

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

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

The IPHAS Survey Collaboration

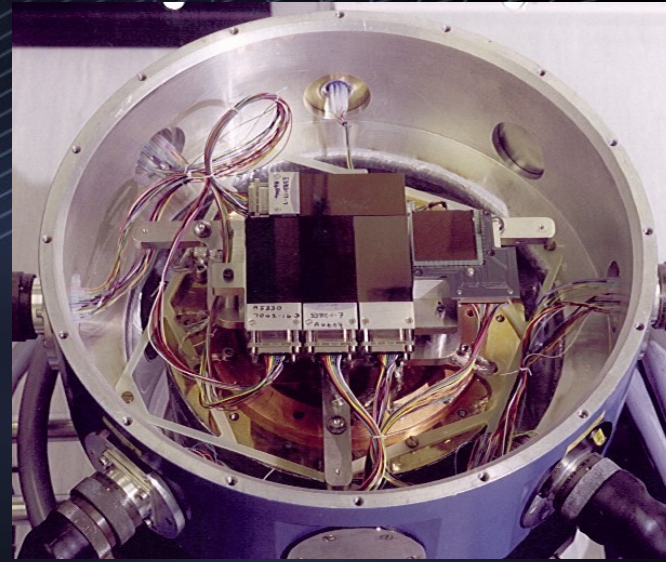
- IPHAS: The Isaac Newton Telescope/ Wide Field Camera Photometric H-alpha Survey of the Northern Galactic Plane (PI: Janet Drew: Imperial, UK)
- IPHAS collaboration - <http://www.iphas.org> :
 - UK: Bristol, Cambridge, Imperial, Keele, Manchester, Hertfordshire, Southampton, UCL, UKATC, Warwick
 - Australia: 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):

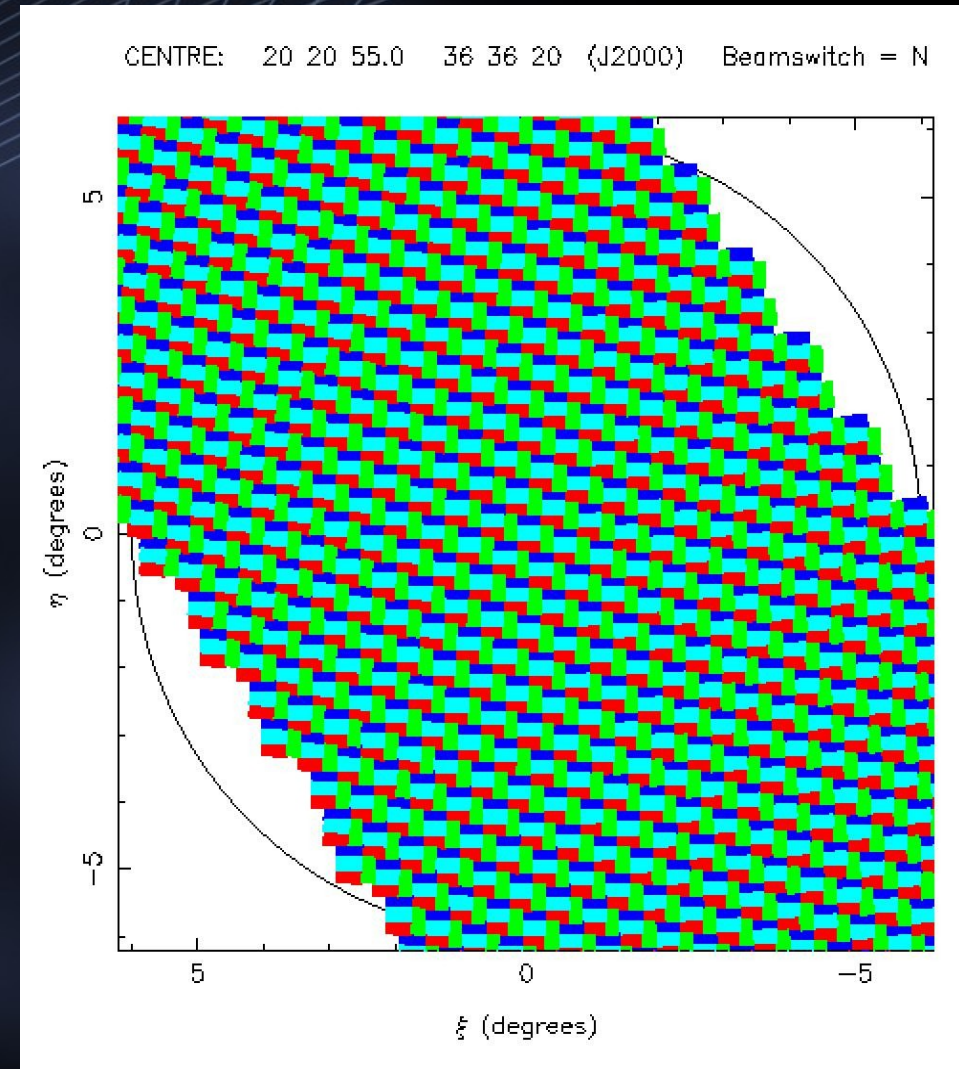
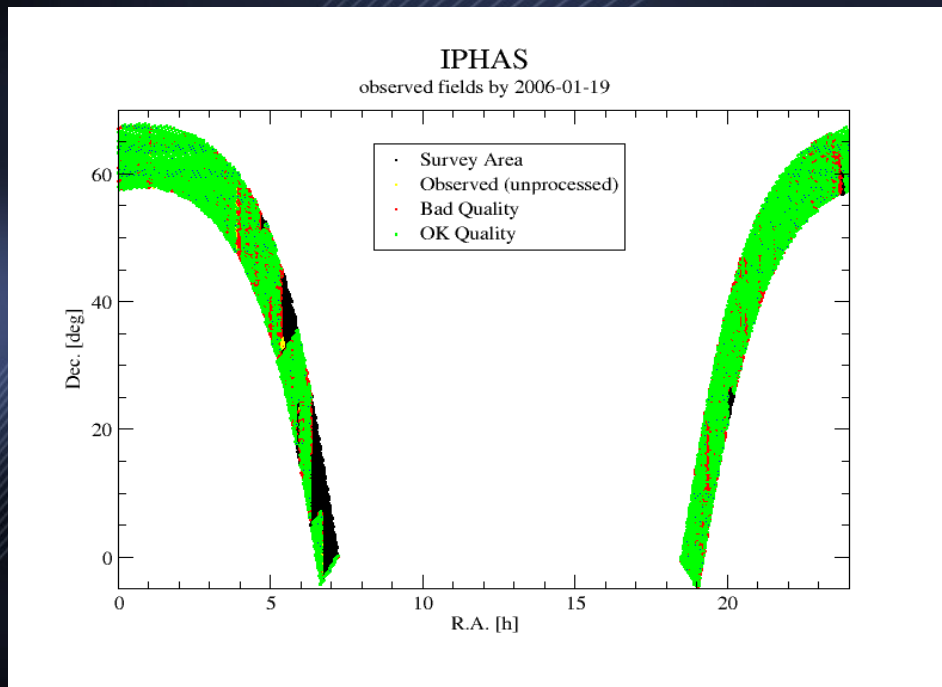
- (Compact) planetary and symbiotic nebulae
- luminous blue variables (P Cygni and eta Car like objects)
- OBA extreme supergiants
- rapidly evolving post-AGB stars
- Be stars of all types (including young Herbig stars)
- good statistics on clusters of T Tau stars
- a range of interacting binary stars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

