

Mapping Galactic Spiral Arm Structure: The IPHAS Survey and Virtual Observatory Access

Nicholas Walton

Institute of Astronomy, University of Cambridge

Janet Drew, Ella Hopewell (Imperial); Robert Greimel (ING); Mike Irwin, Eduardo Gonzalez-Solares (IoA, Cambridge); Paul Groot (Nijmegen)

The IPHAS Consortium: <http://www.iphas.org>

The IPHAS Survey Collaboration

- IPHAS: The Isaac Newton Telescope/ Wide Field Camera Photometric H-alpha Survey of the Northern Galactic Plane (PI: Janet Drew: Imperial, UK)
- IPHAS collaboration - <http://www.iphas.org> :
 - UK: Bristol, Cambridge, Imperial, Keele, Manchester, Hertfordshire, Southampton, UCL, UKATC, Warwick
 - Australia: Macquarie
 - Germany: Thueringer Landessternwarte
 - Holland: Nijmegen
 - Spain: Granada, IAC, ING, Valencia
 - USA: CfA
- Element of the wider IPHAS/VPHAS+/UVEX consortium: forming EGAPS (European Galactic Plane Surveys) – see <http://www.egaps.org>

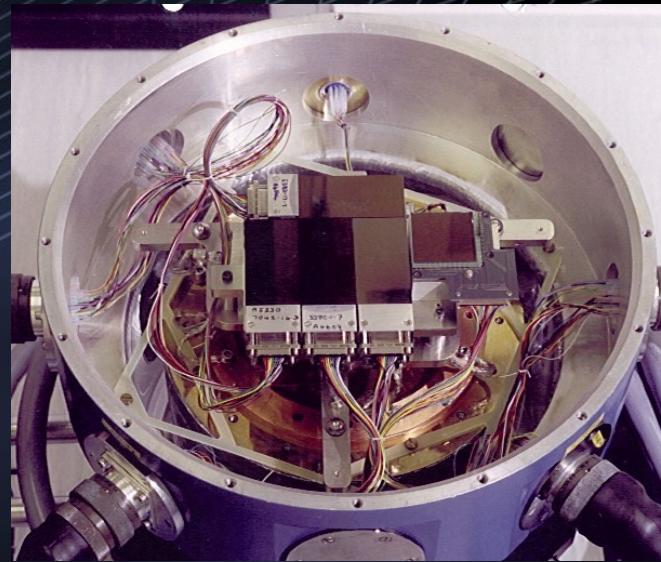
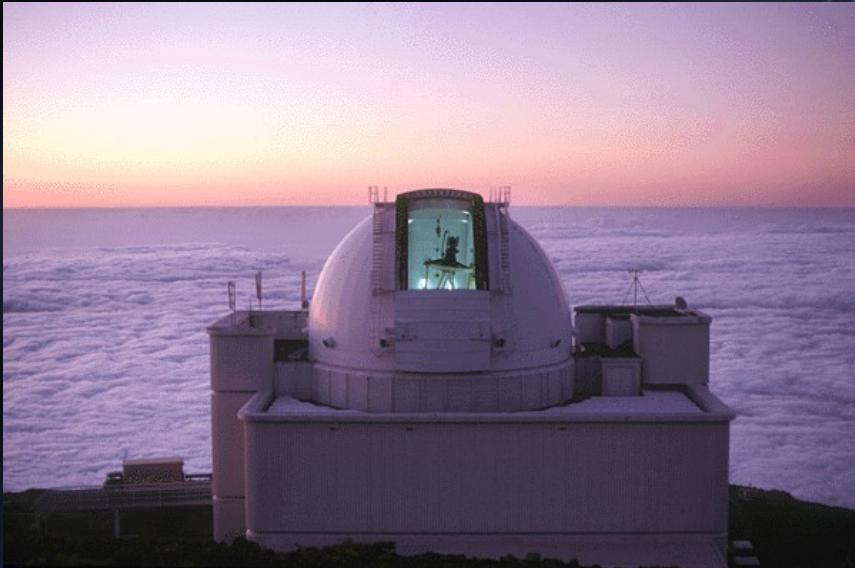


IPHAS Key Goals

Large scale Milky Way structure and study of early and late type populations (preferentially selected via H-alpha emission line properties):

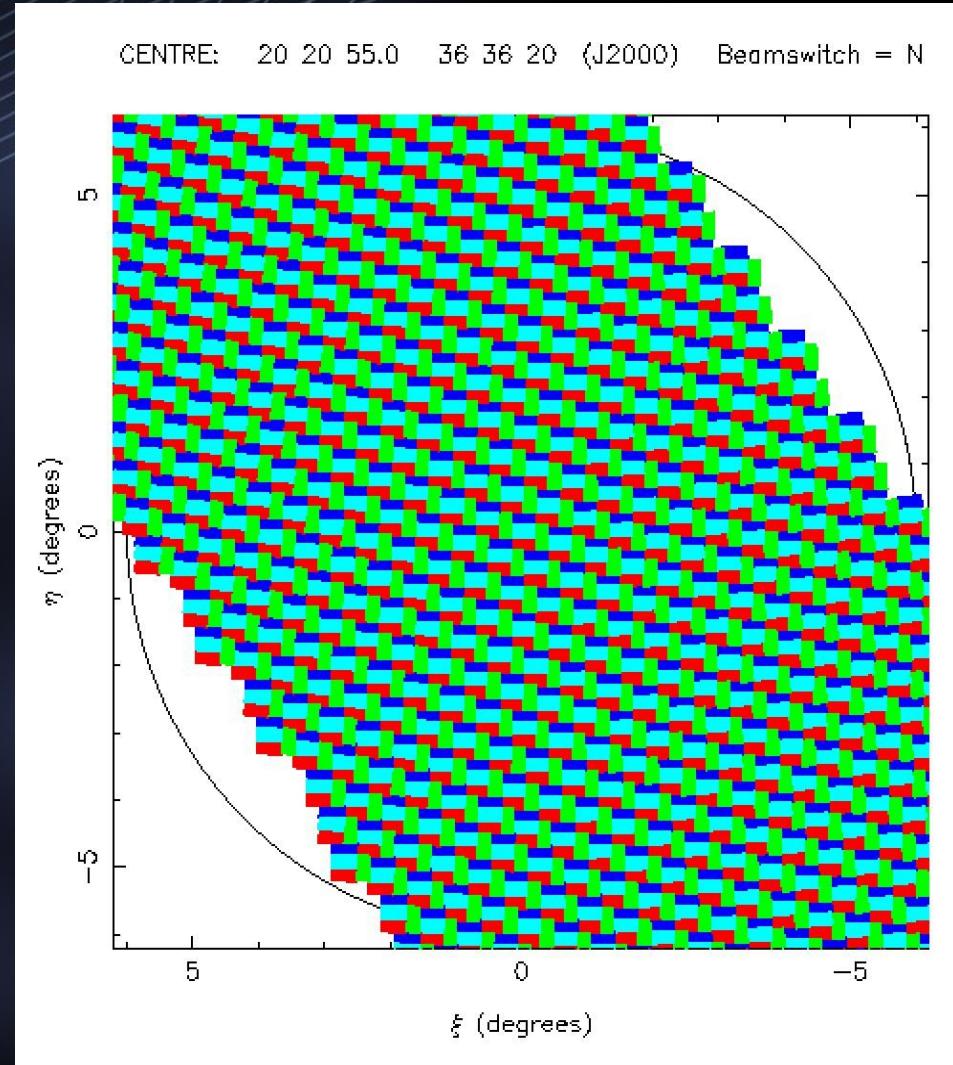
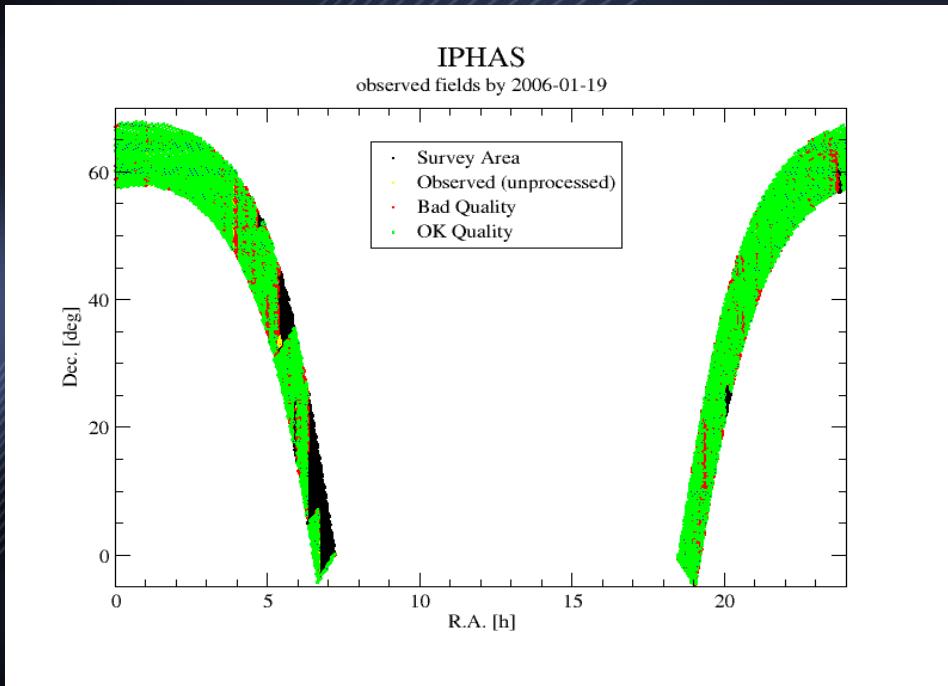
- (Compact) planetary and symbiotic nebulae
- luminous blue variables (P Cygni and eta Car like objects)
- OBA extreme supergiants
- rapidly evolving post-AGB stars
- Be stars of all types (including young Herbig stars)
- good statistics on clusters of T Tau stars
- a range of interacting binary stars (symbiotics, 'supersoft' compact binaries, WD/NS/BH accreting binaries generally)

