ACE: Advanced Composition Explorer
Aerobraking: A maneuver where a spacecraft’s orbit is changed by reducing its energy through repeated passages in a planet’s atmosphere.
Aerocapture: A maneuver where a spacecraft is inserted in orbit around a planet by slowing it down through a passage in the planet’s atmosphere.
Aerogel: A silicon-based foam in which the liquid component of a gel has been replaced with gas or, for use in space, effectively with vacuum, resulting in a very low density solid.
Albedo: in first approximation a measure of the reflecting power of a surface.
Aphelion: The point of maximum distance from the Sun of a solar orbit. Its contrary is the perihelion.
APL: Applied Physics Laboratory
Apoapsis: The point of maximum distance from the central body of any elliptical orbit. This word has been used to avoid complicating the nomenclature, but a term tailored to the central body is often used. The only exceptions used herein owing to their importance were for Earth (apogee) and the Sun (aphelion). The contrary of apoapsis is periapsis.
Apogee: The point of maximum distance from the Earth of a satellite orbit. Its contrary is the perigee.
ASI: Agenzia Spaziale Italiana (Italian Space Agency)
ASPERA: Automatic Space Plasma Experiment with a Rotating Analyzer
Astronomical Unit: To a first approximation the average distance between the Earth and the Sun is 149,597,870,691 (±30) meters.
AU: Astronomical Unit
AXAF: Advanced X-ray Astrophysical Facility
BMDO: Ballistic Missile Defense Organization
BNSC: British National Space Council
Booster: Auxiliary rockets used to boost the lift-off thrust of a launch vehicle.
Bus: A structural part common to several spacecraft.
CAESAR: Comet Atmosphere Encounter and Sample Return or Comet Atmosphere and Earth Sample Return
Glossary

CCD: Charge Coupled Device
CHON: Carbon, Hydrogen, Oxygen, Nitrogen rich molecules
CISR: Comet Intercept and Sample Return
CMOS: Complementary Metal–Oxide Semiconductor
CNES: Centre National d’Etudes Spatiales (the French National Space Studies Center)
Conjunction: The time when a solar system object appears close to the Sun as seen by an observer. A conjunction where the Sun is between the observer and the object is called ‘superior conjunction’. A conjunction where the object is between the observer and the Sun is called ‘inferior conjunction’. See also opposition.
CONTOUR: Comet Nucleus Tour
Cosmic velocities: Three characteristic velocities of spaceflight:
   First cosmic velocity: Minimum velocity to put a satellite in a low Earth orbit. This amount to some 8 km/s.
   Second cosmic velocity: The velocity required to exit the terrestrial sphere of attraction for good. Starting from the ground, this amount to some 11 km/s. It is also called ‘escape’ speed.
   Third cosmic velocity: The velocity required to exit the Solar System for good.
CRAF: Comet Rendezvous/Asteroid Flyby
Cryogenic propellants: These can be stored in their liquid state under atmospheric pressure at very low temperature; e.g. oxygen is a liquid below –183°C.
DASH: Demonstrator of Atmospheric reentry System with Hyperbolic velocity
Deep Space Network: A global network built by NASA to provide round-the-clock communications with robotic missions in deep space.
DeeDri: Deep Driller
Direct ascent: A trajectory on which a deep-space probe is launched directly from the Earth’s surface to another celestial body without entering parking orbit.
DS: Deep Space
DSN: Deep Space Network
Ecliptic: The plane of the Earth’s orbit around the Sun.
EELV: Evolved Expandable Launch Vehicle
Ejecta: Material from a volcanic eruption or a cratering impact that is deposited all around the source.
ESA: European Space Agency
Escape speed: See Cosmic velocities
FIDO: Field Integrated, Design, and Operations
Flyby: A high relative speed and short duration close encounter between a spacecraft and a celestial body.
GPS: Global Positioning System
GRB: Gamma-Ray Bursts
GRO: Gamma-Ray Observatory
GSFC: Goddard Space Flight Center
HER: Halley Earth Return
HST: Hubble Space Telescope
Hypergolic propellants: Two liquid propellants that ignite spontaneously on coming
into contact, without requiring an ignition system. Typical hypergolics are hydrazine and nitrogen tetroxide.

