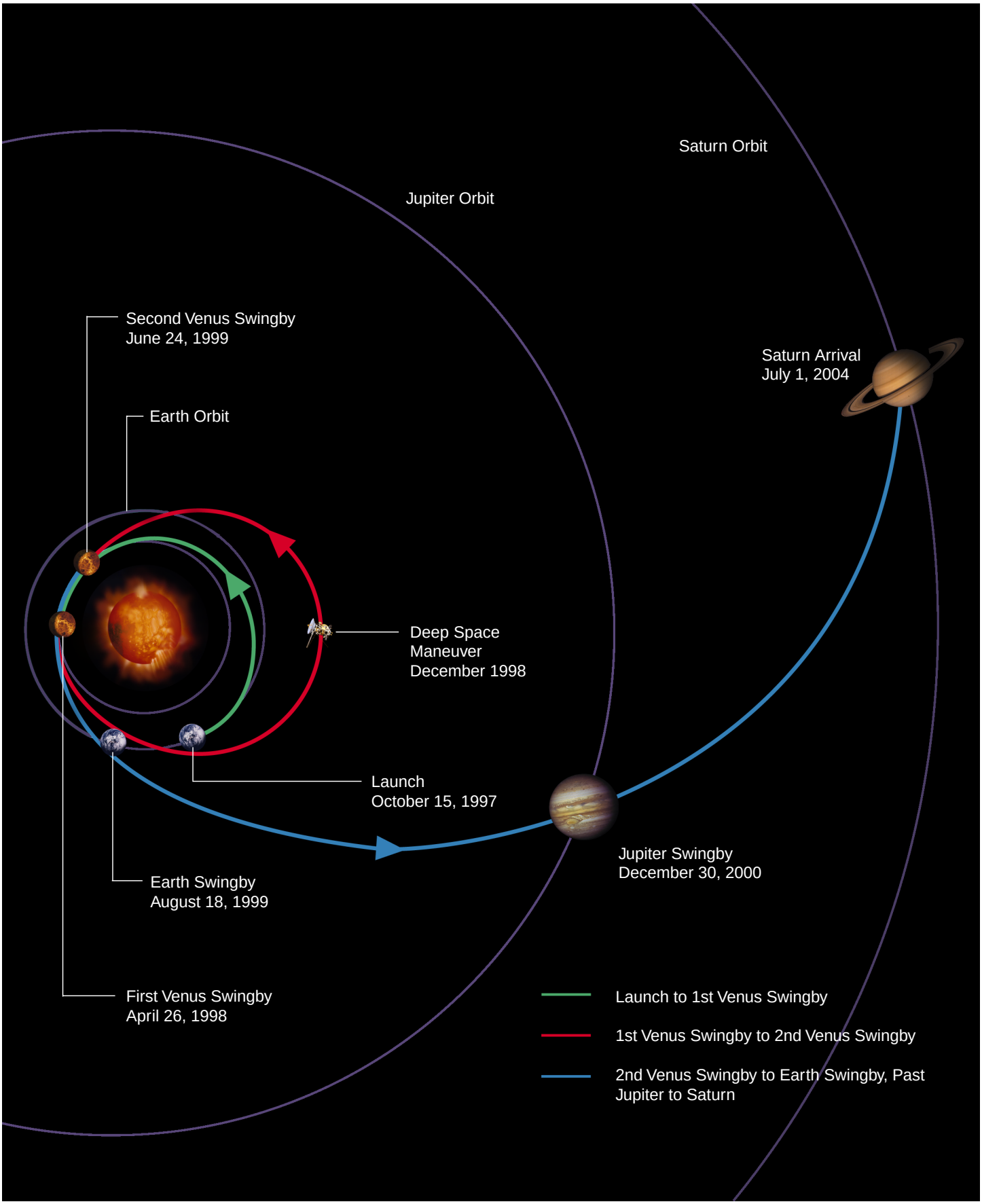
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

VVEJGA Trajectory



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On October 15, 1997, the Cassini–Huygens spacecraft was launched on an almost 7-year journey to the Saturn system. On its way, Cassini–Huygens passes Venus (twice), Earth, and Jupiter — arriving at the Saturn system on July 1, 2004. On arrival, the Huygens probe will be released from the Cassini orbiter and will descend to the surface of Saturn's largest moon, Titan, on November 27, 2004. During the Huygens probe mission, data about Titan's atmosphere, winds, and surface conditions will be collected. These data will be sent back to Earth using the Cassini orbiter's high-gain antenna as a relay. The Cassini orbiter will orbit Saturn for 4 years. The spacecraft's 12 onboard instruments will collect data about Saturn, the rings, the magnetosphere, Titan, and Saturn's smaller moons.