IPHAS data source: 2.5-m INT + WFS



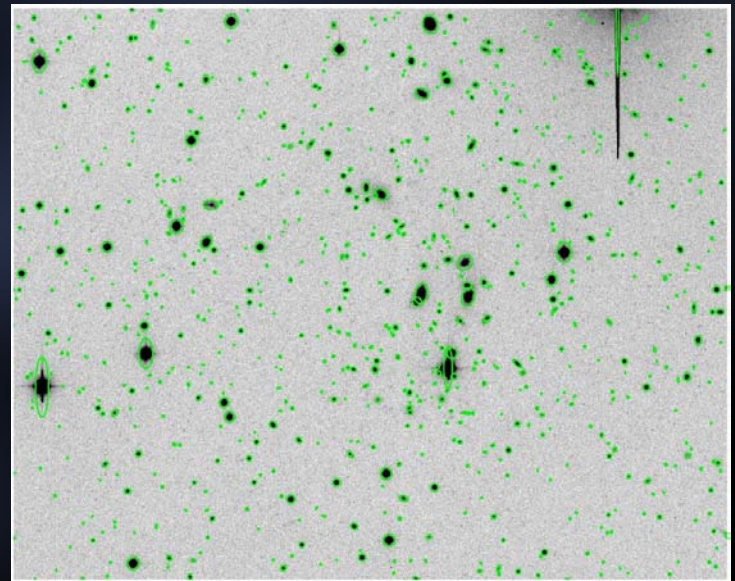
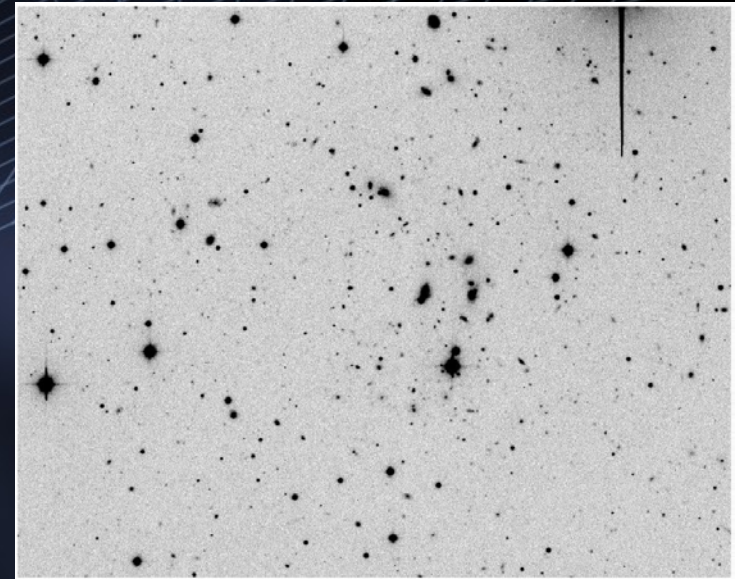
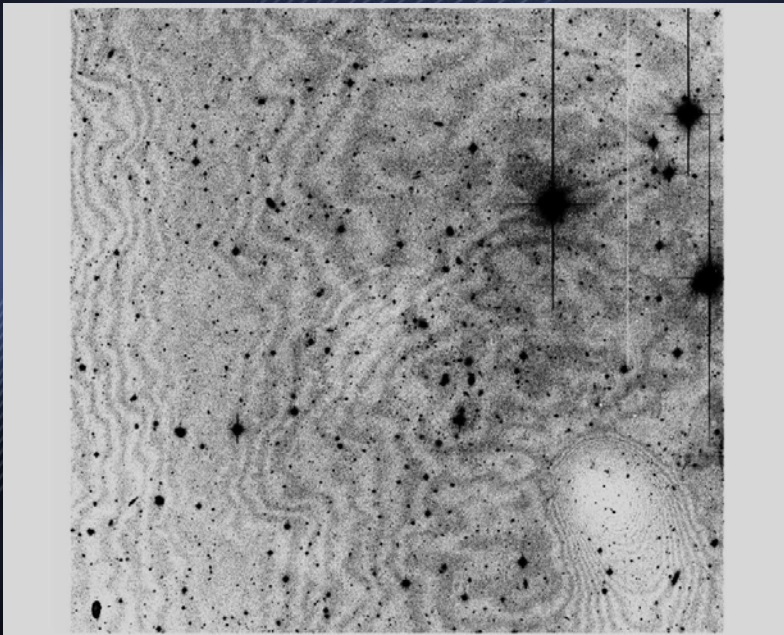
IPHAS Survey

