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# IDIS Small Bodies and Dust Node: Technical innovation and science

M. Giardino, V.F. Braga *, M.C. De Sanctis, L. Giacomini, S. Giuppi, D. Turrini, M.T. Capria

*INAF-IAPS, Via del Fosso del Cavaliere 100, 00133 Roma, Italy*

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**Abstract**

It is not trivial, nowadays, to be fully aware of the impressive amount of astrophysical resources that are at hand. Virtual Observatories (VOs) were therefore created to provide a simple access to what astronomers look for. In this paper we focus on the original data access services developed specifically, in a VO perspective, for the "Small Bodies and Dust Node" (SBDN) in the framework of the Integrated and Distributed Information System (IDIS) initiative of the Europlanet Research Infrastructure project. We describe the scientific goals, along with the innovative technical aspects, of the tools that SBDN presently provides to the scientific community, namely the *Comet Emission Lines* service, and the *Cosmic Dust Catalog* service. In the former, an algorithm for the detection of unidentified emission lines has been implemented.


*Keywords:* Comets; Asteroids; Small bodies; IDIS; Virtual observatory

## 1. Introduction

The Integrated and Distributed Information System (IDIS) is supported by the European Commission's Seventh Framework Program, Europlanet Research Infrastructure, as part of the Capacities Specific Programme. It is an Integrated Infrastructure Initiative, ie. a combination of Networking Activities, Transnational Access Activities and Joint Research Activities. The main tasks of IDIS are to provide an easy-to-use web-based platform to give access to available data, to locate teams and laboratories with specific expertise, to exploit synergies between space-based missions and ground-based observatories. A set of tools for describing, accessing and combining information and data from different European and non-European sources are currently under development. Their goal is to offer a Virtual Observatory-like access to a huge amount of planetary science data. IDIS is organized as a network of six web-servers hosted each by a different institute in Europe. In order to address the full interdisciplinary extent of planetary sciences, five primary scientific areas (*Interior and surfaces*, *Atmospheres*, *Plasma*, *Planet Dynamics* and *Small Bodies and Dust*) have been identified. Each institute of the IDIS initiative is in charge of a scientific area and their own group of experts supports the activities of the node and the screening of the published node contents.

IDIS differs from similar web based services like ESA PSA and NASA Small Bodies Node and is not intended to replace them but instead to offer an alternative solution. Overall, IDIS, rather than being a physical data repository, is intended to offer tools and techniques to facilitate the retrieval of planetary resources archived in organizations such as research institutes, universities and space agencies.

* Corresponding author at: Università Tor Vergata, Via della Ricerca Scientifica 1, 00133 Roma, Italy.

*E-mail addresses:* marco.giardino@iaps.inaf.it (M. Giardino), vittoriofrancesco.braga@iaps.inaf.it (V.F. Braga), mariacristina.desanctis@iaps.inaf.it (M.C. De Sanctis), Livia.Giacomini@iaps.inaf.it (L. Giacomini), Stefano.Giuppi@iaps.inaf.it (S. Giuppi), Diego.Turrini@iaps.inaf.it (D. Turrini), mariateresa.capria@iaps.inaf.it (M.T. Capria).

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IDIS distinguishes also for its distributed nature: each thematic node offers contents and data related to the hosting institute activities. The IDIS SBDN is located at the URL http://sbdn.iaps.inaf.it/web/sbdn/home and its personnel is currently member of both the teams of NASA Dawn mission to Vesta and Ceres and of the ESA Rosetta mission to the comet Churyumov–Gerasimenko. Although in prototype status, node services act as proof of concepts, encouraging users to give their feedback and express their needs: such a contribution is an essential input for the development process and can lead, in the near future, to more mature services providing key functionalities for the planetary science community at large.

## 2. Content and services

Within the SBDN, resources are grouped in four sections dedicated to specific class of small bodies: Comets, Asteroids, Meteors and Dust. A fifth section is dedicated to resources of more general interest. The main page also hosts a space dedicated to newsflash on relevant planetary science and space technology topics.

Internally developed services of the SBDN (which have to be considered its primary resources) are two: the *Comet Emission Lines* service and the *Cosmic Dust Catalog* service. A third internally developed resource, the *Cometary Nucleus Modeling* tool, does not provide yet interactive services to the public. As we shall illustrate in the next sections, innovative and efficient programming techniques have been applied to implement these tools.

