www.contour2002.org

CONTOUR

Comet Nucleus Tour

A Mission to Study the Diversity of Comet Nuclei

The CONTOUR mission is our most detailed look yet at the heart of a comet — its nucleus. CONTOUR will fly to within 100 kilometers (about 60 miles) of at least two comet nuclei, assessing their diversity and discovering how these primitive building blocks of the solar system have evolved since forming more than 4.5 billion years ago.

Key Measurements

- Detailed imaging of the nucleus (4-meter resolution)
- Spectral mapping of the nucleus (100- to 200-meter resolution)
- Analysis of gas and dust surrounding the nucleus

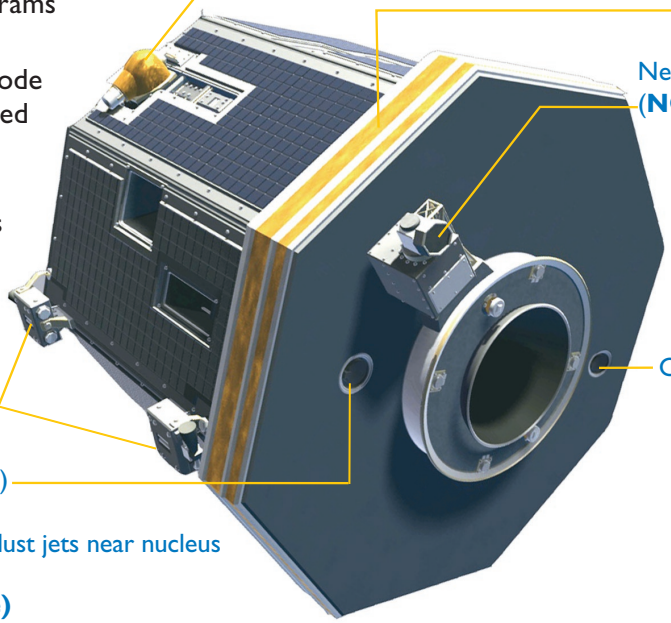
THE SPACECRAFT

Simple and compact, CONTOUR has few hinged and movable parts; a body-mounted solar array; and a mission geometry suitable for fixed, passive antennas. Operators point the instruments and antennas by moving the spacecraft. A layered shield of Nextel and Kevlar protects CONTOUR from speeding dust and particles near the nucleus.

- 8-sided body; 2 meters (6 feet) tall; 2 meters wide
- Total weight: 970 kilograms (2,138 pounds)
  - Dry spacecraft: 387 kilograms
  - Solid rocket motor: 503 kilograms
  - Hydrazine fuel: 80 kilograms
- Two modes of operation
  - Spin-stabilized cruise mode
  - Precision, 3-axis stabilized encounter mode
- Designed for solar distance up to 195 million kilometers (about 121 million miles).
- Two, 5-gigabit solid-state data recorders

MISSION PROFILE

- **Launch:** July 2002 from Cape Canaveral Air Force Station, Florida, aboard a Delta II (7425) launch vehicle.
- **Innovative Launch Concept:** CONTOUR orbits Earth for several weeks after launch, moving into position for maneuver sending it into a solar orbit on Aug. 15, 2002.
- **Close-up Encounters:** Fly past and collect data on comets Encke (Nov. 2003) and Schwassmann-Wachmann 3 (June 2006).
- **Mission Flexibility:** Earth swingbys (gravity-assist maneuvers) refine trajectory for comet encounters or retarget spacecraft toward a "new" comet.
  - Swingbys occur Aug. 2003; Aug. 2004; Feb. 2005; Feb. 2006.
- **Minimal Operations Support:** Spacecraft spends 65% of flight in unattended, spin-stabilized "hibernation."