IPHAS data source: 2.5-m INT + WFS



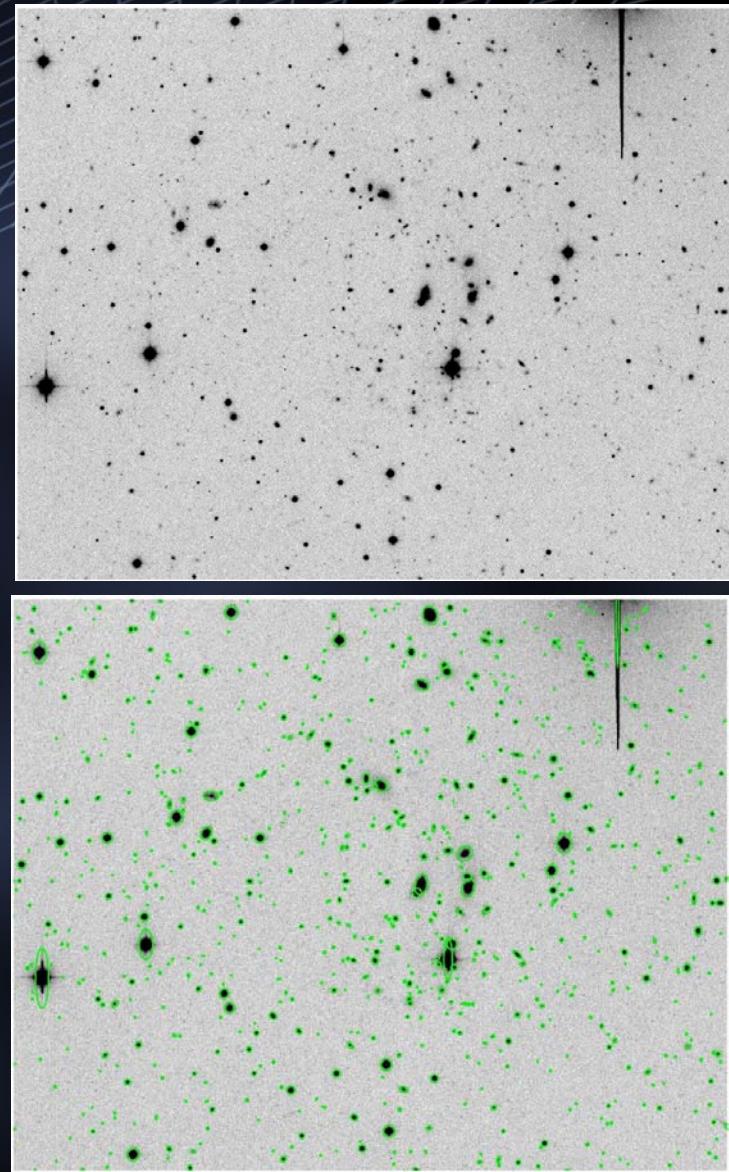
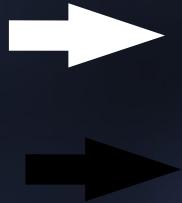
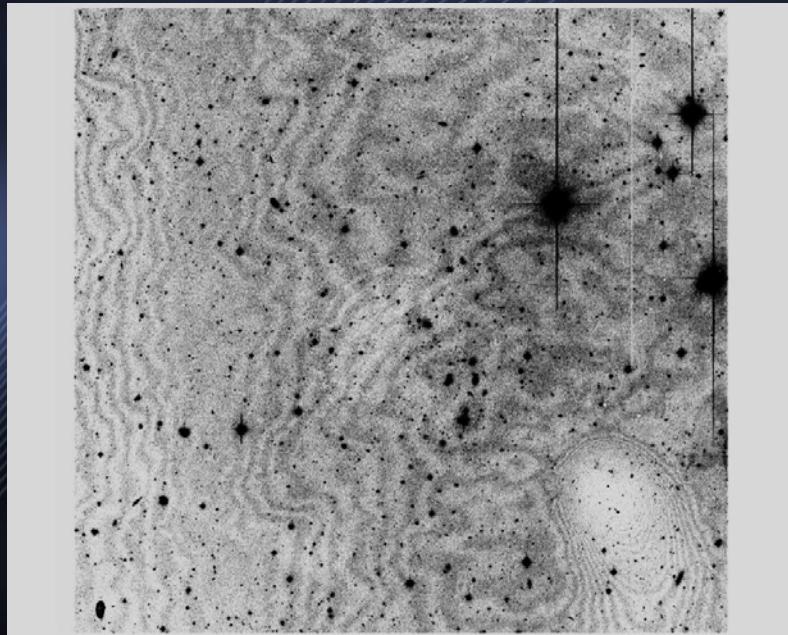
IPHAS Survey

- 7635 Pointings \sim 2000 sq deg
- x 2 (overlap, 5'x5' offset)
- thus 15270 Pointing in total
- r, H α , and i
- \sim 30 GB/night of data = $>$ 1TB total

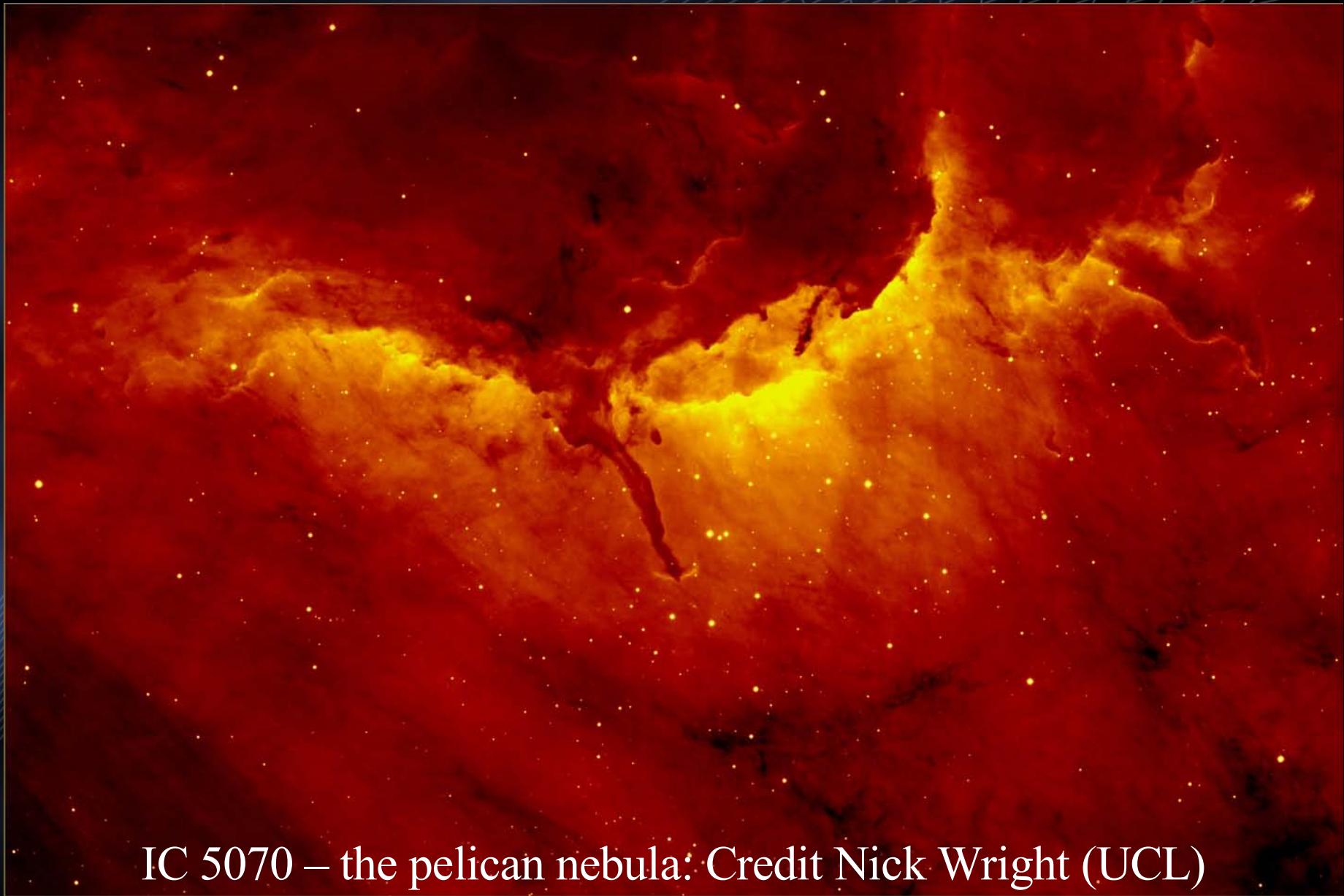


Survey Products

- Photometric catalogue ~100 million objects
- Detection of ~50000 H α -emitting objects

