An interactive service for cosmic dust catalogs at the IDIS Small Bodies and Dust Node

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Introduction

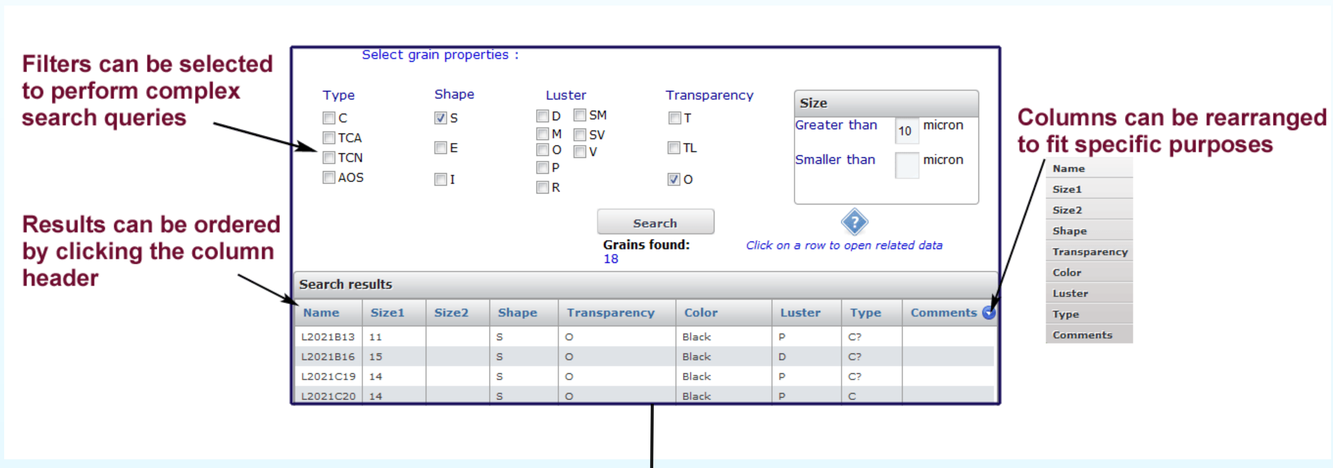
This web based interactive data service allows an easy retrieval and analysis of cosmic dust repositories. Catalogs from the NASA dust catalog collection program have been processed and published, offering 467 grains total, with SEM(Scanning Electron Microscopy) image, EDS (X-ray Energy-Dispersive Spectrometry) spectra and other descriptive data for each grain.
This service has been developed as an original resource of the Europlanet Small Bodies and Dust Node and is available at this URL:
http://www.iasf-roma.inaf.it:8080/web/sbdn/cosmic-dust-catalog

Scientific goals

The direct collection of interplanetary dust in the Earth stratosphere is an effective tool for the understanding of the formation and evolution of our planetary system; the collection of interstellar grains, that penetrate in terrestrial stratosphere [2], can give us insights about the interaction between the Solar System and the Local Interstellar Medium. The upper stratosphere is a suitable environment where to collect cosmic particles, thanks to the low contamination with terrestrial materials and to the high concentration of extraterrestrial particles.
In the early phases of the Solar System formation, dust particles were embedded into icy protoplanets during the accretion of planetesimals, thus remaining stored in the outer Solar System at very low temperatures (10-50 K); during the dynamical evolution of these icy objects, thanks to collisions, dust particles are released as debris from their parent bodies; so interplanetary dust particles (IDPs) can contain a record of physical, chemical and mineralogical processes that took place in the early stages of the primordial Solar System [5]. IDPs are typically in the size range 10 – 100 μm; particles in this size range can survive the atmospheric entry without being totally vaporized by the heating due to the friction with the atmosphere. These particles have been collected in the lower and upper stratosphere by NASA U2 aircrafts and balloons since the '70s. Comets are the main source of IDPs, other sources are asteroids and Kuiper Belt objects. The study of IDPs can help to solve scientific questions in planetology, in astrophysics, in astrobiology, and also in atmospheric sciences.

Service functionalities

This service is web based and doesn't require any client side installation. By opening the URL in a web browser, the user will be able to search inside the dust catalog and to show specific properties of the selected IDPs. The graphical user interface will show the applicable filters to be used for searching inside the catalog.
Filters are grouped into five characteristics: type, shape, luster, transparency and size.
Each characteristic allow several values. Selecting a check box, the relative characteristic will be used as a search criteria, including only the particles having that value satisfied. Selecting multiple values for the same characteristic will apply the logical disjunction of that values in the search criteria (i.e. 'S' and 'I' for Shape will search for particles having spherical OR irregular shape). Differently, selecting multiple values for separate characteristics will apply the logical conjunction of that values in the search criteria (i.e. 'C' for Type and 'O' for Transparency will search for grains of extraterrestrial origin AND opaque). Combining filters in this way, complex query conditions can be obtained as a search criteria operating exclusively through intuitive graphical interactions.
Query results are visualized in a table having one row for each IDP.



Clicking on a row will open a non-modal sub-window with particle data. It is possible to click multiple times on different rows to tile and compare the particle windows. The particle data window has three sections : the SEM image, the EDS spectra and the original PDF page from the dust catalog containing the summary

Catalog details

We have imported the NASA Cosmic Dust Catalog volume 15, which comprises 467 grains collected on January-February and June-July 1994, during 51.8 hours of stratospheric exposure, with large area (300 cm2) dust collectors mounted on a NASA ER-2 aircraft. The grains have been analyzed with a SEM, equipped with a Si(Li) detector and PGT 4000T analyzer for X ray energy- dispersive spectrometry. Both the SEM image and the spectrum in the 0-10 KeV range for each particle has been obtained.
Not only cosmic dust grains are present in the archive but Aluminium spheres and terrestrial contamination (both artificial and natural) grains too.
It is currently under development the integration of the volume 18 of the same NASA collection program: the new catalog will be available in the same service, thus allowing the user to perform a single search on both catalogs and browsing the results in a seamless way.

Technology

This service is implemented as a single portlet fully compliant with enterprise standard [3].
The portlet technology allows a complete integration of the application within the site pages, avoiding any client-side software installation and thus maximizing its usability.
Complete platform independence is obtained by using an abstraction layer, transparent both for the user and the developer.
Software has been developed using Java language on the server side, while Ajax is used for the front end.
Liferay Portal 6 has been chosen as the reference framework for web development.
The dust catalog has been modeled into an E-R diagram, then translated in a database schema and finally imported into MySQL.

Conclusions

We believe our service represents an interesting and useful tool for cosmic dust research activity. Its clean graphical interface is comfortable for both scientific staff and for people having general interest on the subject. The future extensions with more catalogs (the volume 18 is already on the way) will make this service even more appealing and constitute a reference implementation for cosmic dust analysis tools. In a virtual observatory approach, we are also planning to expose this service as a Planetary Science Table Access Protocol (IDIS-TAP) service [4].

References

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