IBEX: Interstellar Boundary Explorer
ICE: International Cometary Explorer
IRAS: Infrared Astronomical Satellite
ISAS: Institute of Space and Astronautical Sciences
ISO: Infrared Space Observatory
ISS: Cassini’s Imaging Science Subsystem
ISS: International Space Station
ITAR: International Traffics in Arms Regulations
IUS: Inertial Upper Stage (previously: Interim Upper Stage)
JAXA: Japanese Aerospace Exploration Agency
JPL: Jet Propulsion Laboratory (a Caltech laboratory under contract to NASA)
Lagrangian Points: Five equilibrium points for a gravitational system comprising two large bodies (e.g. the Sun and a planet) and a third body of negligible mass.
Lander: A spacecraft designed to land on another celestial body.
LaRC: Langley Research Center
Launch window: A time interval during which it is possible to launch a spacecraft to ensure that it attains the desired trajectory.
Lidar: laser radar
LINEAR: Lincoln Near Earth Asteroid Research
Lyman-alpha: The emission line corresponding to the first energy level transition of an electron in a hydrogen atom.
MAGE: Mars Airborne Geophysical Explorer
MAV: Mars Ascent Vehicle
MCO: Mars Climate Orbiter
MER: Mars Exploration Rovers
MESSENGER: Mercury Surface, Space Environment, Geochemistry and Ranging
MGS: Mars Global Surveyor
MINERVA: Micro/Nano Experimental Robot Vehicle for Asteroid
MIT: Massachusetts Institute of Technology
MPF: Mars Pathfinder
MPL: Mars Polar Lander
MRO: Mars Reconnaissance Orbiter
MUSES: MU [rocket] Space Engineering Satellite
NAS: National Academy of Sciences
NASA: National Aeronautics and Space Administration
NASDA: National Space Development Agency
NEAR: Near-Earth Asteroid Rendezvous
NEAT: Near-Earth Asteroid Tracking program
NEP: Nuclear Electric Propulsion
NExT: New Exploration of Tempel 1
NOTSNIK: Naval Ordnance Test Station “Sputnik”
NSTAR: NASA Solar Electric Propulsion Technology Application Readiness
Occultation: When one object passes in front of and occults another, at least from the point of view of the observer.

OMEGA: Observatoire pour la Minéralogie, l’Eau, les Glaces et l’Activité, observatory for mineralogy, water, ices and activity

OMV: Orbital Maneuvering Vehicle

Orbit: The trajectory on which a celestial body or spacecraft is traveling with respect to its central body. There are three possible cases:

Elliptical orbit: A closed orbit where the body passes from minimum distance to maximum distance from its central body every semiperiod. This is the orbit of natural and artificial satellites around planets and of planets around the Sun.

Parabolic orbit: An open orbit where the body passes through minimum distance from its central body and reaches infinity at zero velocity in infinite time. This is a pure abstraction, but the orbits of many comets around the Sun can be described adequately this way.

Hyperbolic orbit: An open orbit where the body passes through minimum distance from its central body and reaches infinity at non-zero speed. This describes adequately the trajectory of spacecraft with respect to planets during flyby maneuvers.

Opposition: The time when a solar system object appears opposite to the Sun as seen by an observer.

Orbiter: A spacecraft designed to orbit a celestial body.

OSCAR: Orbiting Sample Capture and Return

Parking orbit: A low Earth orbit used by deep-space probes before heading to their targets. This relaxes the constraints on launch windows and eliminates launch vehicle trajectory errors. Its contrary is direct ascent.

PAW: Position Adjustable Workbench

Periapsis: The minimum distance point from the central body of any orbit. See also apoapsis.