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

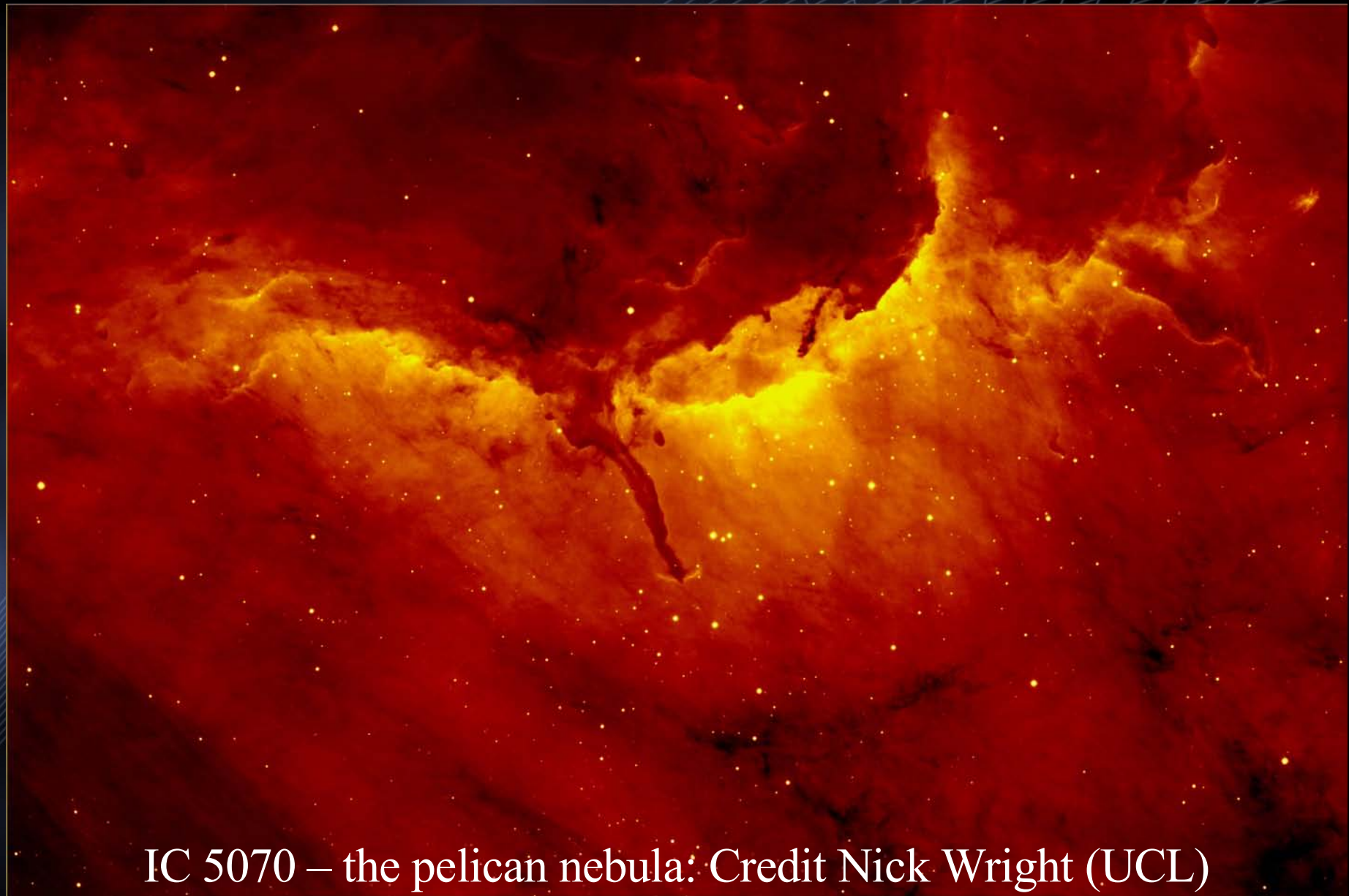


Survey Products

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

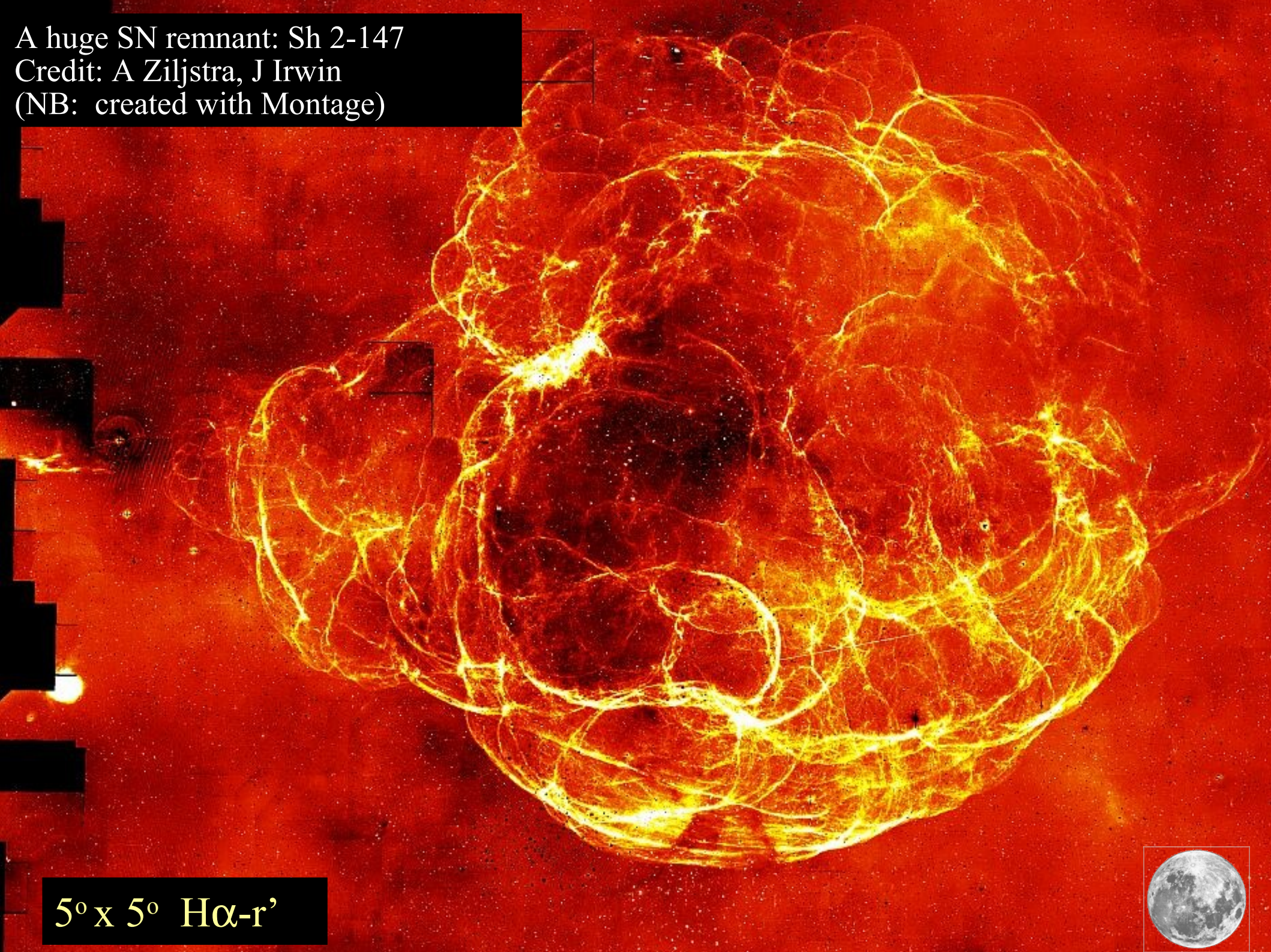


IPHAS: Images



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

