited time, the infrared and visible cameras are only expected to last about sixteen weeks into the primary mission before they are rendered useless in the hostile environment surrounding Jupiter.

To protect the other instruments, Juno is equipped with a titanium radiation vault, shielding the rest of the instrument suite. However, the solar panels will also suffer degradation, which is the main reason the mission is only slated to last eighteen months before being directed to crash into Jupiter. Unless the damage is lower than expected, the spacecraft will lose the power necessary to carry out science or respond to commands from Earth.