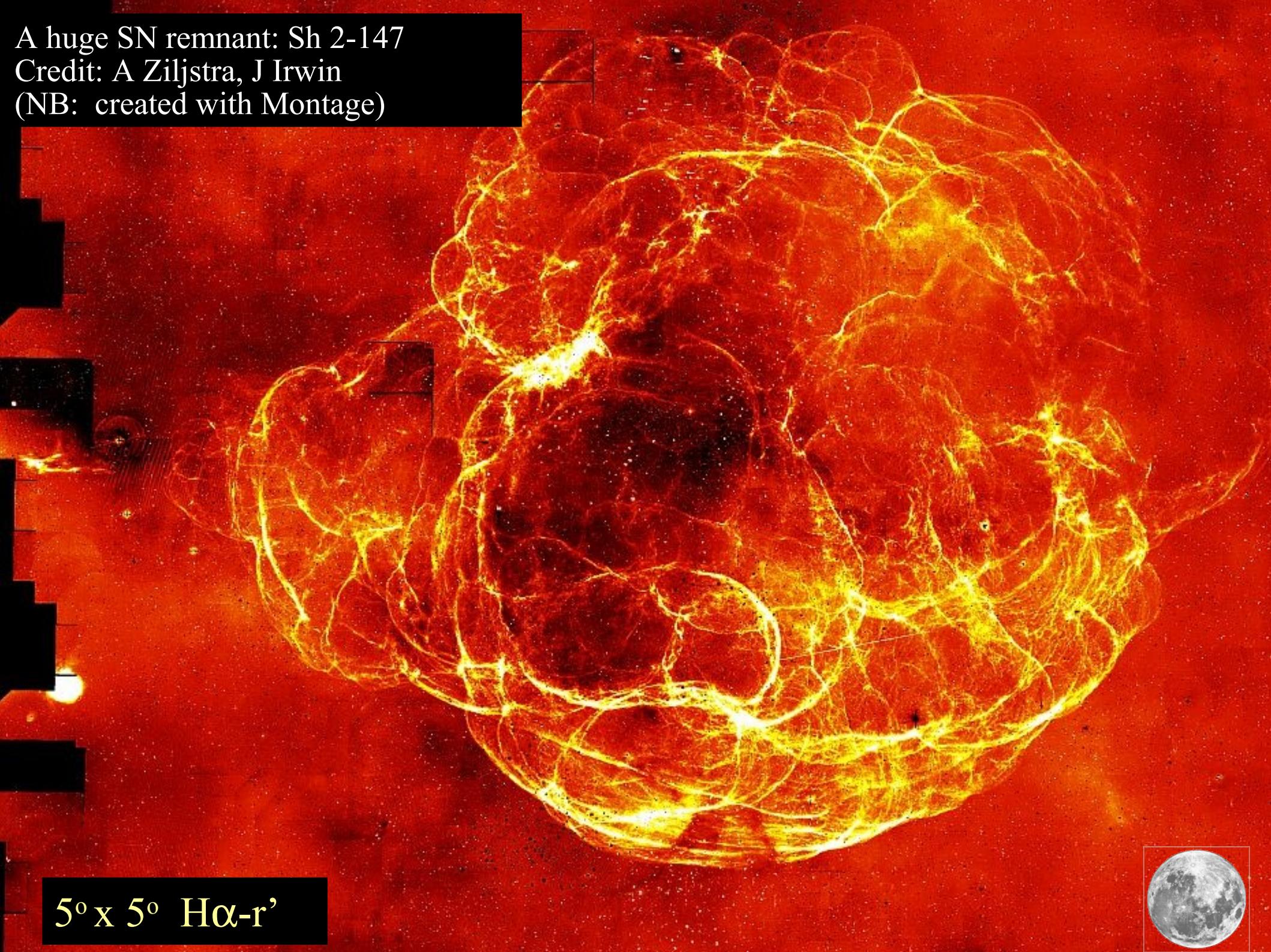


IPHAS: Images



IC 5070 – the pelican nebula: Credit Nick Wright (UCL)

A huge SN remnant: Sh 2-147
Credit: A Zijlstra, J Irwin
(NB: created with Montage)



5° x 5° H α -r'



AstroGrid: UK's Virtual Observatory

Empowerment of scientists

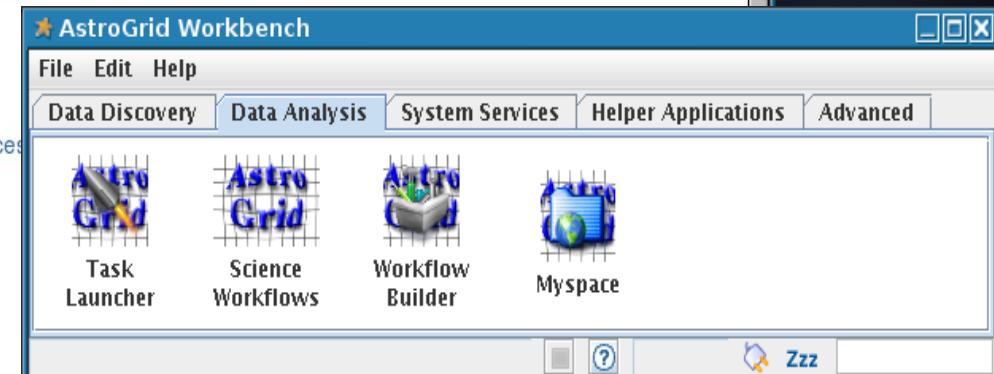
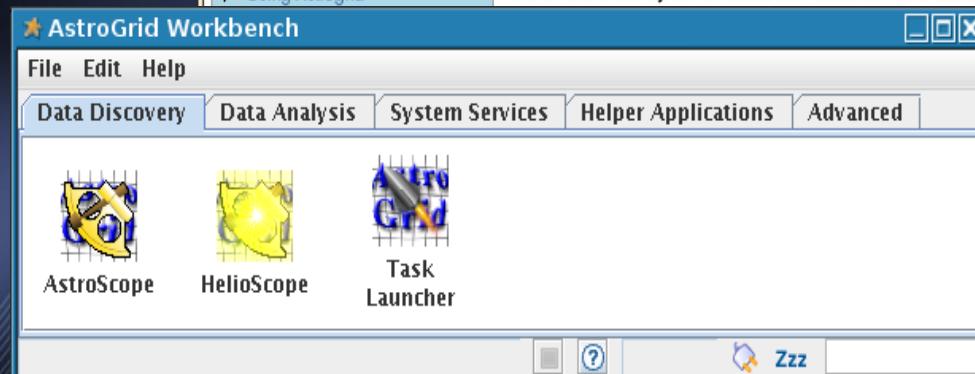
- Improve the quality, ease, speed and cost effectiveness of on-line astronomy
- Make comparison and integration of data seamless
- Removing barriers to multi-wavelength astronomy
- Enable access to very large data sets

Project: 2001-2007: ~£10M: key data and resource providers in consortium



AstroGrid 2006.3 Release: Aug 2006

The screenshot shows a Mozilla Firefox window displaying the AstroGrid Project - AstroGrid Release 2006.3 homepage. The title bar reads "AstroGrid Project - AstroGrid Release 2006.3 - Mozilla Firefox". The menu bar includes "File Edit View Go Bookmarks Tools Help". The main content area features a large banner with the text "ASTROGRID 2006.3" in a metallic, reflective font. Below the banner, a message states "Last published: 05 July 2006 | Doc for 2006.3" and links to "Front | Users | Installers | Developers". On the left, a sidebar titled "About Astrogrid" contains links to "Announcing Astrogrid 2006.3", "What is Astrogrid?", "FAQ", "Report Bugs & Enhancements", and "License". It also includes a "User's Guide" section with a link to "Using Astrogrid". The central content area is titled "AstroGrid Release 2006.3" and announces the software release, stating "Astrogrid is pleased to announce software release 2006.3. The source code is tagged as AG2006-3." It also mentions that users will find useful information about the site.