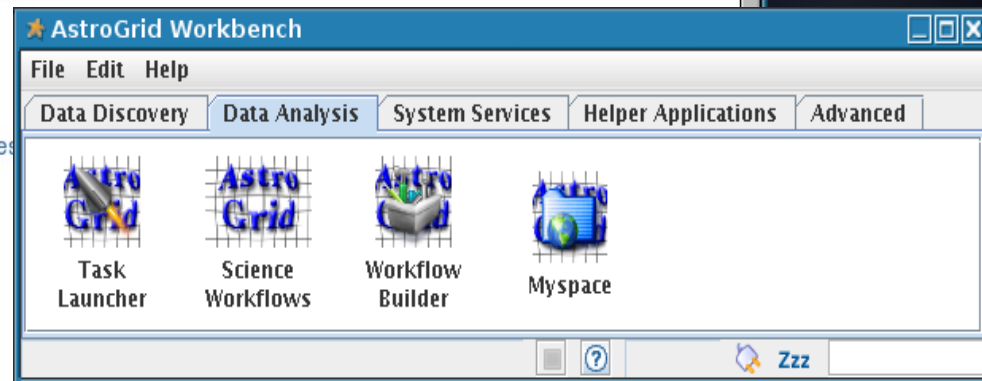
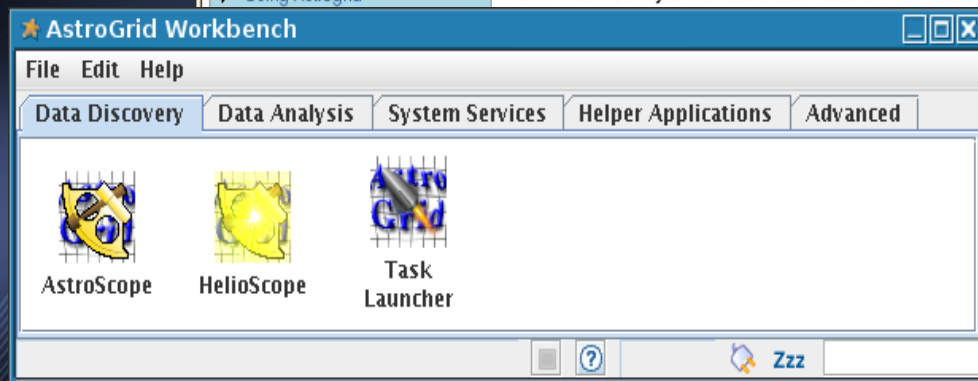
Empowerment of scientists

- 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



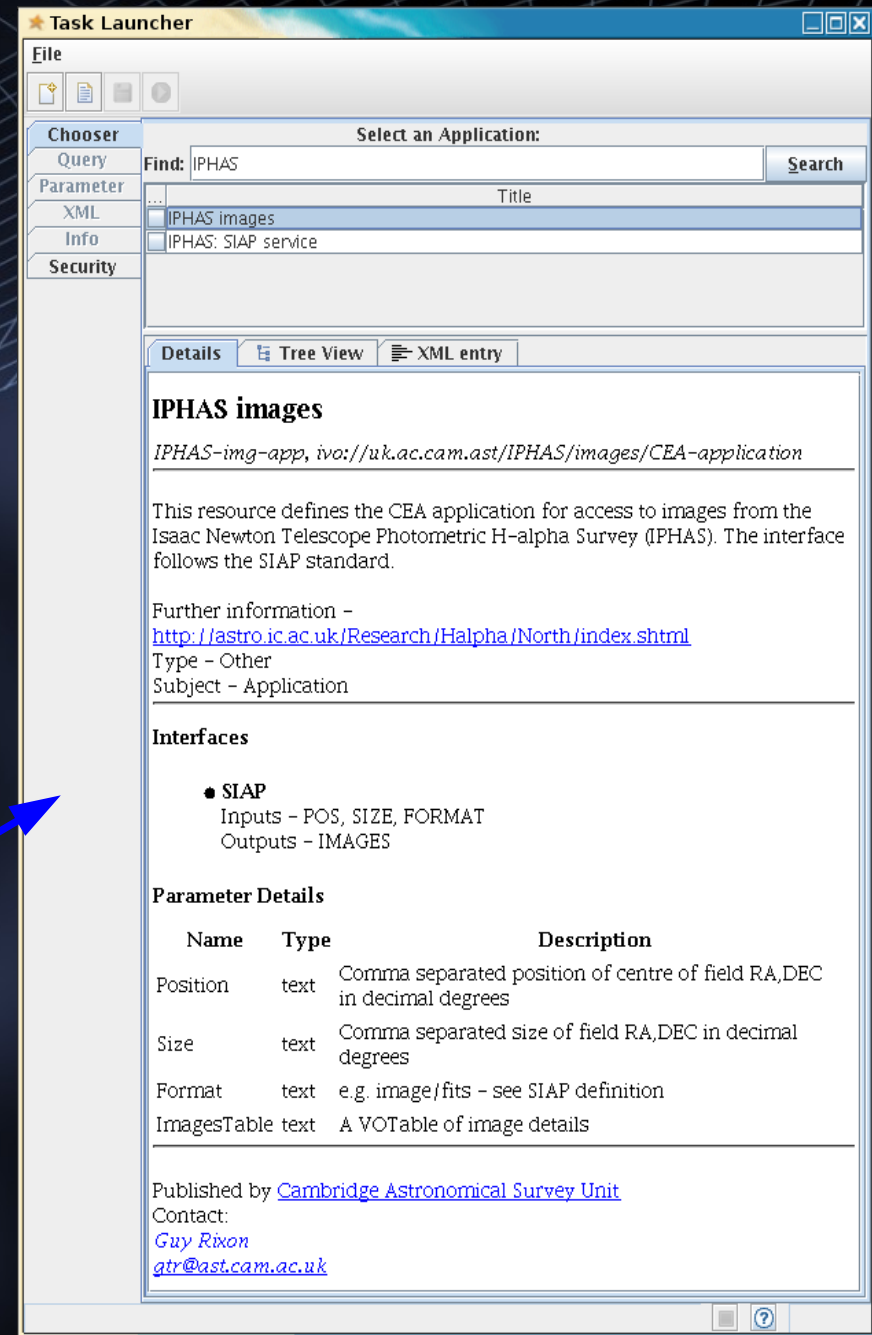
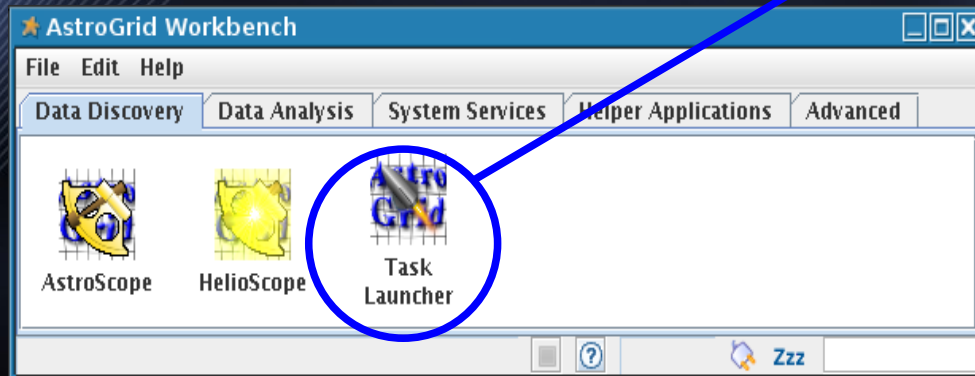
<http://www.astrogrid.org/launch>

