NASA Facts

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

Genesis Solar Wind Sample Return Mission

Genesis will bring back samples of solar matter in the form of the solar wind for analysis in Earth laboratories, in order to better understand the origin of the solar system.

Genesis will head out of Earth's atmosphere to a location where it is balanced between the Sun's and Earth's gravities. Once there, it will open and expose collector arrays of ultrapure materials such as sapphire, gold and diamond to capture particles from the solar wind.

Science Background

All the objects in our solar system originated from a cloud of interstellar gas, dust and ice, known as the solar nebula, which scientists assume was relatively homogeneous in its chemical and isotopic composition.
In contrast, the most striking feature of the present solar system is the great diversity among its objects. Even the smallest moons around outer solar system planets appear to differ among themselves. Meteorites can show great differences in composition from their parent asteroids and comets in the asteroid belt. Yet all this diversity appears to have arisen from a comparatively homogeneous solar nebula.

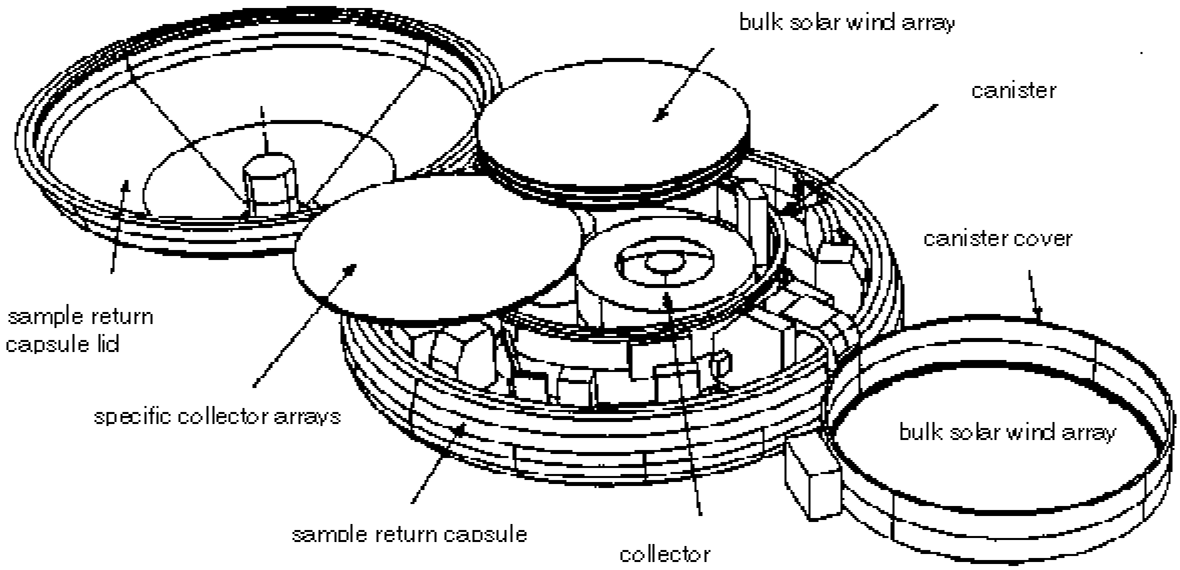
To know the conditions, processes and events in the solar nebula that produced these highly diverse objects, scientists will compare the chemical and isotopic compositions of the planets with the solar nebula compositions provided by Genesis. For the first time, precise information will be available to model these questions. Genesis will also investigate fundamental assumptions, such as whether or not solar and nebular compositions are really identical.

The Sun's outer layer from which the solar wind emanates has the same composition as the original solar nebula. The solar system was formed by the gravitational collapse of an interstellar gas-dust-ice cloud. Though the interior of the Sun has been modified by nuclear reactions, the outer layers preserve the initial solar composition because no matter is exchanged between the interior and the surface of the Sun.

The collection approach used by Genesis was successfully demonstrated by the University of Bern, Switzerland, during the Apollo missions to the Moon. An aluminum foil flag was planted on the Moon's surface and, since the Moon has no atmosphere or magnetic field, exposed to the solar wind at the beginning of the mission and brought in at the end. The Apollo experiment measured only helium and neon isotopes, but obtained results of great importance, Genesis will be able to measure more elements, more precisely.

Genesis Mission Science Objectives:

• *Gather precise data about the relative amounts of the different forms of a given element in solar composition.* For some elements -- like oxygen or neon -- it is certain that these isotopic ratios will differ from those found in the same elements on Earth.