<http://www.astrogrid.org/launch>

Nicholas

PPARC

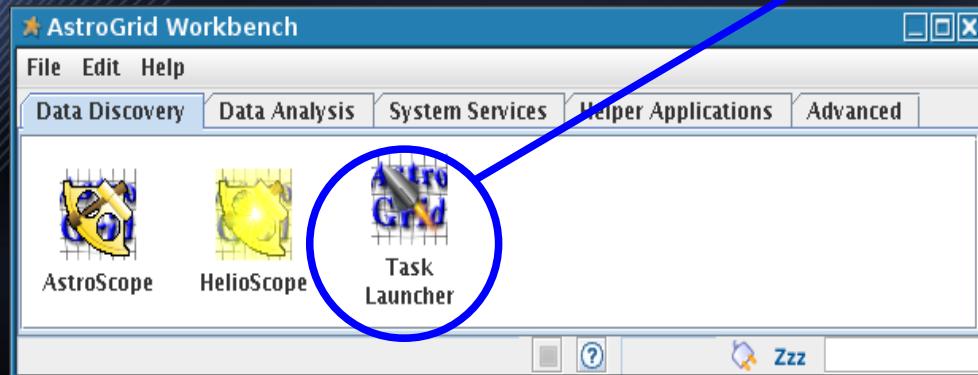
Astro
Grid

Integrating IPHAS Data

- Data Products from CASU pipeline include:
 - FITS images (per image pointing)
 - FITS table catalogues (per image pointing)
 - Single unified merged object source catalogues
 - Sybase IQ DMS system
- Access to these products expedited by use of AstroGrid interface mechanisms:
 - Images: via Simple Image Access protocol service
 - Catalogues (FITS tables):
 - Merged catalogues: Data Set Access component to database

SIAP Image service

- Simple Image Access to IPHAS images
 - physically data distributed from the Cambridge Astronomical Survey Unit (CASU @ IoA, Cambridge)
- Accessible through standard Virtual Observatory (VO) interfaces - e.g. AstroGrid Workbench



The screenshot shows the "Task Launcher" application window. The title bar says "Task Launcher". The left sidebar has tabs for "Chooser", "Query", "Parameter", "XML", "Info", and "Security", with "Chooser" selected. A search bar at the top right contains the text "Find: IPHAS" and a "Search" button. The main area is titled "Select an Application:" and shows a list with "IPHAS" expanded, revealing "IPHAS images" and "IPHAS: SIAP service". Below this is a "Details" tab, which is currently active, showing the following information:

IPHAS images
IPHAS-img-app, ivo://uk.ac.cam.ast/IPHAS/images/CEA-application

This resource defines the CEA application for access to images from the Isaac Newton Telescope Photometric H-alpha Survey (IPHAS). The interface follows the SIAP standard.

Further information -
<http://astro.ic.ac.uk/Research/Halpha/North/index.shtml>

Type - Other
Subject - Application

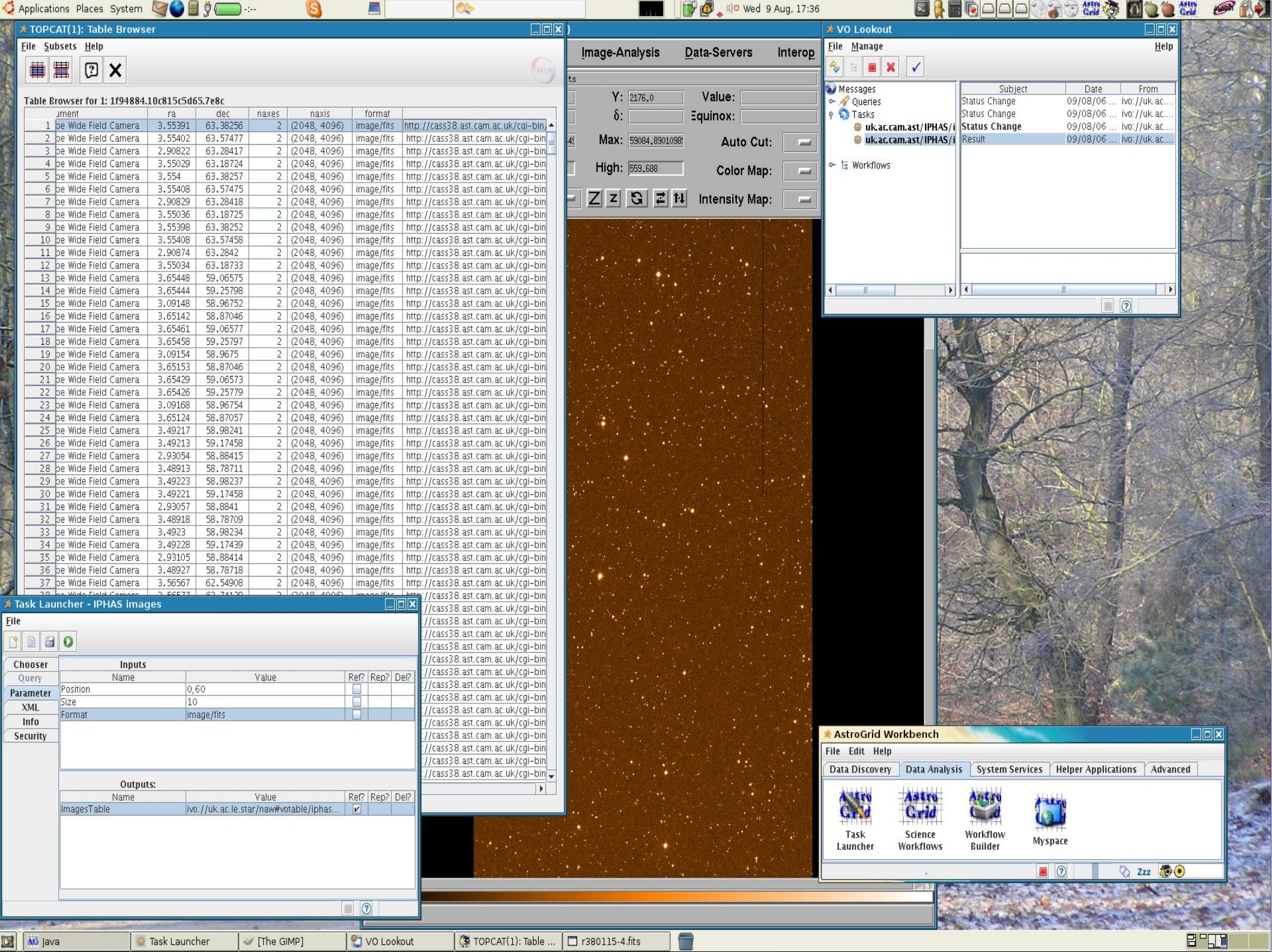
Interfaces

- SIAP
 - Inputs - POS, SIZE, FORMAT
 - Outputs - IMAGES

Parameter Details

Name	Type	Description
Position	text	Comma separated position of centre of field RA,DEC in decimal degrees
Size	text	Comma separated size of field RA,DEC in decimal degrees
Format	text	e.g. image/fits - see SIAP definition
ImagesTable	text	A VOTable of image details

Published by [Cambridge Astronomical Survey Unit](#)
Contact:
Guy Rixon
atr@ast.cam.ac.uk



Catalogue Access

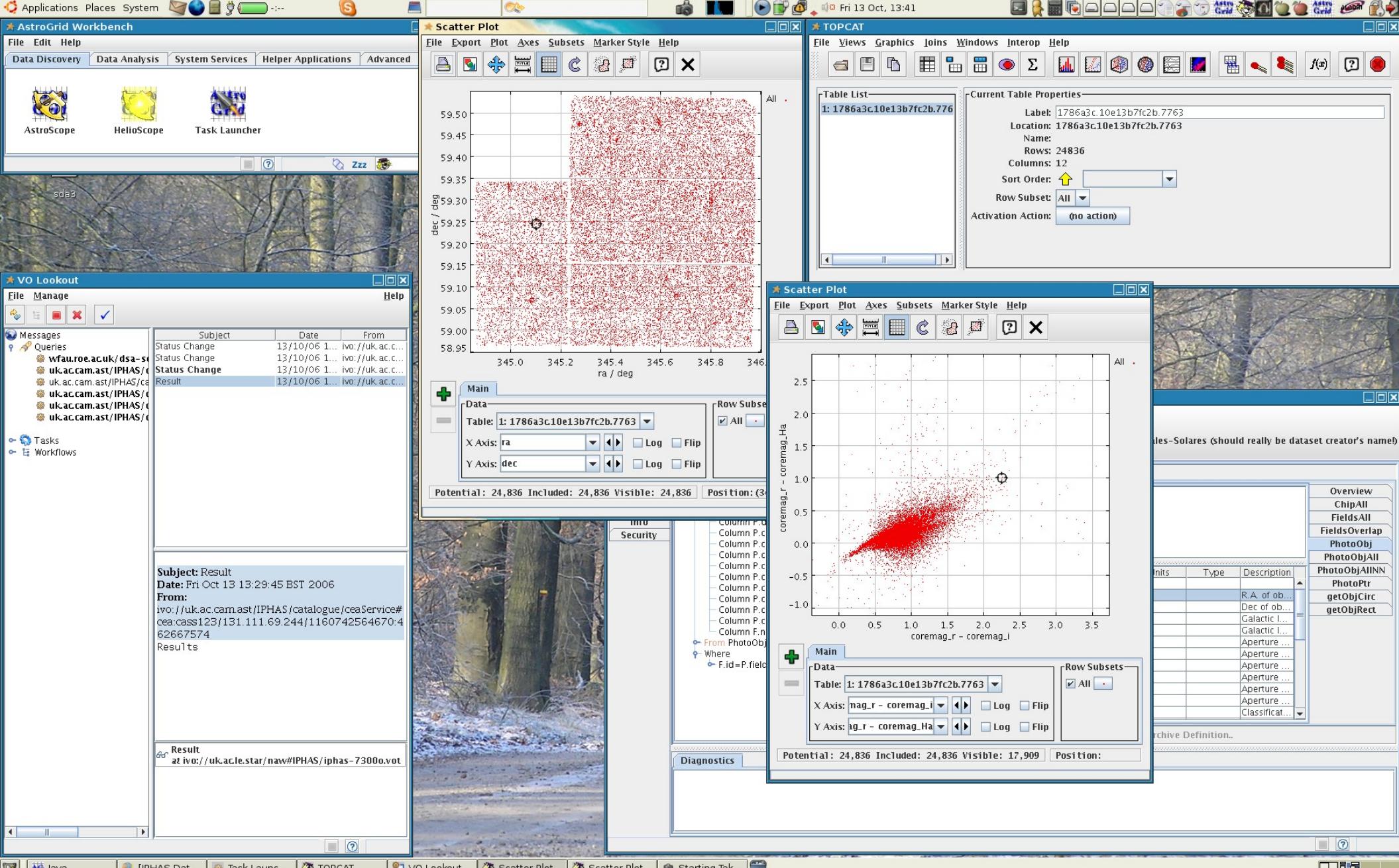
- Catalogue data available both as FITS tables on a per pointing basis
- In release – unified object catalogues