Emission lines tables have been analyzed and a statistical method to recognize unidentified transition lines across different comets, subsequently implemented in the *Comet Emission Lines* service, has been conceived and applied to the database. Physical and mineralogical parameters of dust grains have been arranged into query parameters, in order to easily filter desired ones on the *Cosmic Dust Catalog* service. The former is the service on which most of the scientific effort has been devolved, together with the *Cometary Nucleus Modeling* tool, as explained in Sections 2.1 and 2.3.

All the resources, both internal and external, hosted in the SBDN are synchronized with the *Resource List* of the IDIS Technical Node, its purpose being a resource repository for the whole group of IDIS thematic nodes.

### 2.1. Comet Emission Lines service

Originally built on a single data table published by researchers of our institute (Cremonese et al., 2007), the *Comet Emission Lines* service currently uses data from four different comet emission lines catalogs and allows to simply operate a query to find the lines of interest. Comets in this catalog are Brorsen–Metcalf (Brown et al., 1996), Swift–Tuttle (Brown et al., 1996), Hale–Bopp (Zhang et al., 2001), De Vico (Cochran and Cochran, 2002) and Ikeya–Zhang (Cremonese et al., 2007) which have been observed with Echelle spectrographs mounted on ground based observatories, with a spectral resolution of 37,000 to 60,000.

For each line, the peak wavelength ($\lambda_{peak}$), observed chemical species, transition, intensity, equivalent width and distance of observation are provided. Not all of these properties are available for all lines, depending on the original catalog.

The service not only provides a search tool to find the desired lines but also implements a statistical method to spot unidentified lines which could be the mark of the same electronic transition occurring in more than one comet.

The method is based on the difference in the $\lambda_{peak}$ between lines; we call $\delta$ this difference. As an example, looking at Table 1, we spot the C2 Swan 0-1 R1(21) transition line in three comets. We define these lines to be a triplet within a $\delta = 0.110$ Å range. Our idea is to measure the $\delta$ of all the groups of identified lines (4420 pairs, 1414 triplets, 1097 quadruplets, 350 quintuplets and 239 sextuplets, for a total of 7520 groups and 20654 lines) and obtain a distribution (plotted in Fig. 1) for all $\delta(i)$.

Table 1
A sample of rows of the comet lines tool database.

| $\lambda_{peak}$ [Å] | Species | Elec. trans. | Vib. trans. | Rot. trans. | Comet | Catalog[a] | Intensity[b] | Eq. width [mÅ] | Dist. [AU] |
|---|---|---|---|---|---|---|---|---|---|
| 5586.150 | Unid | | | | De Vico | Coc02 | | | 0.660 |
| 5586.150 | Unid | | | | Hal-Bop | ZZH01 | | 17 | 0.920 |
| 5586.160 | Unid | | | | Ike-Zha | Cre07 | 3.347 | | 0.890 |
| 5586.180 | Unid | | | | Swi-Tut | Bro96 | 98.000 | | 1.045 |
| 5586.220 | Unid | | | | Hal-Bop | ZZH01 | | 16 | 0.918 |
| 5586.270 | Unid | | | | Hal-Bop | ZZH01 | | 21 | 0.991 |
| 5586.305 | Unid | | | | Ike-Zha | Cre07 | 2.329 | | 0.890 |
| 5586.320 | Unid | | | | De Vico | Coc02 | | | 0.660 |
| 5587.520 | C2 | Swan | 0-1 | R1(21) | Ike-Zha | Cre07 | 2.32 | | 0.890 |
| 5587.533 | C2 | Swan | 0-1 | R1(21) | De Vico | Coc02 | | | 0.660 |
| 5587.630 | C2 | | (0,1) | R1(21) | Swi-Tut | Bro96 | 83 | | 1.045 |
| 5587.630 | C2 | | (0,1) | R2(20) | Swi-Tut | Bro96 | 83 | | 1.045 |

[a] Bro96, Coc02, Cre07 and ZZH01 correspond, respectively, to the references Brown et al. (1996), Cochran and Cochran (2002), Cremonese et al. (2007) and Zhang et al., 2001.
[b] In arbitrary units.