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The ISO Spectral Analysis Package ISAP

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Abstract. We briefly describe the ISO Spectral Analysis Package ISAP. This package has been and is being developed to process and analyse data from the two spectrometers on board ISO, the Infrared Space Observatory of the European Space Agency (ESA). ISAP is written in pure IDL. Its command line mode as well as the widget based graphical user interface (GUI) are designed to provide ISO observers with a convenient and powerful tool to cope with data of a very complex character and structure. ISAP is available via anonymous ftp and is already in use by a world wide community.

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1. Introduction

ISO, the Infrared Space Observatory of the European Space Agency, was launched in November 1995. It carries 4 different instruments including the short and long wavelength spectrometers SWS and LWS (see Kessler et al. 1996). The ISO Spectral Analysis Package, ISAP, plays an important role in ISO data analysis. It is a software package, written in pure IDL[2], for the reduction and scientific analysis of the ISO SWS and LWS Auto Analysis Results (AARs). AARs are the end product of the official automatic pipeline processing, which processes the raw data, as they are received from the satellite, via a number of intermediate products to this AAR stage, which is then sent to the observer. Being the end product of the pipeline of the spectrometers an AAR should be - at least in principle - a "valid" spectrum which is appropriate for immediate scientific analysis. However, the spectra are heavily affected by glitches, detector transients, memory effects and other phenomena, caused, e.g., by cosmic ray hits. The best way to cope with these effects is to keep as much redundancy as possible (i.e., all elementary measurements) in the pipeline products, to enable an appropriate, interactive, post-processing. For this reason elaborate software has been developed (see e.g., Wieprecht et al. 1998, and Lahuis et al. 1998, for a description of the SWS pipeline and Interactive Analysis System), and a lot of instrument and expert knowledge is needed to treat the AARs correctly.

Hence, there was a clear need for a software package that could be given to the observers in addition to the AARs, to impart the expertise, and to enable the observers to process the data further and eventually analyse them. Since both SWS and LWS are spectrometers with AARs that are at least very similar, the LWS and SWS consortia decided in the summer of 1995 to start a collaboration to develop such a package as a common tool for both spectrometers.

2. ISAP

A specific emphasis was put on the ability of the computing environment to easily and immediately plot and visualize data. A widget toolkit was also mandatory. Since IDL fulfills all the requirements, and since a large part of ISO's data processing software, like the Interactive Analysis Systems, had already been written in IDL, it was decided to use it as computing environment for ISAP as well.

ISAP operates on the final pipeline products, and one of its primary functions is to improve these products (AARs). It therefore offers and simplifies all the necessary steps for post-processing the data. Several functions for data input and output are available, as well as elaborate plotting tools for visualization. Bad data such as outliers can be masked out, erased or corrected and replaced. Spectra can, for instance, be averaged, flatfield corrected, normalized, rebinned and smoothed. Removal of fringes and many more operations can also be performed.

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[2]IDL is a trademark of Research Systems Inc. (RSI)

The result of the first part of a typical ISAP session is expected to be a "simple spectrum" (single-valued and resampled to uniform wavelength scale if desired) that can further be analyzed and measured either with other ISAP functions, native IDL functions, or exported to a different analysis package (e.g., IRAF, MIDAS) if desired. ISAP itself provides many tools for detailed analysis, like line and continuum fitting and flux measurements, unit conversions, conversions from wavelength space to frequency space, dereddening or synthetic photometry and models including a zodiacal light model to predict and subtract the dominant foreground at SWS wavelengths.

All these tools and routines are accessible via two different modes: a command line mode and a Graphical User Interface (GUI). The command line mode is embedded in the basic IDL environment. Full access to all the ISAP routines is provided, and, in addition, all standard IDL routines are available in the usual manner. Suitable command sequences can be combined in scripts and automatically performed. It is, hence, the most powerful mode of ISAP, but it needs some expert knowledge about ISAP and IDL. A more user friendly - and in particular more beginner friendly - mode is the GUI mode, a graphical user interface that is built around the ISAP commands. Figure 1 shows ISAP's main GUI. The first row provides some general information, such as object name or type of observation. The FITS header can be viewed, help pages accessed, etc. A number of buttons in the following rows give some instrument specific informations about, e.g., the detectors used in the observation, or the number of scans, and can be used to extract subsets of the data.