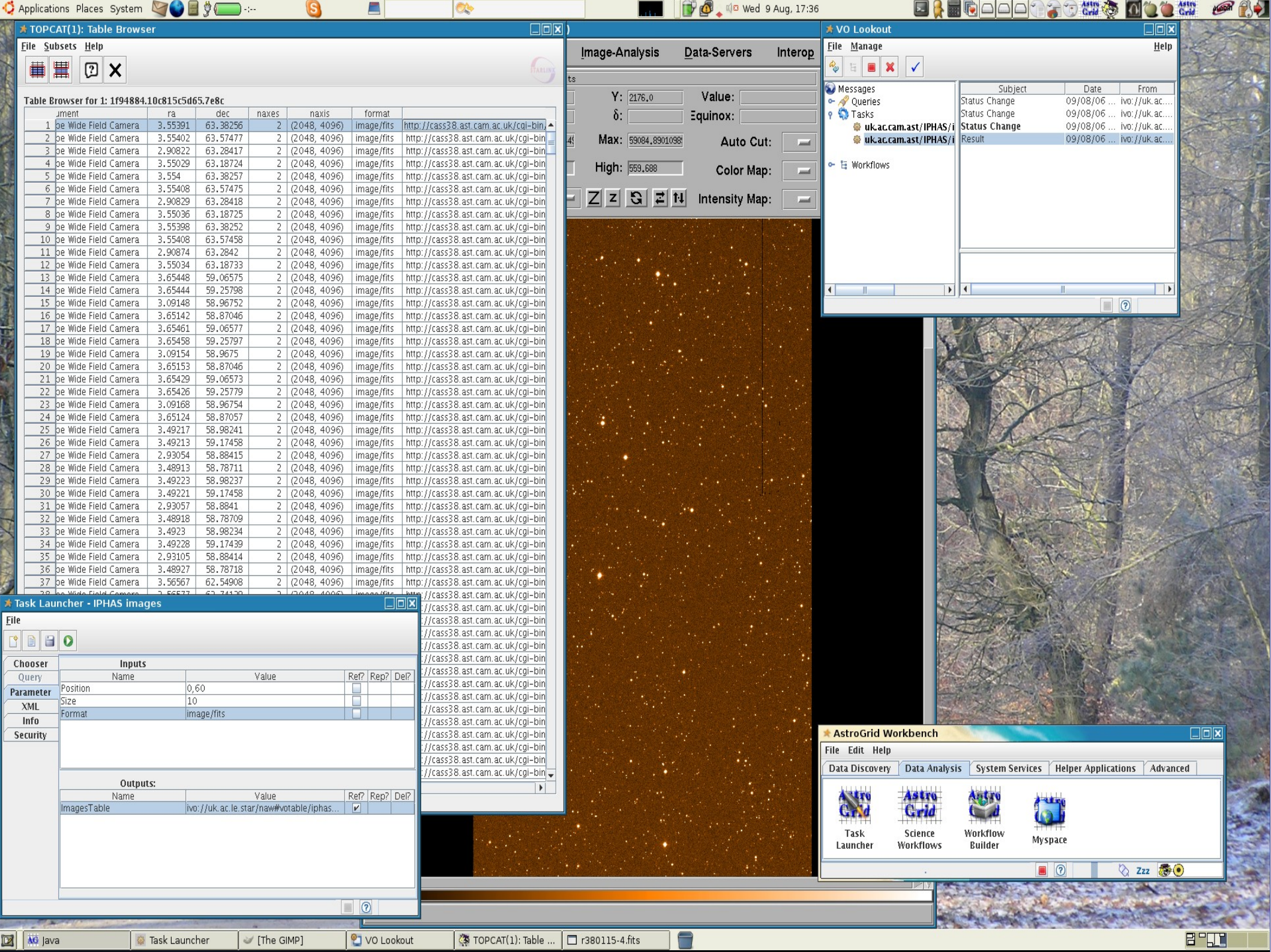
Integrating IPHAS Data

- 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





TOPCAT(1): Table Browser

File Subsets Help



Table Browser for 1: 1f94884.10c815c5d65.7e8c

id	comment	ra	dec	naxes	naxis1	format	url
1	Wide Field Camera	3.55391	63.38256	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
2	Wide Field Camera	3.55402	63.57477	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
3	Wide Field Camera	2.90822	63.28417	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
4	Wide Field Camera	3.55029	63.18724	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
5	Wide Field Camera	3.554	63.38257	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
6	Wide Field Camera	3.55408	63.57475	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
7	Wide Field Camera	2.90829	63.28418	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
8	Wide Field Camera	3.55036	63.18725	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
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11	Wide Field Camera	2.90874	63.2842	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
12	Wide Field Camera	3.55034	63.18733	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
13	Wide Field Camera	3.65448	59.06575	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
14	Wide Field Camera	3.65444	59.25798	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
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27	Wide Field Camera	2.93054	58.88415	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
28	Wide Field Camera	3.48913	58.78711	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
29	Wide Field Camera	3.49223	58.98237	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
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35	Wide Field Camera	2.93105	58.88414	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
36	Wide Field Camera	3.48927	58.78718	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...
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38	Wide Field Camera	3.56537	62.74130	2	(2048, 4096)	image/fits	http://cass38.ast.cam.ac.uk/cgi-bin/...

Task Launcher - IPHAS images

File

Chooser

Inputs	Name	Value	Ref?	Rep?	Del?
Query	Position	0,60	☐	☐	☐
Parameter	Size	10	☐	☐	☐
XML	Format	image/fits	☐	☐	☐
Info					
Security					

Outputs:

Name	Value	Ref?	Rep?	Del?
ImagesTable	ivo://uk.ac.le.star/naw/votable/iphas...	☒	☐	☐

Image-Analysis Data-Servers Interop

Y: 2176.0 Value:

δ : Equinox:

Max: 59084.8901098 Auto Cut: ☐

High: 559.688 Color Map: ☐

Intensity Map: ☐

☐ ☐ ☐ ☐ ☐ ☐



VO Lookupout

File Manage Help

Messages

- Queries
- Tasks
- Workflows

Subject	Date	From
Status Change	09/08/06 ...	ivo://uk.ac...
Status Change	09/08/06 ...	ivo://uk.ac...
Status Change	09/08/06 ...	ivo://uk.ac...
Result	09/08/06 ...	ivo://uk.ac...

