NASA Cosmic Dust:

Current Status and Future Directions

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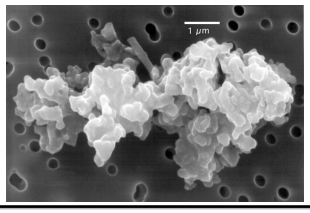
Collecting Dust Since 1981

The NASA Cosmic Dust (CD) collection has been actively collecting, curating, and distributing material since 1981. The collection is composed of interplanetary dust collected from the Earth's stratosphere by NASA high-altitude aircraft. Recently, a suite of new policies and directions has been implemented. These policies will improve access to the collection and improve standardization of loan practice across the NASA collections. The new directions will improve Cosmic Dust acquisition of new material, and place new priority on "timed collection" of material from specific parent bodies. A description of the changes to Cosmic Dust is offered here.



Right: An example of a cosmic dust particle, also known as an interplanetary dust particle (IDP). Typical size is ~10-50 μm with a very fine-grained composition.

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NASA Cosmic Dust Website

Changes to Loan Procedures

When Cosmic Dust (CD) started lending material almost forty years ago, typical analyses would consume an entire CD particle. As a result, material was loaned with no expectation that it would be returned to the CD collection. Since then, advances in instrumentation and sample processing allow multiple measurements on a single particle. Ultramicrotomy [1] and focused ion beam (FIB) [2] make sub-sectioning of CD material commonplace, allowing multiple sub-samples and many analyses per particle. CD policies have been updated to reflect this modern reality. Requests for CD material now typically cover a period of five years and require an official loan agreement approved by the requesting institution and by NASA. If needed, a request for a loan extension can be made to the Cosmic Dust Curator. Material is subject to recall if requested by a different investigator, but in that case, completion of work under the initial request will be prioritized. These changes bring the CD collection to the same standards as other NASA small particle collections, including Stardust and NASA's portion of Hayabusa1 samples.

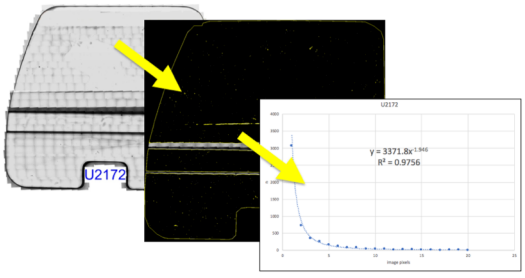
Advanced Curation and Collection Improvement

Balloon-Based Collection

CD has initiated an effort with Texas A&M to fashion a prototype dust collector for use on NASA high altitude balloons. *Balloon-based flights are intended to complement, not replace, aircraft-based collection*. The reasons for this include programmatic depth/resilience, "Timed Collections" improvement, and sampling diversity improvement. The prototype has been named Cometary and Asteroidal Research of Dust in Near-space Atmospheric Levels (CARDINAL), a name chosen by the undergraduate student team at Texas A&M. The device will use two collectors on a rotating arm, producing an airspeed over the collector surfaces that is much lower than that experienced in aircraft-based collection (see "dry collection", right). NASA long duration balloons (LDBs) can fly missions of over 100 days' duration, permitting a total number of particles on par or exceeding that of a typical aircraft flight. The collectors are sealed during ascent and descent of the balloon, and the size and spin rate are chosen to collect at least an estimated one particle/day/collector of flight. CARDINAL will be complete by the end of the 2019 academic spring semester. A request has been submitted with the NASA balloon program for two test flights in 2019.

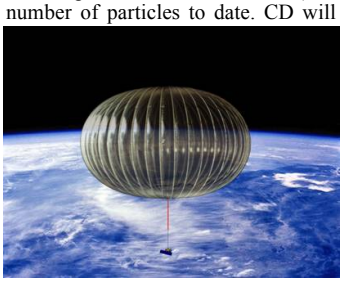
Entire-Collector Imaging

CD is instituting an effort to collect visible-light imagery of all collectors post-flight. There are two principal reasons why: good curation practice, and as a means for identification of "timed collection" material. Imaging the entire collector will allow particle size distribution (PSD) analysis which could identify when a "timed collection" collector has gathered material that differs significantly from that of the sporadic background. This offers the possibility of identifying material *from a specific meteor shower, and thus from a specific parent body*. Pairing PSD with a non-destructive, non-contact means of identifying particle type (i.e. cosmic, terrestrial, artificial) will probably be necessary to round out this technique.



"Dry" Collection

Collection of dust using oil-coated collectors is a proven and reliable method, but the oil is a contaminant for important investigations to include oxygen isotopes, native carbon/organics, and amorphous silicates. "Dry" (i.e. oil-free) foam collectors have been explored as an alternative (Messenger et al 2015) and have collected a small number of particles to date. CD will emphasize "dry" collection to provide oil-free material to the scientific community. Dry collection may be especially well suited to balloon-based dust collection. Collection via aircraft involves airspeeds across the collector at speeds of up to 0.8 Mach, potentially shedding "captured" material from the collector over time. Balloon-based collection is much gentler, with airspeeds generally in the m/s range, with maxima dependent upon airflow over the balloon. Flight times for balloons are much longer to compensate for the lower collection rate. These effects will be quantified with a series of aircraft- and balloon-based flights with a combination of oil-coated and dry collectors.



An example of a NASA high altitude balloon. CARDINAL will fly as a "piggy back" payload for high altitude (up to 36.5 km), low-airspeed CD particle collection.

"Old Collector" Testing

CD material is collected by high-altitude aircraft using silicone oil coated on flat-plate collectors. A test was performed to examine old silicone oil to test whether the oldest material in the CD collection can still be reliably extracted for allocation. Small-area collector W7016, which was flown in 1981, was drawn from curation storage for processing. One dozen particles were removed from W7016 and processed to include SEM/EDS analysis. McBride reports that the mechanical behavior of the silicone was indistinguishable from more recent collectors, and reports no problems in removing and handling the samples. Therefore, over the current lifespan of the CD collection, alteration of silicone oil is not a significant impediment to long-term storage and use of oil-collected particles.