The screenshot shows the 'Task Launcher - IPHAS catalogue' window with several tabs and panels:

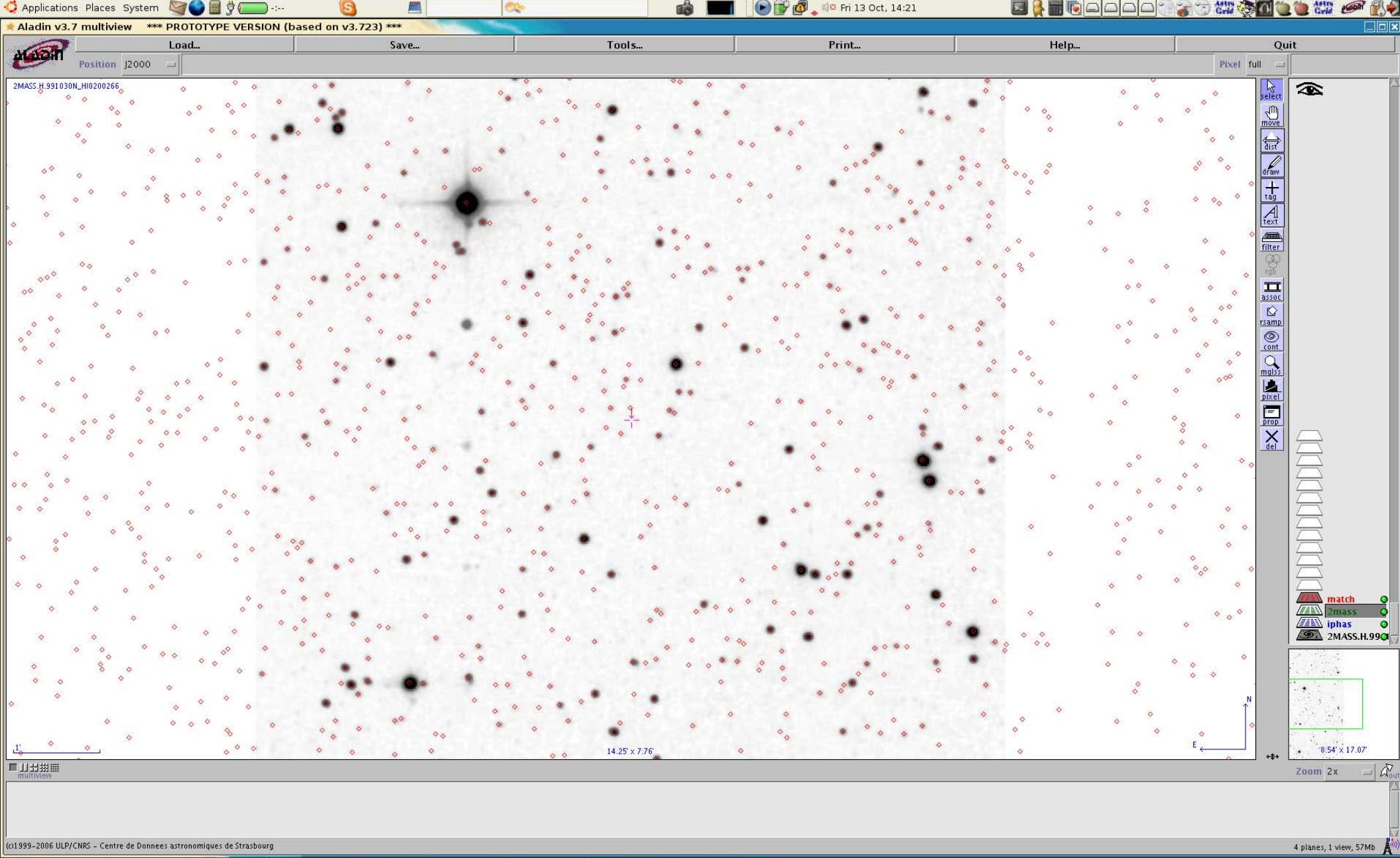
- Table Columns**: Shows a list of columns for the 'IPHAS catalogue'.

Col	Name	UCD	Units	Type	Description
0	id	ID_NUMBER			R.A. of ob...
1	ra	POS_EQ_R...	deg		Dec of ob...
2	dec	POS_EQ_D...	deg		Galactic l...
3	glon	POS_GAL...	deg		Galactic l...
4	glat	POS_GAL...	deg		Aperture ...
5	coremag_r	PHOT_MA...	mag		Aperture ...
6	coremag_i	PHOT_MA...	mag		Aperture ...
7	coremag_ha	PHOT_MA...	mag		Aperture ...
8	coremag...	PHOT_MA...	mag		Aperture ...
9	coremag...	PHOT_MA...	mag		Aperture ...
10	coremag...	PHOT_MA...	mag		Aperture ...
11	class_r	CLASS_CO...			Classification
- Table Description**: Shows a message: "No description available".
- Selected table**: A list of table names:
 - Overview
 - ChipAll
 - FieldsAll
 - FieldsOverlap
 - PhotoObj
 - PhotoObjAll
 - PhotoObjAllNN
 - PhotoPtr
 - getObjCirc
 - getObjRect
- Query being built**: A panel showing the SQL query being constructed:

```
SELECT
  Column P.ra,
  Column P.dec,
  Column P.coremag_r,
  Column P.coremag_i,
  Column P.coremag_ha,
  Column P.coremagerr_r,
  Column P.coremagerr_i,
  Column P.coremagerr_ha,
  Column P.class_r,
  Column P.class_i,
  Column P.class_ha,
  Column F.name
FROM PhotoObj as P, FieldsAll as F
WHERE
  F.id=P.field_id And F.name Like '%73000%'
```
- Diagnostics**: A panel showing diagnostic information.
- List of tables in the database**: A panel showing the list of tables in the database, which corresponds to the 'Selected table' list.



