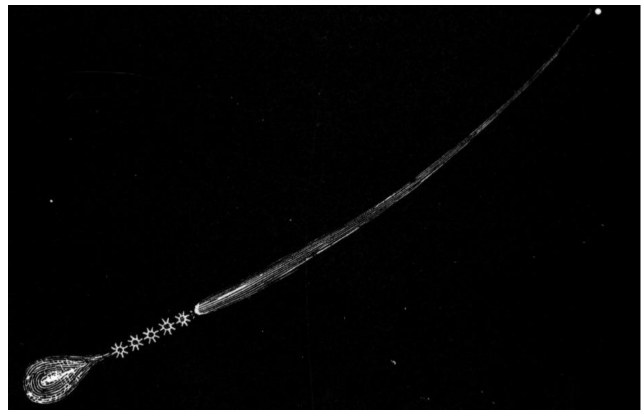
Dynamic Design: A Collection Process

Micrometeoroids and More

STUDENT TEXT

METEOROIDS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Micrometeoroids are a possible contaminant for the Genesis mission.

Meteors are the streaks of light that many people call shooting stars. Of course they are not stars at all but particles of asteroids or comets that enter our atmosphere. These particles range in size from a piece of dust to a piece of popcorn. As they fall through the air, the particles are burned up by friction and leave a bright trail of burning particles behind them. Most of the time these meteors are small bits of rock and/or metal that travel through space. On a few occasions, man-made satellite and spacecraft parts enter the atmosphere and burn up. Meteors move at speeds of over 10,000 km/hr.

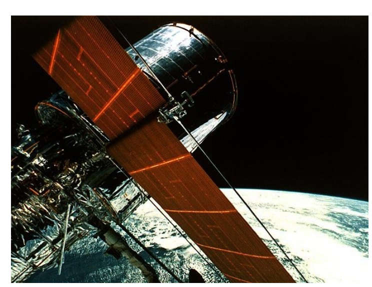
Unless someone is looking for meteors, they are often only seen out of the corner of the eye. On a regular basis, people can view a meteor shower on the Earth (see table below). These showers coincide with the times that the Earth crosses the path of a comet. Comets, which are named after those who discovered them, are said to be dirty snowballs traveling through space. Comets originate in a large cloud located about 10,000 AU from the sun, named the Oort cloud for Jan H. Oort who proposed this model in 1950. Some comets, such as Haley's that visits the Earth every 76 years, are short period comets because their orbital period is less than 200 years. Hale-Bopp, which visited us in 1997, is an example of a long period comet, with an orbital period of between 400 and 500 years. It is believed that meteors occur because comet material is heated when the comet passes by the sun causing a loss of icy material from the comet's nucleus. This icy material tends to follow the orbit of the original comet. When the Earth crosses this path during its journey around the sun, the material from the comet enters our atmosphere causing a meteor shower.

Major Yearly Meteor Showers

Name	Dates	Average Meteors per hour
Quadrantid	January 1-4	30
Aquarid	May 2-6	5
Perseid	July 29-August 17	40
Orionid	October 18-26	13
Taurid	September 15-December 15	5
Leonid	November 14-20	6
Geminid	December 7-15	55

Note: Meteor Showers are named for the constellation in which one looks to see the meteors. For information on minor meteor showers go to: http://comets.amsmeteors.org/meteors/calendar.html

Larger objects that hit the ground are called **meteorites**. These range in size from being microscopic (micrometeoroids) to as large as 1000 km. If you are interested in collecting micrometeoroids, more information can be found at: http://learn.jpl.nasa.gov/micromet.htm


NASA

Micrometeoroid Impact with Hubble Space Telescope

Micrometeoroid impacts have been observed on the Hubble Space Telescope. STS-82 was the second of four scheduled service missions to the space telescope.

