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AstroGrid Virtual Observatory Access to Large Scale Surveys: The IPHAS Galactic Plane Survey—a Science Driven Example

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Abstract. This paper describes how the IPHAS galactic plane survey data products are being made available utilizing the AstroGrid Virtual Observatory system (`http://www.astrogrid.org`). This is enabling the analysis of the large pipeline-processed IPHAS data products, both images and catalogs. Note is made of how the AstroGrid system is being used by the astronomer, for instance in the use of workflows to automate certain routine analysis operations, such as generating lists of candidate emission line stars, based on database queries of the IPHAS catalog data. Specific science use-case examples are given that benefit from the powerful VO access to the IPHAS data, including use of emission line stars as probes of galactic structure.

1. Introduction

The Isaac Newton Telescope Photometric Hα Survey (IPHAS[1]) (Drew et al, 2005) is a large systematic survey being carried out with the 2.5-m Isaac Newton Telescope's Wide Field Imaging Camera of the entire northern galactic plane ($|b| < 5$). The survey is being carried out in the broad band r and i bands and a narrow band Hα filter to a depth of $\sim$20 mag. (10σ) in the r band.

IPHAS, together with the VPHAS+ Southern extension (the complimentary survey program employing ESO's 2.5-m VST) provides a springboard to a quantitative revolution in our understanding of the extreme phases of stellar evolution. Photographic Hα surveys of the Galaxy begin to be incomplete even at $V = 12$. The more recent SuperCOSMOS Hα Survey (SHS) (Parker et al. 2005) pushes this down to $V \sim 15$, achieving 10–20% success rates in the selec-

[1]http://www.iphas.org

tion of emission line stars. IPHAS facilitates much higher success rates down to $r \sim$20 ($V \sim$18-19) (see e.g., Hopewell, 2006).

IPHAS and VPHAS+, both public surveys, are sufficiently sensitive that A dwarfs and all intrinsically brighter early-type emission line stars are readily detected in all but the most heavily obscured locations of the Galactic Plane. The data will multiply the number of known galactic emission line objects by ten or more, yielding greatly improved statistics on a range of rare short-lived object types. The superior photometric accuracy will also facilitate large-area stellar population studies within the Plane that have hitherto not been possible. The total final catalogs for the two surveys will contain in the range of 400–500 million objects.

2. IPHAS: Survey Products and Examplar Science

The IPHAS data (now several TB of reduced images) have been processed using the optical pipeline (Irwin & Lewis, 2001), from the Cambridge Astronomical Survey Unit. The data products consist of fully processed multi-extension FITS images in different bands as well as band-merged catalogs in ASCII format for each image. Images are compressed using the Rice compression algorithm. They contain data quality control keywords in the headers like seeing, magnitude zero point, astrometric precision, etc.

There are two main exemplar science programs, where the ability to rapidly search and analyse the large IPHAS object catalogs is essential. The first is facilitating the discovery of cataclysmic variables (CVs) and other interacting binaries in the Plane (pilot work of Witham et al. 2006). The CVs are discovered from their position in the $r-\mathrm{H}\alpha/r-i$ color-color plot, being blue objects with a Hα excess. The second is building up a significant sample of early-A dwarfs, from color selection sensitive to strong Hα absorption, as probes of Galactic structure. The distribution of these can be compared to predictions from models of the galaxy (e.g. the four arm model of Vallee (2005)), and provides a powerful complement to existing tracers of structure such as OB associations, which poorly sample some directions such as the galactic anticentre (see Russeil, 2003).

3. IPHAS: Data Access with AstroGrid

The AstroGrid[2] Virtual Observatory (VO) system (Walton, 2007) is being utilized to provide access to these IPHAS data products. The development work has been supported by AstroGrid, this program being one of the successful AstroGrid May 2006 Science Call programs.

The AstroGrid interface to the data products supports a number of typical science use access cases such as:

- The user requires images covering a region of sky, searching for those with seeing better than some limit obtained in photometric conditions. The

[2]http://www.astrogrid.org

user retrieves the images and the catalogs associated with the images and displays them.
- The user runs a query against the catalog database and selects a sample of objects. Then she wants to obtain cutout images for each source and display them. Moreover she wants to know what else is available for each source.