AstroGrid Workbench

File Edit Help

Data Discovery Data Analysis System Services Helper Applications Advanced

Task Launcher Science Workflows Workflow Builder Myspace

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. It features a 'Chooser' panel on the left with tabs for 'Query', 'Parameter', 'XML', 'Info', and 'Security'. The 'Query' tab is active, showing a 'Tree' view of the database schema. A 'Query being built' box highlights the 'From' clause: 'PhotoObj as P, FieldsAll as F' and the 'Where' clause: 'F.id=P.field_id And F.name Like %7300o%'. The main panel displays the 'IPHAS catalogue' with a 'Table Description' box showing 'No description available'. A 'Table Columns' box points to a table of columns with headers: Col, Name, UCD, Units, Type, and Description. The columns listed are: 0 id, 1 ra, 2 dec, 3 glon, 4 glat, 5 coremag_r, 6 coremag_i, 7 coremag_ha, 8 coremage..., 9 coremage..., 10 coremage..., and 11 class_r. A 'Selected table' box points to the 'PhotoObj' table in the 'Overview' panel on the right. A 'List of tables in the database' box points to the 'Overview' panel. The 'Diagnostics' panel is at the bottom.

Table Columns

Col	Name	UCD	Units	Type	Description
0	id	ID_NUMBER			
1	ra	POS_EQ_R...	deg		R.A. of ob...
2	dec	POS_EQ_D...	deg		Dec of ob...
3	glon	POS_GAL...	deg		Galactic l...
4	glat	POS_GAL...	deg		Galactic l...
5	coremag_r	PHOT_MA...	mag		Aperture ...
6	coremag_i	PHOT_MA...	mag		Aperture ...
7	coremag_ha	PHOT_MA...	mag		Aperture ...
8	coremage...	PHOT_MA...	mag		Aperture ...
9	coremage...	PHOT_MA...	mag		Aperture ...
10	coremage...	PHOT_MA...	mag		Aperture ...
11	class_r	CLASS_CO...			Classificat...