SQL query selecting IPHAS field 7300o objects = 24000 sources

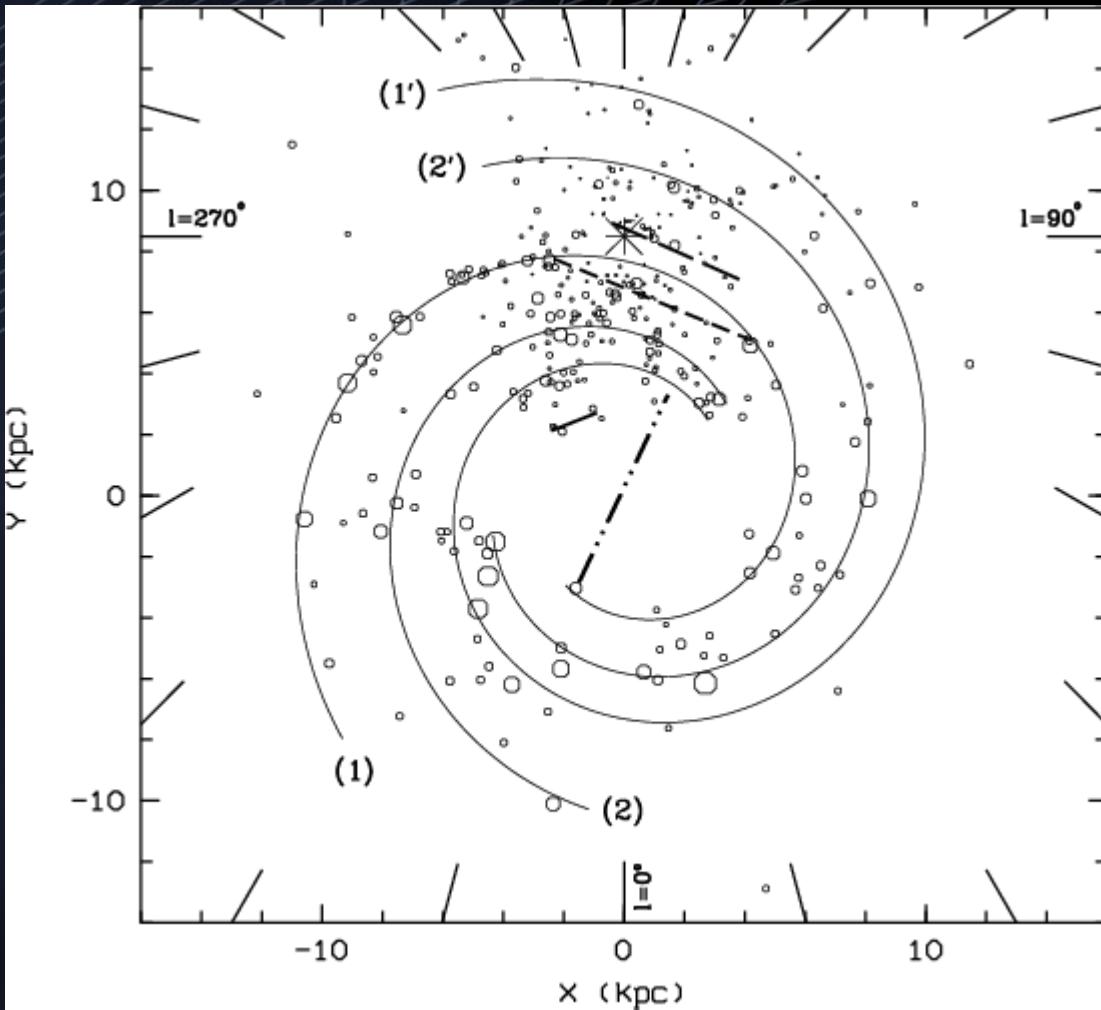


Cross match of IPHAS and 2MASS for element of Field 7300o

Nicholas Walton: IPHAS: Oct 16, 2006 @ ADASS XVI Tucson p16 Printed: 13/10/06

Models for Galactic Structure

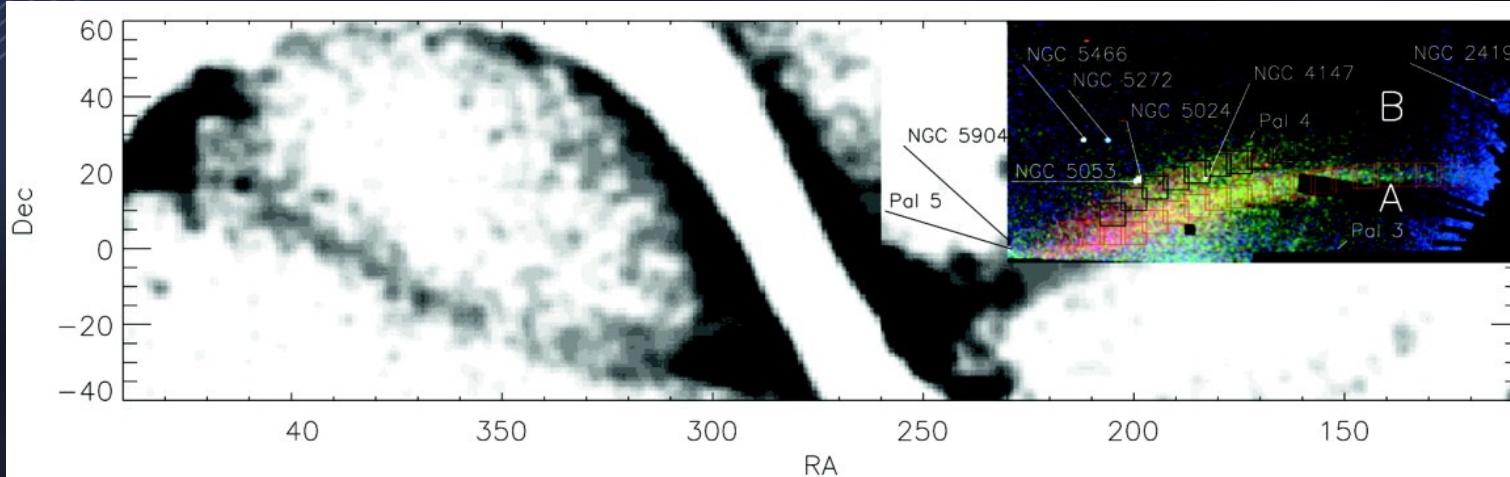
- Young populations good tracers of galactic structure
- e.g. Russeil (2003) study based on positions of star forming complexes (from HI, HII, CO observations)
- Vallee (2005) statistical study of recent work – points also to 4 arm model
 - uncertainties over interarm distances
 - incompleteness in certain directions e.g. $180 < l < 270$, anticentre direction



Russeil 4-arm model - 1) Sagittarius-Carina, 2) Scutum-Crux, 1') Norma-Cygnus, 2') Perseus arms – sun marked by X

Aside: streams in the Milky Way

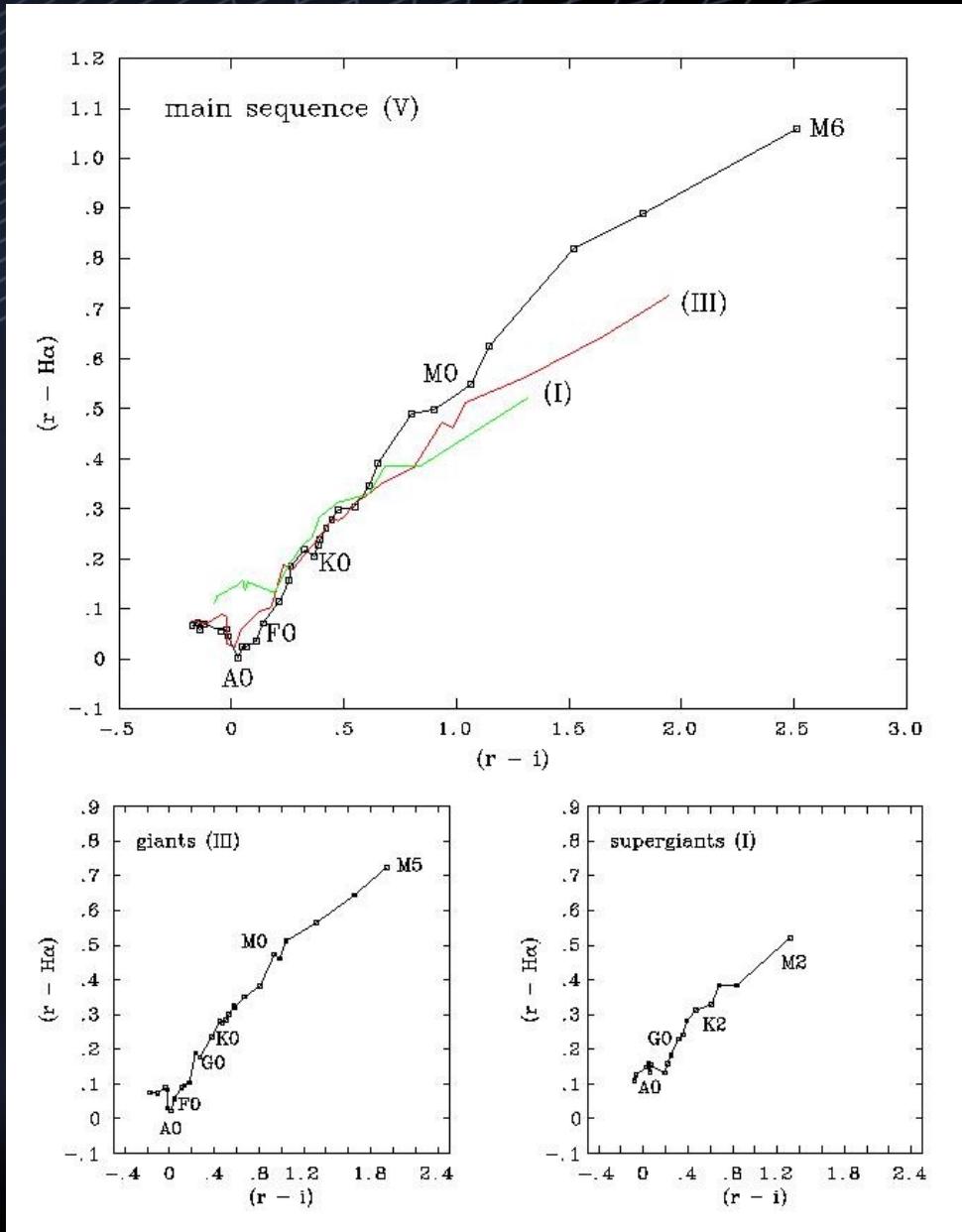
- Stellar streams are a good indication of galaxy hierarchical merger models (accretion of galaxies)
- Various (old) tracer populations used to map galactic streams
 - blue A coloured stars (inc BHs) (e.g. Yanny et al 2000, Ibata et al, 2001)
 - M giants (e.g. Majewski et al 2003)
 - RR Lyrae stars (e.g. Ivezic et al 2000)
- IPHAS to trace young (for galactic spiral structure) and old (for streams)