PEPE: Plasma Experiment for Planetary Exploration

Perigee: The minimum distance point from the Earth of a satellite. Its contrary is apogee.

Perihelion: The minimum distance point from the Sun of a solar orbit. Its contrary is the aphelion.

PFF: Pluto Fast Flyby

PICA: Phenolic Impregnated Carbon Ablator

PKE: Pluto Kuiper Express

PLUTO: Planetary Underground Tool

PREMIER: Programme de Retour d’Echantillons Martiens et Installation d’Expériences en Réseau, Mars sample return and network experiment establishment program

‘Push-broom’ camera: A digital camera consisting of a single row of pixels, with the second dimension created by the motion of the camera itself.

RAT: Rock Abrasion Tool

Rendezvous: A low relative speed encounter between two spacecraft or celestial bodies.
REP: Radioisotope Electric Propulsion
Retrorocket: A rocket whose thrust is directed opposite to the motion of a spacecraft in order to brake it.
Rj: Jupiter radii (approximately 71,200 km)
Rover: A mobile spacecraft to explore the surface of another celestial body.
Rs: Saturn radii (approximately 60,330 km)
RTG: Radioisotope Thermal Generator
RTH: Radioisotope Thermal Heater
SEDSat: Students for the Exploration and Development of Space Satellite
SERT: Space Electric Rocket Test
SEP: Solar Electric Propulsion
SIRTF: Shuttle (or Space) Infrared Telescope Facility
SMART: Small Missions for Advanced Research in Technology
SOCCER: Sample of Comet Coma Earth Return
Sol: A Martian solar day, lasting 24 Terrestrial hours, 39 minutes, and 35.244 seconds
Solar flare: A solar chromospheric explosion creating a powerful source of high energy particles.
Space probe: A spacecraft designed to investigate other celestial bodies from a short range.
Spectrometer: An instrument to measure the energy of radiation as a function of wavelengths in a portion of the electromagnetic spectrum. Depending on the wavelength the instrument is called, e.g. ultraviolet, infrared, gamma-ray spectrometer etc.
Spin stabilization: A spacecraft stabilization system where the attitude is maintained by spinning the spacecraft around one of its main inertia axes.
Synodic period: The period of time between two consecutive superior or inferior conjunctions or oppositions of a solar system body.
TEGA: Thermal and Evolved Gas Analyzer
Telemetry: Transmission by a spacecraft via a radio system of engineering and scientific data.
THEMIS: Thermal-Emission Imaging System
3-axis stabilization: A spacecraft stabilization system where the axes of the spacecraft are kept in a fixed attitude with respect to the stars and other references (the Sun, the Earth, a target planet etc.)
UTC: Universal Time Coordinated (essentially Greenwich Mean Time)
UTTR: Utah Test and Training Range
VESAT: Venus Environmental Satellite
Vidicon: A television system based on resistance changes of some substances when exposed to light. It has been replaced by the CCD.
VLBI: Very Long Baseline Interferometry
WIRE: Wide-field Infrared Explorer
WSB: Weak Stability Boundaries
## CHRONOLOGY OF SOLAR SYSTEM EXPLORATION 1997–2003