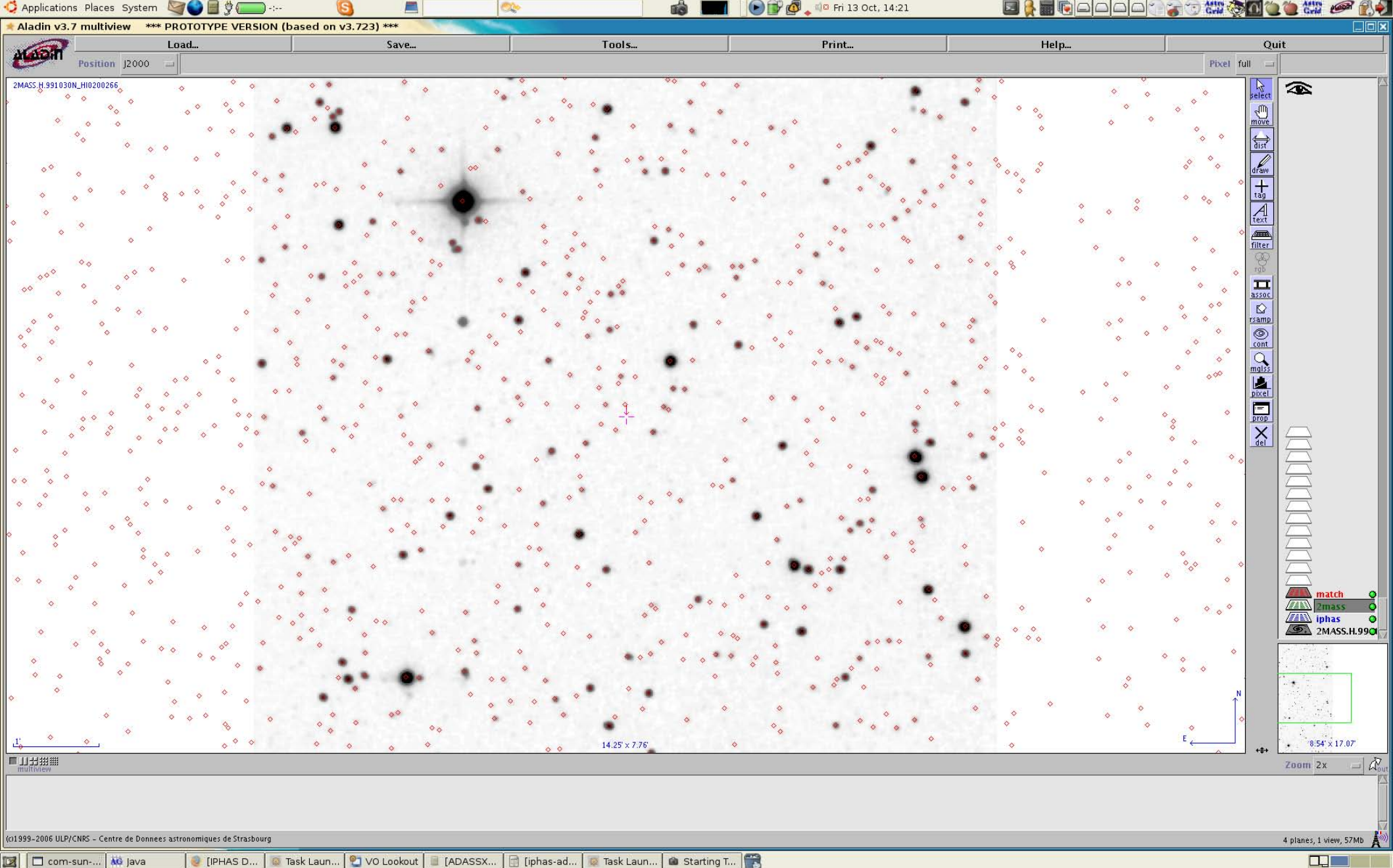
Table Description

No description available

Selected table

Query being built

List of tables in the database

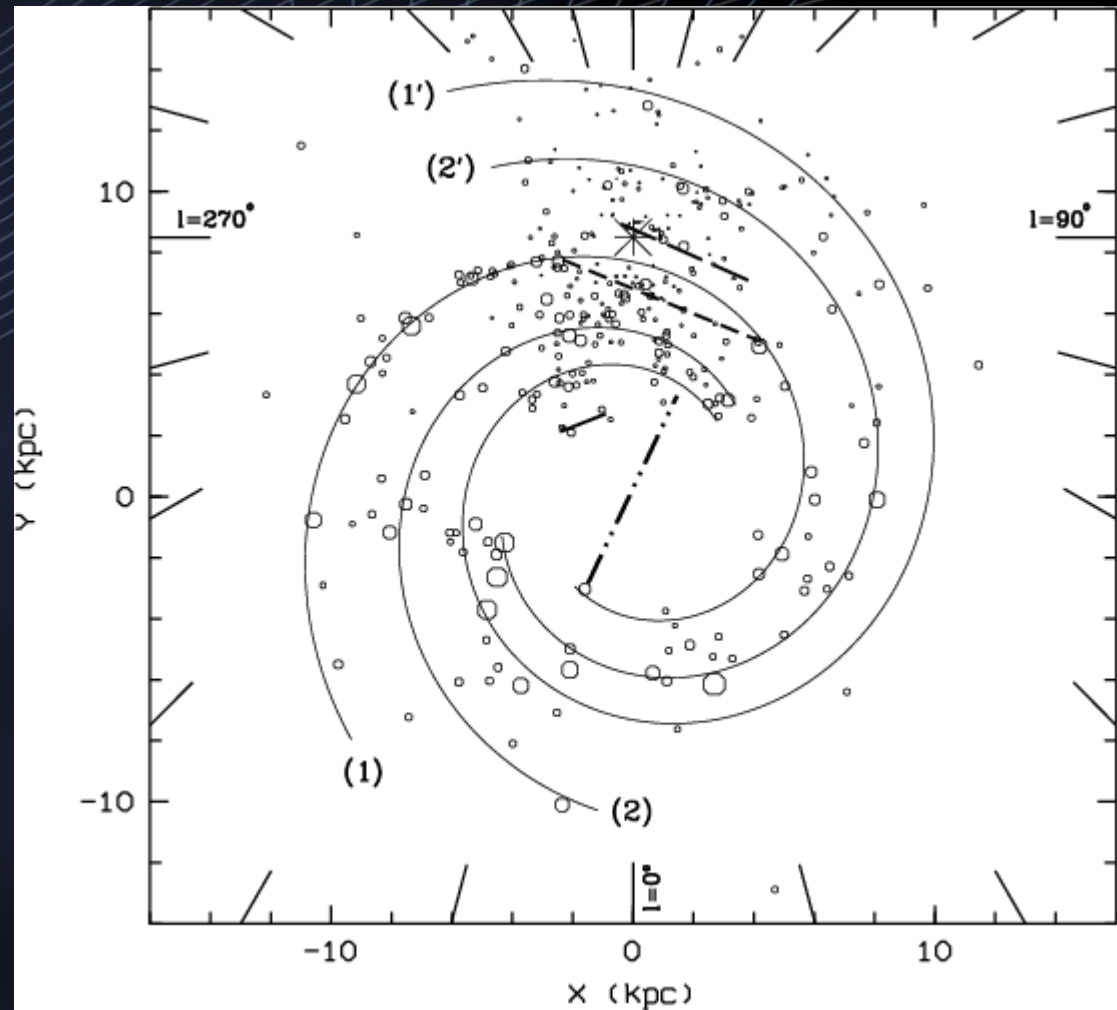


Cross match of IPHAS and 2MASS for element of Field 7300o

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

Models for Galactic Structure

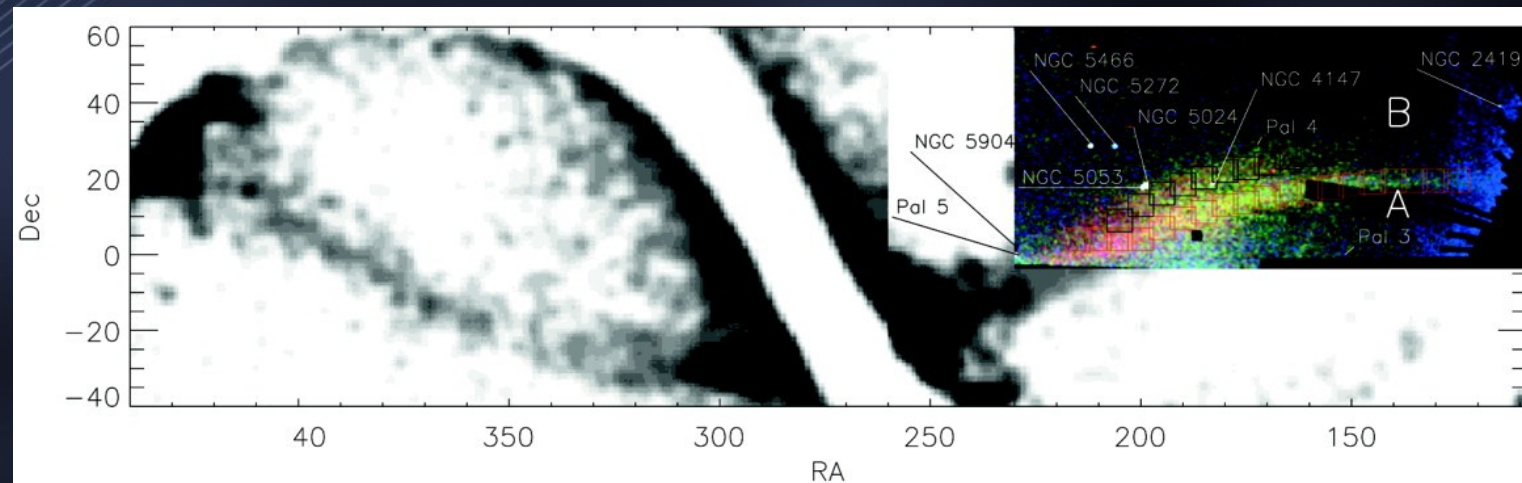
- Young populations good tracers of galactic structure
- e.g. Russeil (2003) study based on positions of star forming complexes (from HI, HII, CO observations)
- Vallee (2005) statistical study of recent work – points also to 4 arm model
 - uncertainties over interarm distances
 - incompleteness in certain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