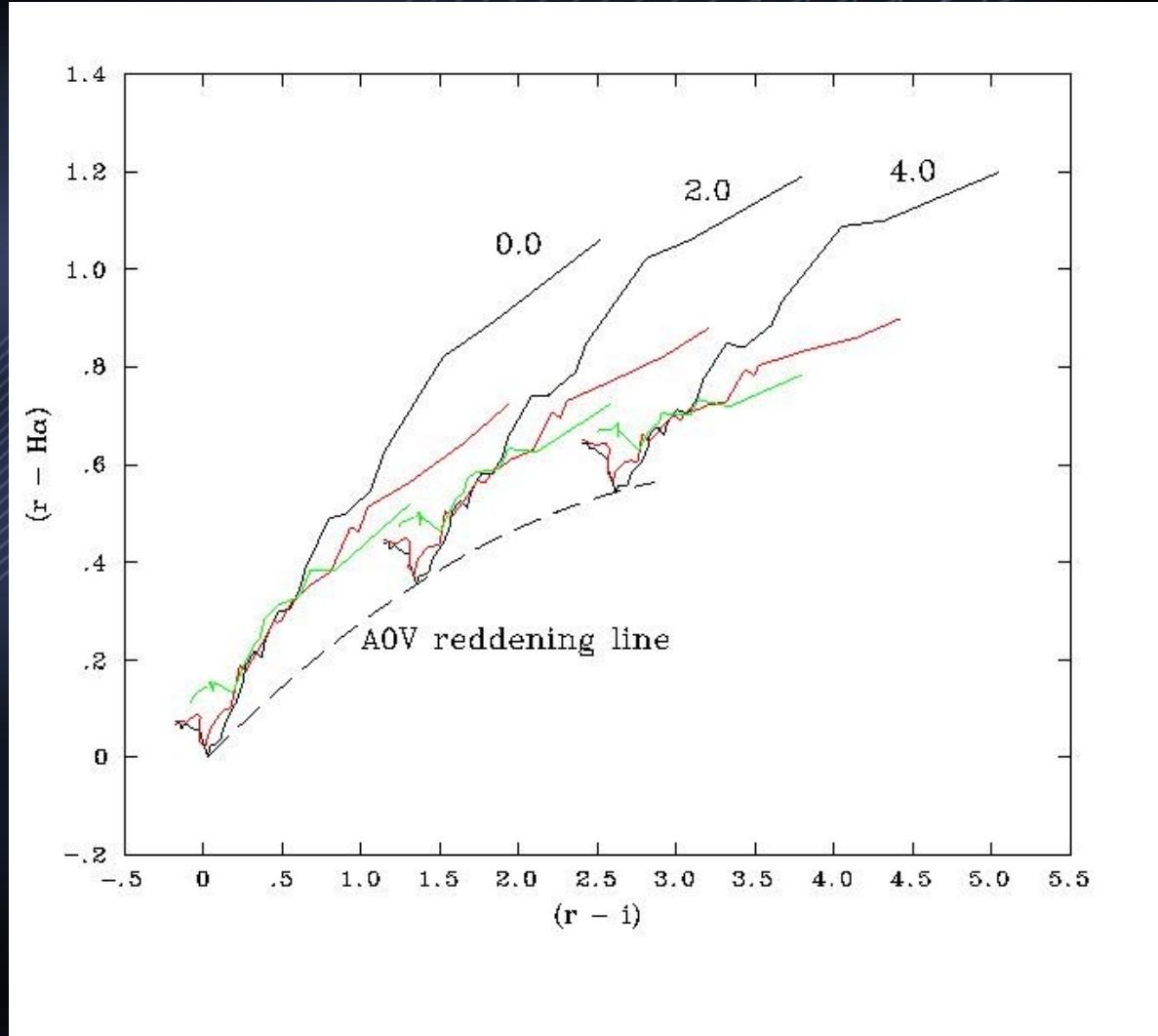
Panoramic view of the Sgr stream, obtained by combining the 2MASS M giants of Majewski et al. (2003) with the SDSS stars of Belokurov et al. 2006). Marked on the figure are branches A and B of the stream, together with some of the globular clusters

Structure: use of the IPHAS survey

- IPHAS is deep enough to sample most of the plane
 - $r \sim 20$ = unreddened A0 dwarfs at 20kpc
- A stars are luminous to allow for the study of distant clusters
- A0V reddening line \rightarrow a population of easily-modelled ‘standard candles’
- Thus select early type (A, B stars) from their position in the colour-colour plane

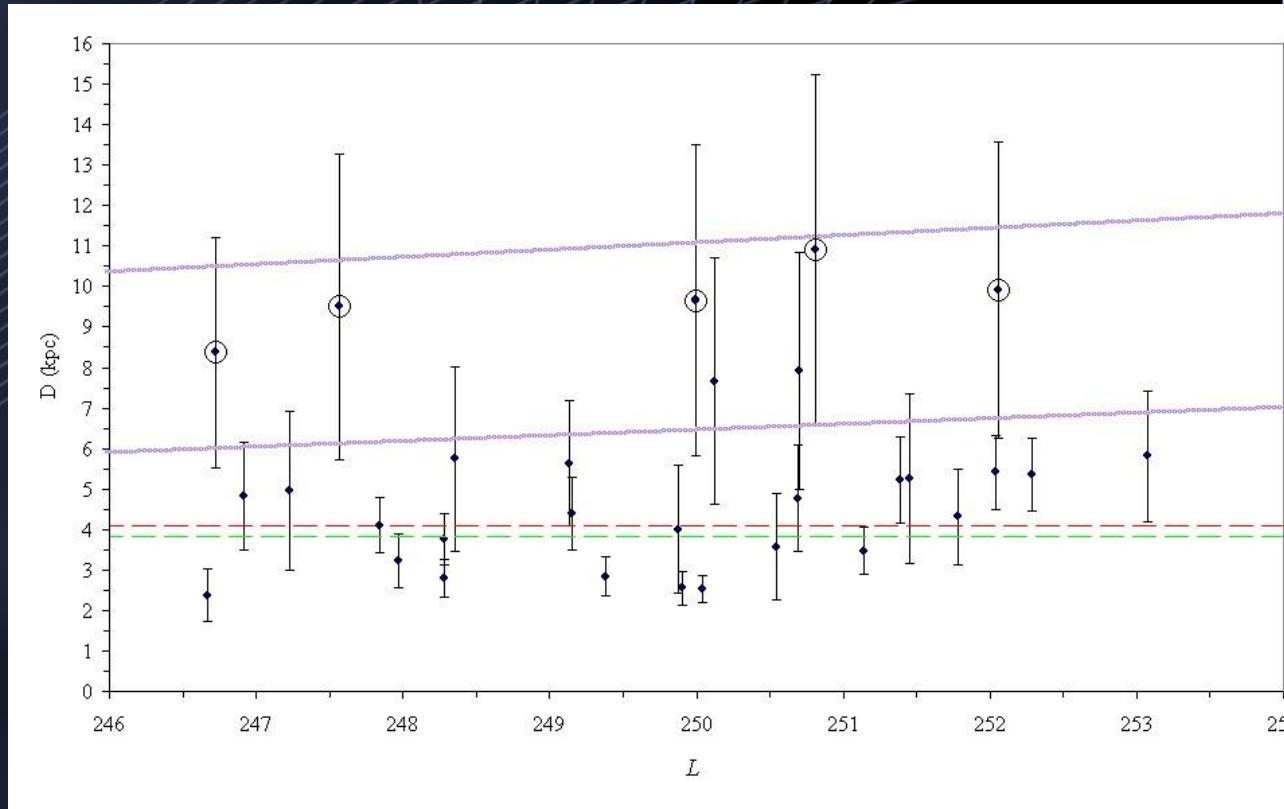


Early-A Reddening Line



Pilot Study Results: SHS data

- Trail test utilising SuperCosmos H-Alpha Survey data of the southern galactic plane
 - sample selection based on colour criteria
 - spectral typing via 6dF spectra
 - reddening via SED
 - determine distance via spectroscopic parallax
- First results (stars $< R \sim 14$) for the Perseus arm give a distance of 3.8 ± 0.1 kpc