The Cassini–Huygens mission is managed for the National Aeronautics and Space Administration (NASA) by the Jet Propulsion Laboratory (JPL) of the California Institute of Technology. The European Space Agency, the Italian Space Agency (Agenzia Spaziale Italiana), and many European and American academic and industrial partners have teamed with NASA to make the Cassini–Huygens mission a reality.

The Cassini orbiter stands 2 stories tall; at launch, it weighed 5,300 kilograms (11,594 pounds). Over half of the orbiter's mass is propellant. The Huygens probe, built by ESA, is 2.7 meters (8.86 feet) in diameter and weighs approximately 350 kilograms (766 pounds).

Getting to Saturn

Because the rockets we now have are not large enough to send a spacecraft as massive as Cassini–Huygens directly to Saturn, and because the spacecraft cannot carry enough fuel to take it directly from Earth to Saturn, mission designers make use of the gravity of other planets to increase Cassini–Huygens' speed, thus allowing it to reach Saturn. Cassini–Huygens' journey to Saturn will take it past Venus (twice), Earth, and Jupiter in a trajectory known as VVEJGA (pronounced Vee-Jay-Gah) — the Venus-Venus-Earth-Jupiter Gravity Assist trajectory.

On October 15, 1997, Cassini–Huygens was launched from Earth on a path toward Venus. The spacecraft flew by Venus on April 26, 1998. Venus gave Cassini–Huygens a change in velocity of 7 kilometers per second (15,750 miles per hour). Thanks to Venus, Cassini–Huygens turned its back to the Sun (so to speak) and began to journey out beyond the orbit of Earth. However, the spacecraft did not have enough energy (speed) to reach to the orbit of Saturn if it were to continue on this path. So, on December 3, 1998, Cassini–Huygens performed a deep space maneuver with its large rocket engine. This modified the spacecraft's path, so that it looped back toward the Sun to take advantage of another gravity assist from Venus.

In summer 1999, Cassini–Huygens made two planetary swingbys: one swingby of Venus (June 24, 1999) at 6.7 kilometers per second (14,990 miles per hour) and one of Earth (August 18, 1999) at 15.5 kilometers per second (34,680 miles per hour). These two swingbys gave Cassini–Huygens enough energy to send it on a path towards Jupiter, where it will get its final boost to Saturn. Cassini–Huygens' swingby of Jupiter will occur on December 30, 2000 (at 2.2 kilometers per second or 4,923 miles per hour). This swingby will put Cassini–Huygens on a final path towards Saturn where it is scheduled to arrive on July 1, 2004.

EDUCATIONAL ACTIVITY

How Far is Far?

To get an idea of how far away Saturn is from Earth, we can consider the following question recently submitted by a reader of the Cassini website (<http://www.jpl.nasa.gov/cassini>): At 65 miles per hour, how long would it take to traverse the distance from Earth to Saturn?

Since the shortest straight-line distance between the orbits of Earth and Saturn is about 1,200,000,000 kilometers (about 750,000,000 miles), to traverse that distance at 65 miles per hour would take over 1,300 years!

However, it is almost impossible to travel from Earth to Saturn in a straight line outward from the Sun; that requires far too much energy. If there were no gravity assists available, the lowest-energy transfer orbit would be an ellipse — with the Sun at one focus, Earth at the closest point of the ellipse, and Saturn at the farthest point of the ellipse. Such a trajectory is typical of many past spacecraft missions to the planets. Along such a trajectory, the distance from Earth to Saturn is about 3,650,000,000 kilometers (2,270,000,000 miles). To traverse that distance at 65 miles per hour would take almost 4,000 years!

However, the actual trajectory is one along which the Cassini–Huygens spacecraft travels inward toward Venus, circles the Sun once and flies past Venus and Earth, flies past Jupiter, and finally arrives at Saturn. The total distance traversed is close to 5,000,000,000 kilometers (about 3,200,000,000 miles), and the corresponding time to travel that distance at 65 miles per hour is a whopping 5,600 years! Cassini–Huygens makes this same trip in 6.7 years, and its average speed is therefore more than 54,000 miles per hour! Far out!

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