In another column direct access is given to buttons which allow some basic operations, like data input and output, plot control, and special functions such as unit conversion, which operate on the AAR as a whole.

The heart of the GUI is the plot window, offering a completely mouse oriented way of data visualization and selection: zooming in, getting information about single data points and selecting parts (or all) of the data for subsequent processing can be performed by clicking (and dragging) with one of the mouse buttons. A large number of plotting styles can be chosen from a menu. After selecting some data (with the right mouse button) a toolbox pops up, presenting a variety of ISAP tools which can be applied to the selected data. The more complex applications are simplified through separate, dedicated graphical user interfaces, which become available on request. The "average" GUI, e.g., guides the user through the necessary decisions for the type of averaging (across scans for each detector individually, or across detectors), the bin size, or the averaging technique (e.g., mean or median, with and without clipping., etc.). The result can be immediately examined in two separate plot windows, which display the data before and after application of the operation. Again, zooming in with the mouse and individual adjustment of the plot style is possible, just like in the main GUI.

ISAP is currently being developed by less then 10 programmers and scientists (part time) at different sites in Europe and the United States, on different machines under different operating systems (Unix and VMS), demonstrating the high efficiency of programming in IDL and the high portability of IDL programmes. It also makes use of the astronomical users' library of IDL. A few programmer's guidelines form the basis of very simple configuration control.

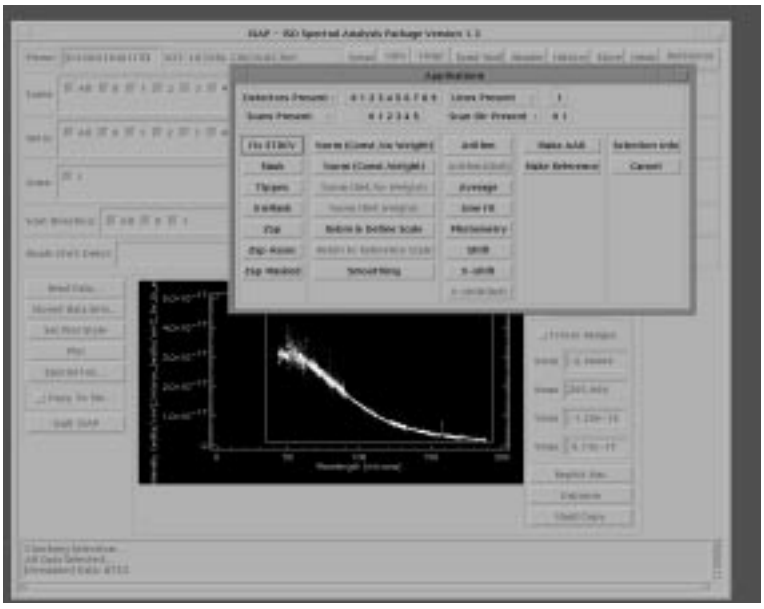

Figure 1. The main ISAP GUI

One main advantage of this approach is, that every user can write his or her own application. Provided the users stick to these guidelines, they can easily add their own routines to their ISAP installation - or ask the ISAP team to officially include them in the next release.

ISAP is publicly available via anonymous ftp and it is already in use world-wide. Currently well over 100 astronomers have downloaded it from the official ftp sites. For many of them it has already become the main processing and analysis tool for ISO spectra. After the proprietary period for ISO data, i.e., when all ISO data will be public, an even larger interest is to be expected.

ISAP has certainly some potential for future astronomical (space) missions. Inevitably a large part of it is very instrument specific, the basic principles and algorithms, however, as well as the whole interface, could easily be adapted for other spectrometers.

More information about ISAP (and how to get it) can be found on the World Wide Web: see the ISAP homepages at
http://www.ipac.caltech.edu/iso/isap/isap.html or
http://www.mpe-garching.mpg.de/iso/observer/isap/

References

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