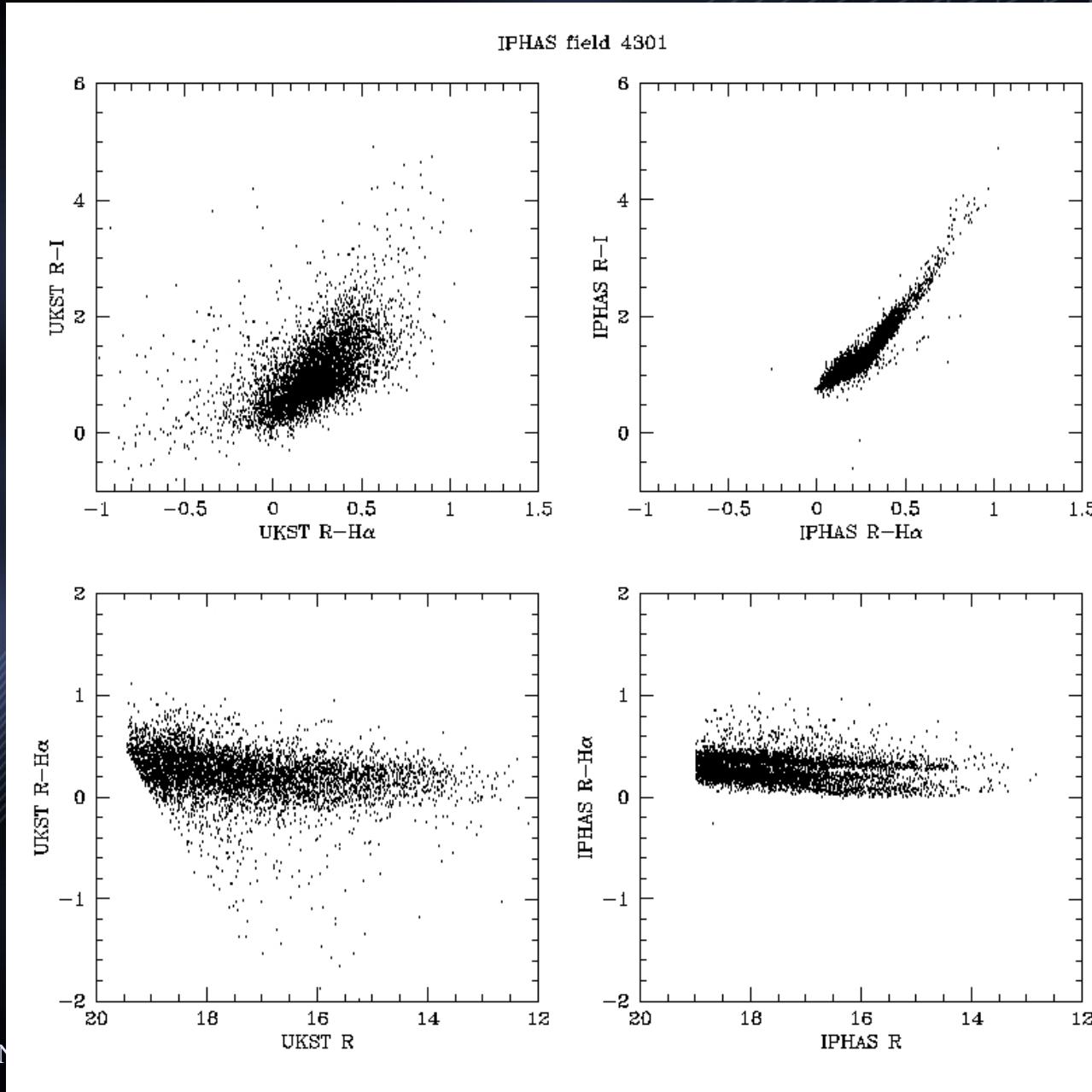
Purple lines: upper Norma-Cygnus arm, lower Perseus arm (from Russeil 2003 models). Green line : fit to sample B stars (excluding outliers, circles which may map the Norma-Cygnus arm)

Result in agreement with Vallee (2005) concordance model

IPHAS Extension

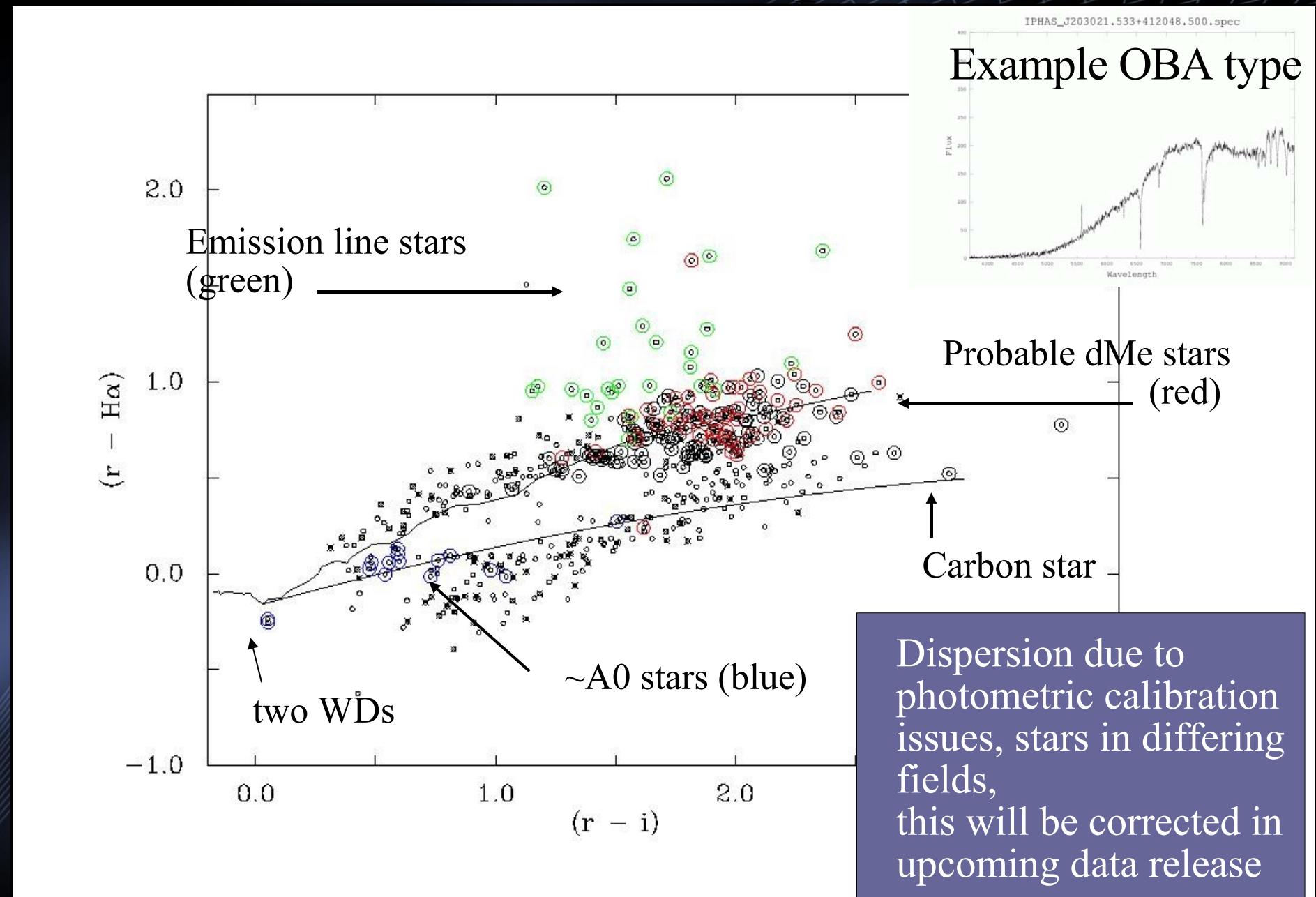
- Selection of A-stars based on colour criteria
 - issue: selection of A-type stars – young (A0V) and old (BHB's)
 - use u-g, g-r colours to distinguish between two types
 - also addition of IR data from UKIDSS Galactic Plane Survey
- Thus with the IPHAS and IR data
 - confirmation of early A SEDs
 - reddening
 - distances
 - and with UVEX u,g – metallicity
- Spectroscopy not required although helpful
- First results on galactic structure end 2006
 - pilot in the CygOB2 region (IPHAS + 2MASS J,K to probe structure of the OB association and environment)
 - Hectospec observations of A stars outside the Solar Circle
 - kinematics in the outer galaxy

IPHAS c.f. Existing Plate Surveys



- Photometry and colour-colour diagrammes much improved c.f. SuperCosmos H-alpha Survey (Parker et al, 2005)

Selection: MMT HectoSpec Confirmations



Closing

- This year will see the first public release of IPHAS galactic plane survey data
 - VO access to data will enable key science programmes including studies of galactic structure
- Key Links
 - IPHAS: <http://www.iphas.org>
 - EGAPS: <http://www.egaps.org>
 - AstroGrid: <http://www.astrogrid.org> and <http://wiki.astrogrid.org>
- ASTROGRID DEMO: EXHIBITION AREA