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>23 September 1999</td>
<td>Mars Climate Orbiter is lost as it crashes on Mars</td>
</tr>
<tr>
<td>3 December 1999</td>
<td>Mars Polar Lander is lost as it crashes on Mars</td>
</tr>
<tr>
<td>22 September 2001</td>
<td>Deep Space 1 flies by comet Borrelly</td>
</tr>
<tr>
<td>24 October 2001</td>
<td>Mars Odyssey enters orbit around Mars</td>
</tr>
<tr>
<td>25 December 2003</td>
<td>Mars Express enters orbit around Mars while the Beagle 2 lander is lost</td>
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**Related milestones**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>2 January 2004</td>
<td>Stardust flies by comet Wild 2</td>
</tr>
<tr>
<td>4 January 2004</td>
<td>Spirit lands on crater Gusev, Mars</td>
</tr>
<tr>
<td>25 January 2004</td>
<td>Opportunity lands in Meridiani Planum, Mars</td>
</tr>
<tr>
<td>1 July 2004</td>
<td>Cassini enters orbit around Saturn</td>
</tr>
<tr>
<td>8 September 2004</td>
<td>Genesis crashes to Earth, returning samples of the solar wind</td>
</tr>
<tr>
<td>15 January 2005</td>
<td>Huygens lands on Titan</td>
</tr>
<tr>
<td>12 September 2005</td>
<td>Hayabusa rendezvous with asteroid Itokawa</td>
</tr>
<tr>
<td>15 January 2006</td>
<td>Stardust returns samples of comet Wild 2 to Earth</td>
</tr>
<tr>
<td>13 June 2010</td>
<td>Hayabusa returns samples of asteroid Itokawa to Earth</td>
</tr>
<tr>
<td>15 February 2011</td>
<td>Stardust flies by comet Tempel 1</td>
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### PLANETARY LAUNCHES 1997–2003

<table>
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<tr>
<th>Launch Date</th>
<th>Name</th>
<th>Main Target</th>
<th>Launcher</th>
<th>Nation</th>
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<td>Cassini</td>
<td>Saturn</td>
<td>Titan IVB</td>
<td>USA/Italy</td>
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<tr>
<td></td>
<td>Huygens</td>
<td>Titan</td>
<td>M-V</td>
<td>Japan</td>
</tr>
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<td>3 July 1998</td>
<td>(Nozomi)</td>
<td>Mars</td>
<td>M-V</td>
<td>Japan</td>
</tr>
<tr>
<td>24 October 1998</td>
<td>Deep Space 1</td>
<td>Asteroid + Comet</td>
<td>Delta 7326</td>
<td>USA</td>
</tr>
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<td>11 December 1998</td>
<td>(MCO)</td>
<td>Mars</td>
<td>Delta 7425</td>
<td>USA</td>
</tr>
<tr>
<td>3 January 1999</td>
<td>(MPL)</td>
<td>Mars</td>
<td>Delta 7425</td>
<td>USA</td>
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<td>7 February 1999</td>
<td>Stardust</td>
<td>Comet</td>
<td>Delta 7426</td>
<td>USA</td>
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<td>Mars Odyssey</td>
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<td>Delta 7925</td>
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<td>30 June 2001</td>
<td>WMAP</td>
<td>L2</td>
<td>Delta 7425-10</td>
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<td>Soyuz-FG</td>
<td>ESA</td>
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<td>(Beagle 2)</td>
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<td>UK/ESA</td>
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<td>Spitzer</td>
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<td>Delta 7920H</td>
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Missions in parentheses are missions that failed, but the status of Genesis is disputed. Despite crashing to Earth instead of landing the sample-return mission looks set to achieve its objectives.

### CASSINI TARGETED ENCOUNTERS

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<tr>
<th>Date</th>
<th>Satellite</th>
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<td>11 June 2004</td>
<td>Phoebe</td>
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<td>26 October 2004</td>
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<td>Enceladus (E1)</td>
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<td>Titan (T5)</td>
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<td>Tethys</td>
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Aerospace America
l’Astronomia (in Italian)
Aviation Week & Space Technology
Espace Magazine (in French)
Flight International
Novosti Kosmonavtiki (in Russian)
Science
Scientific American
Sky & Telescope
Spaceflight

INTERNET SITES

ESA (www.esa.int)
Jonathan’s Space Home Page (planet4589.org/space/space.html)
JPL (www.jpl.nasa.gov)
Malin Space Science Systems (www.msss.com)
NASA NSSDC (nssdc.gsfc.nasa.gov)
Novosti Kosmonavtiki (www.novosti-kosmonavtiki.ru)
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Space Daily (www.spacedaily.com)
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