In supporting access to IPHAS data, VO access mechanisms have been implemented to support functionality such as:

- Retrieve full images covering a region specified by the user and with some user defined constraints (e.g. seeing better than $1\farcs2$). Retrieve cutouts of images covering a particular source. These are enabled through the use of a Simple Image Access Protocol (SIAP[3]) service which gives VO access to the IPHAS image data.
- Retrieve catalogs for each image/cutout.
- Allow catalog queries (e.g. selecting all sources in a region of sky with some particular colors). This is enabled by use of the AstroGrid Data Set Access (DSA) component which enables remote SQL queries of the IPHAS catalogs as stored in a Sybase database management system.
- Provide a mosaic service for mosaicing a list of images defined by the user.

Figure 1 shows a typical user session where analysis of IPHAS data products are being undertaken. Utilising the AstroGrid system scientists can not only retrieve images, but also perform complex queries of the science catalogs. Further, through use of the AstroGrid workflow system, complex operations can be carried out, for instance automating the generation of large image mosaics, where access to the large remote storage provided by AstroGrid is essential.

4. IPHAS Early Data Release

The IPHAS consortium will be releasing their first early data release towards the end of 2006—with product availability solely available through the VO interfaces described here. Full details of the IPHAS data release will be made at `http://www.iphas.org`. IPHAS data products can be accessed through the AstroGrid system. Go to `http://www.astrogrid.org/launch` to access the AstroGrid workbench.

5. Closing Remarks

The IPHAS data will form a powerful resource for the study of our Milky Way. Use of the AstroGrid system to provide the access to the data products provides a cost effective solution in opening up this large and complex data set to the astronomy community. Additionally, the ability to easily federate the IPHAS data with other VO accessible data, e.g. UKIDSS IR data (see `http://www.ukidss.org`), will substantially enhance its value to the community.

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[3]http://www.ivoa.net/Documents/latest/SIA.html

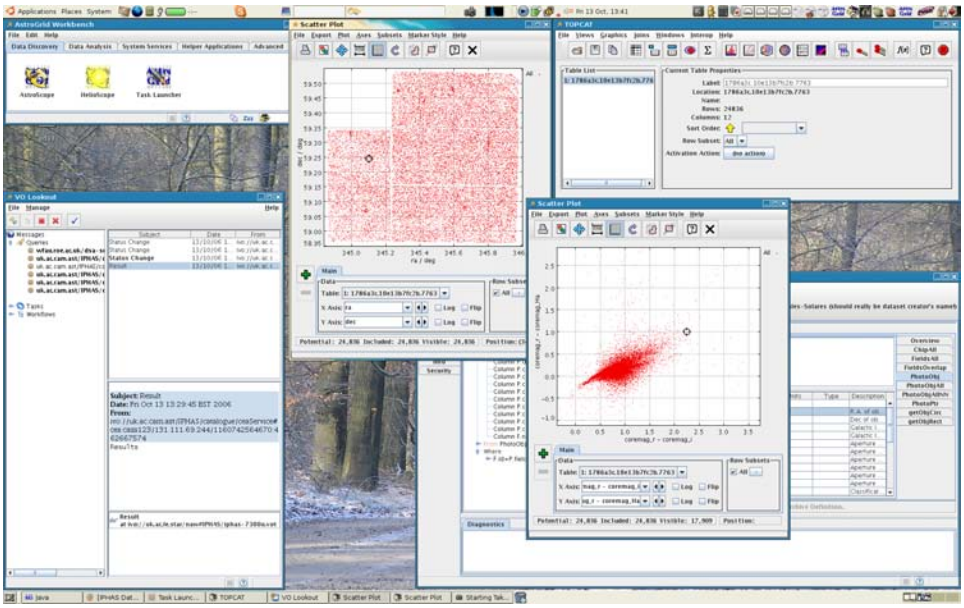

Figure 1. This figure shows the AstroGrid workbench, top left. From this access can be gained to the range of VO services, including those giving access to IPHAS images and catalogs. Here the IPHAS data catalog is being queried, with results being visualized using the TopCat (Taylor 2005) application.

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