CONTOUR Remote Imager/Spectrograph (**CRISP**)
- Takes high-resolution photos of nucleus
- Maps ice and rock types on surface

Mass: **26.7 kg (59 pounds)**
Power: **45 watts (average)**
Supplier: **Johns Hopkins University Applied Physics Laboratory**

Dust Shield

Neutral Gas and Ion Mass Spectrometer (**NGIMS**)
- Counts and analyzes atoms, molecules and ions around nucleus

Mass: **13.5 kg (30 pounds)**
Power: **47 watts (average)**
Supplier: **NASA/ Goddard Space Flight Center**

Comet Impact Dust Analyzer (**CIDA**)
- Determines composition of dust surrounding nucleus

Mass: **10.5 kg (23 pounds)**
Power: **13 watts (average)**
Supplier: **von Hoerner & Sulger, GmbH**

Thruster Pods (2 of 4)

CONTOUR Forward Imager (**CFI**)
- Locates comet on approach
- Snaps color pictures of gas, dust jets near nucleus

Mass: **9.7 kg (21 pounds)**
Power: **10 watts (average)**
Supplier: **Johns Hopkins University Applied Physics Laboratory**

THE COMETS

CONTOUR's target comets have diverse physical characteristics and will be relatively close to Earth during each encounter.

Evolved yet active, **Encke** has been observed at more apparitions (57) than any other comet, even Halley. Encke takes about 3 years to orbit the Sun. Encke has traveled this orbit for thousands of years, so its continued activity is rather puzzling.

Schwassmann-Wachmann 3 was discovered in 1930. Its activity was predictable until the mid-1990s, when it split into several pieces. When CONTOUR reaches SW3 in 2006, it could see relatively fresh, unaltered surfaces and evidence of materials *inside* the nucleus.

A "New" Comet

Should a new, scientifically appealing comet reach the inner solar system during the mission, CONTOUR can change its path (after the Encke encounter) to study it. The potential target should be active and bright — much like comet Hale-Bopp, which was prominent in 1997.

THE ENCOUNTERS

CONTOUR first "sees" the target comet several days before each encounter, while the nucleus is still thousands of kilometers away. The mission team then directs the craft toward the comet and prepares to gather data.

Timeline

60 to 10 days before encounter: The mission team determines the spacecraft's position and checks out its systems and instruments.

10 days to 12 hours before: CONTOUR snaps pictures and makes spectral observations of the coma. The images also help operators navigate the spacecraft.

12 hours before to 12 hours after: CONTOUR is in full encounter mode; all instruments are turned on and programmed to fill the spacecraft's data recorders.

12 hours to 15 days after: CONTOUR sends data back to Earth, and the mission team verifies the spacecraft's orbit.

THE CAMERA EYE

A simulated look at Encke's nucleus through CRISP, noting time and distance to closest approach.

1 astronomical unit (AU) is the average distance between Earth and the Sun, about 150 million kilometers (93 million miles).

Encounter Date	Sun Distance (AU)	Earth Distance (AU)	Flyby Speed (km/sec)
Encke, 11/12/03	1.08	0.27	28.2
SW3, 6/19/06	0.96	0.32	14.0

MISSION MANAGEMENT

Principal Investigator:
Dr. Joseph Veverka, Cornell University

Project Management, Spacecraft Development and Mission Operations:
The Johns Hopkins University Applied Physics Laboratory

Navigation and Deep Space Network (DSN) Support:
NASA Jet Propulsion Laboratory

Science Team:
18 co-investigators from universities, industry and government agencies in the U.S. and Europe

A NASA DISCOVERY MISSION

CONTOUR is the sixth mission in NASA's innovative Discovery Program of low-cost, highly focused scientific exploration projects. Other Discovery missions to small bodies include Near Earth Asteroid Rendezvous (NEAR) — the first mission to orbit and land on an asteroid — the Stardust and Deep Impact comet studies, and the Dawn asteroid-orbiter mission. For more information visit **http://discovery.nasa.gov**.

EDUCATION AND PUBLIC OUTREACH

The mission's comprehensive Education and Public Outreach efforts are designed to bring students, teachers and the public along on CONTOUR's amazing ride of scientific discovery. The program brings the thrill and wonder of exploring comets into classrooms and homes through Web sites, teacher and student workshops, educational programs, electronic materials, professional and amateur astronomer involvement and media events.

Visit CONTOUR on the Web: **www.contour2002.org**

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