Genesis' sample return capsule

• *Significantly improve knowledge about the differing amounts of elements in solar composition, called solar abundances*. Genesis' goal is to improve by at least threefold the accuracy of estimates of the abundance of each element. The best present source of elemental abundances has uncertainties in its modeling that result in significant errors in the calculated abundances.
• *Obtain separate samples of the three different types or regimes of solar wind*. These will be collected separately, and compared to the bulk of the solar wind.
• *Provide a reservoir of solar matter for 21st century science.* The mission phase of sample analysis will not consume all of the available collector material. The remainder will be carefully curated for future studies. There need be only one solar wind sample return mission.

Building on these general objectives, the Genesis science team has developed a set of 18 specific measurement objectives to address specific science issues. For example, differences in the solar and terrestrial isotopic compositions of nitrogen and the noble gases (neon, argon, krypton and xenon) will form the basis for definitive modeling of the extent of losses from Earth's atmosphere early in the history of our planet.

Science Operations

The part of the spacecraft that returns to Earth, the sample return capsule, contains a canister that holds the solar wind collector materials, protecting them from contamination during launch and reentry. The canister was built at the Jet Propulsion Laboratory, then cleaned in an ultra-pure environment at Johnson Space Center, before the collector materials were loaded. Also inside the canister is a solar wind concentrator, a bowl-shaped instrument that will focus the ions in the solar wind to 20 times its normal concentration on a special set of target materials. The enhanced concentration is necessary to measure elements such as oxygen and nitrogen above the impurity background in all available materials.

After the craft enters its orbit, the solar collectors fold out, allowing ions and particles from the solar wind to embed themselves in small hexagonal collector tiles on the face of the arrays. The solar wind concentrator is exposed as the collector arrays move out.

As time passes, the spacecraft encounters the different solar wind regimes. These are recognized by electron and ion monitors located on the spacecraft's main body outside the sample return capsule. The signals from the monitors to recognize the different solar wind regimes are processed by onboard computers. Once a regime is identified, a collector array dedicated to this regime is deployed and two other sets of arrays are hidden, providing independent samples of the different regimes.

Mission Profile

The spacecraft was launched on August 8, 2001, from Kennedy Space Center, Cape Canaveral, Florida, on a Delta 7326 rocket. It left Earth's atmosphere and traveled out to a point where gravity from the Earth and Sun are precisely balanced, called the L1 Lagrange point, clear of Earth's magnetosphere. In early November 2001, it entered into a halo orbit around L1 -- an orbit around a point in space, not a particular body. The collector arrays opened up in

December 2001 to the solar wind, and Genesis orbits in this position for about two years. Then the arrays will be stowed in a contamination-tight canister within the sample return capsule.

The spacecraft will head back to Earth and return on September 8, 2004. A few hours before re-entry, the sample return capsule will be separated from the spacecraft. The spacecraft will then perform a maneuver that will place it in an orbit around the Sun. The sample return capsule's trajectory will carry it over the Oregon coast as it makes its decent into the Utah Test and Training Range (southwest of Salt Lake City). The sample return capsule will release a parachute and be caught in midair by one of two specially-modified helicopters. The helicopter will then carry its solar booty to a temporary cleanroom located on the nearby Michael Army Air Field.

The canister will be transported to the Johnson Space Center, Houston, Texas, and the collector tiles removed and distributed for analysis.

Spacecraft and Science Payload

The concentrator and arrays are placed in an ultra-clean canister housed inside the sample return capsule. Simple rotations deploy and retract the collector arrays. Telecommunications, attitude control, command and data handling, power, and propulsion are provided by a flight system deck attached to the sample return capsule.

The Genesis Team

Dr. Don Burnett of the California Institute of Technology, Pasadena, Calif., is the principal investigator of the mission. Lockheed Martin Astronautics, Denver, Colo., has developed the spacecraft and the sample return capsule. Lloyd Oldham of Lockeed Martin is the deputy project manager.

Dr. Roger Wiens of Los Alamos National Laboratory, Los Alamos, N. M., leads the solar wind concentrator project. Dr. Bruce Barraclough, also of Los Alamos National Laboratory, is the lead scientist for the ion monitors. Johnson Space Center, Houston, Texas, will prevent and control contamination of the solar wind collectors, and safely maintain the returned samples. Dr. Eileen Stansbery leads Johnson Space Center's efforts.

The Jet Propulsion Laboratory, Pasadena, Calif., manages the mission for NASA's Office of Space Science, Washington, D.C. Data acquisition and tracking of the spacecraft are provided by NASA's Deep Space Network, which is operated by JPL. Spacecraft operations are performed at Lockheed Martin Astronautics, while navigation and flight design are coordinated by JPL.

Don Sweetnam of JPL is the project manager. The NASA program manager is Steven Brody.

04/20/04 DCA