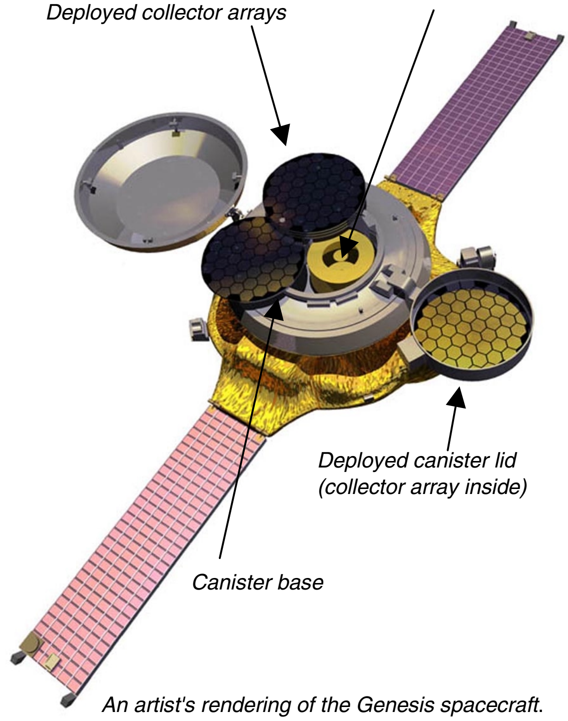
During astronauts Greg Harbaugh's and Joe Tanner's first extra vehicular activity (EVA), they saw evidence of "very small penetrations of the solar arrays, apparently from micro-meteorites [sic] although it could be from low-altitude orbital debris as well. So it looks like space is a fairly harsh environment even as high as we are, susceptible to either micro-meteorites and/or orbital debris."(Harbaugh, 1997)

Micrometeoroid Impact with Genesis Collectors

Micrometeoroids might damage or cause contamination of the Genesis solar wind collection. Could micrometeoroids jeopardize the mission if the collectors were to break into fragments, causing the canister closing mechanism to fail? Several tests were performed to help find out.

One test was performed to determine how much of the collector area was damaged by cratering of the collector material due to meteoroid impacts. Upon impact, the silicon wafer is compressed by a shock wave coming from the impact point. The pressure from the impact is high enough to liquefy and vaporize the silicon near the impact point. Silicon is a brittle metal, so a micrometeoroid that hits a wafer will leave only a little meteoroid matter in the wafer. During the two-year exposure time, only a few mg-sized particles will hit a meter-sized array. Finally the returned collector materials will be analyzed with microscopes to determine contamination.

To determine whether the wafers would shatter and cause payload problems on the Genesis mission, Johnson Space Center conducted several high velocity tests at their Impact Laboratory. Nylon spheres were launched by a light-gas gun in order to impact the wafer at a velocity near 7 km/s. The smallest of the three nylon projectiles (microns) caused a clean single crack in all tests. The rubber washer used to hold the wafers together was similar to the wafer fasteners for the spacecraft. The washer support held the wafer portions so that no collector was lost. From these tests only minimal damage is predicted to occur during the mission due to micrometeoroid impacts.



An artist's rendering of the Genesis spacecraft.

Other Causes of Contamination

Other important sources of contamination include assembly and handling of the collectors on the ground. The strategy to deal with this potential problem includes using ultra-pure materials, cleaning collectors and the canister with ultra-pure water in a clean room prior to installation, maintaining a contaminant-free environment and cleaning the collectors prior to analysis of the solar wind. The thrusters that are used to keep the spacecraft in orbit are also a potential source of contamination. Because of this contamination, the spacecraft itself was redesigned. An extended barrier has been placed around the perimeter of the spacecraft between the thrusters and the sample return capsule. This barrier will keep most of the gasses from the thrusters away from the sensitive payload. Mission scientists will also control contamination from thrusters by using ultra-pure hydrazine thrusters, by limiting the size and duration of thrust and by designing the thrusters in a way so they are far enough away from the collectors. Finally contamination due to out-gassing and re-entry re-pressurization was considered when planning this mission.

Contamination is an inevitable problem to be faced by the scientists of this mission. Scientists have predicted potential sources of contaminants and have conducted tests that will help minimize contamination. Designing the spacecraft and the collector arrays to withstand micrometeoroids and other contaminants will result in having clean solar wind samples returned that will help scientists learn more about the origin of our solar system.