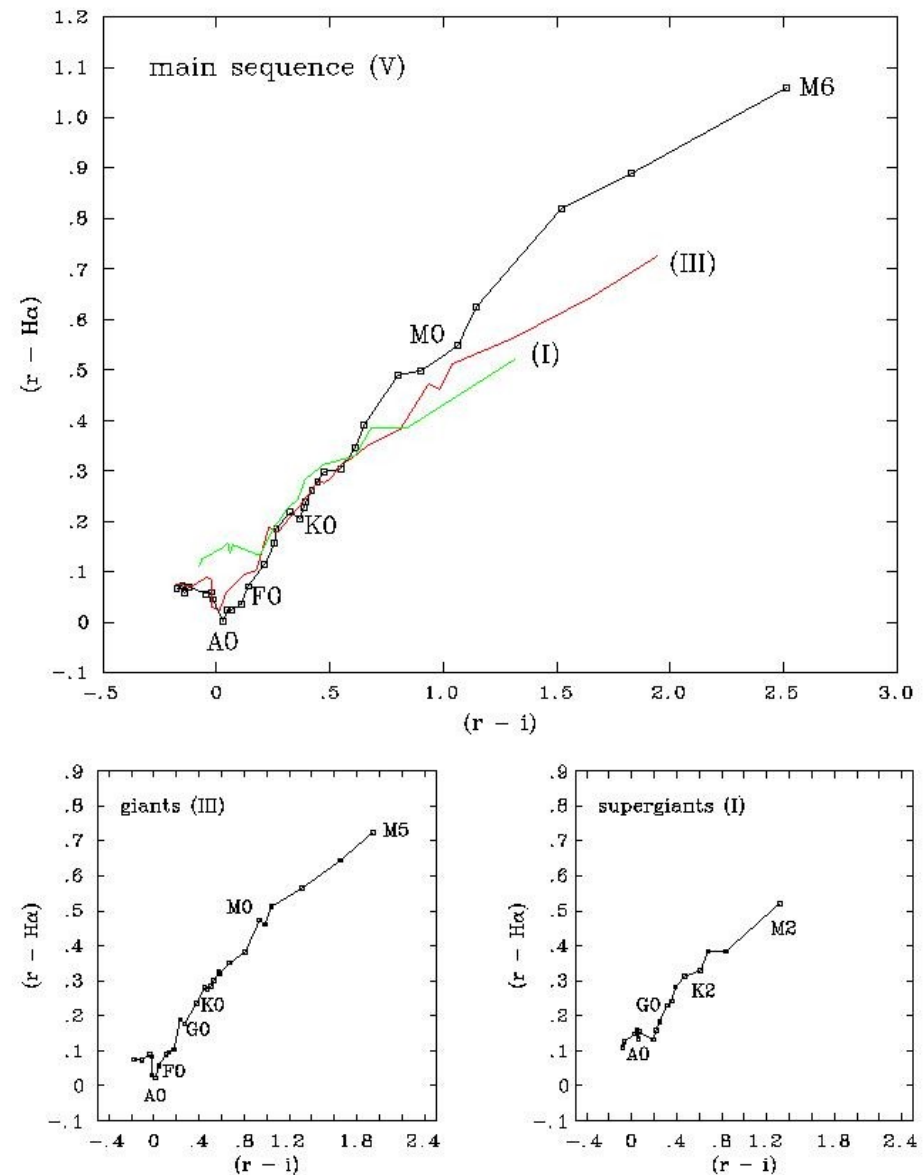
- Stellar streams are a good indication of galaxy hierarchical merger models (accretion of galaxies)
- Various (old) tracer populations used to map galactic streams
 - blue A coloured stars (inc BHBs) (e.g. Yanny et al 2000, Ibata et al, 2001)
 - M giants (e.g. Majewski et al 2003)
 - RR Lyrae stars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



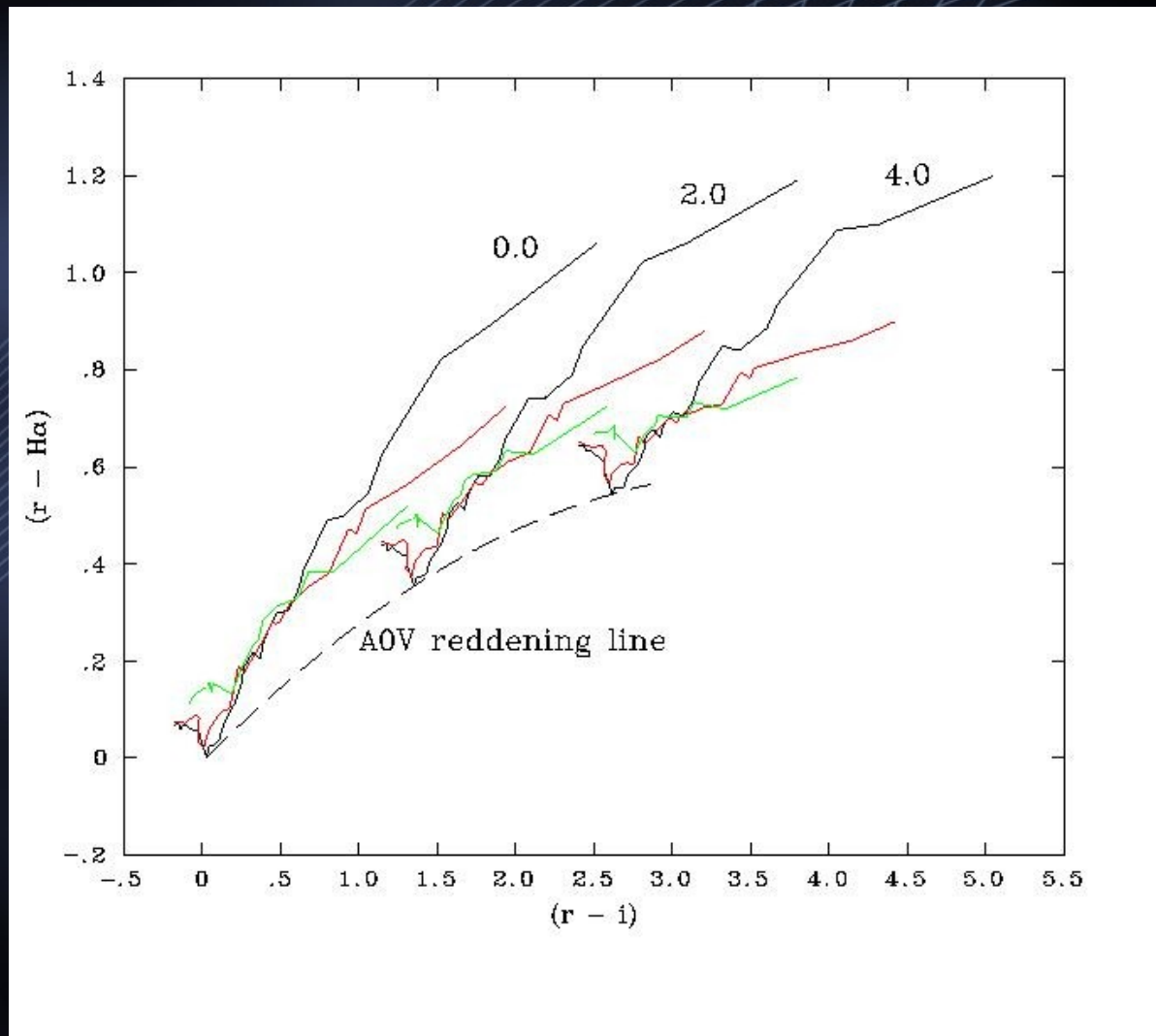
Panoramic view of the Sgr stream, obtained by combining the 2MASS M giants of Majewski et al. (2003) with the SDSS stars of Belokurov et al. 2006). Marked on the figure are branches A and B of the stream, together with some of the globular clusters

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

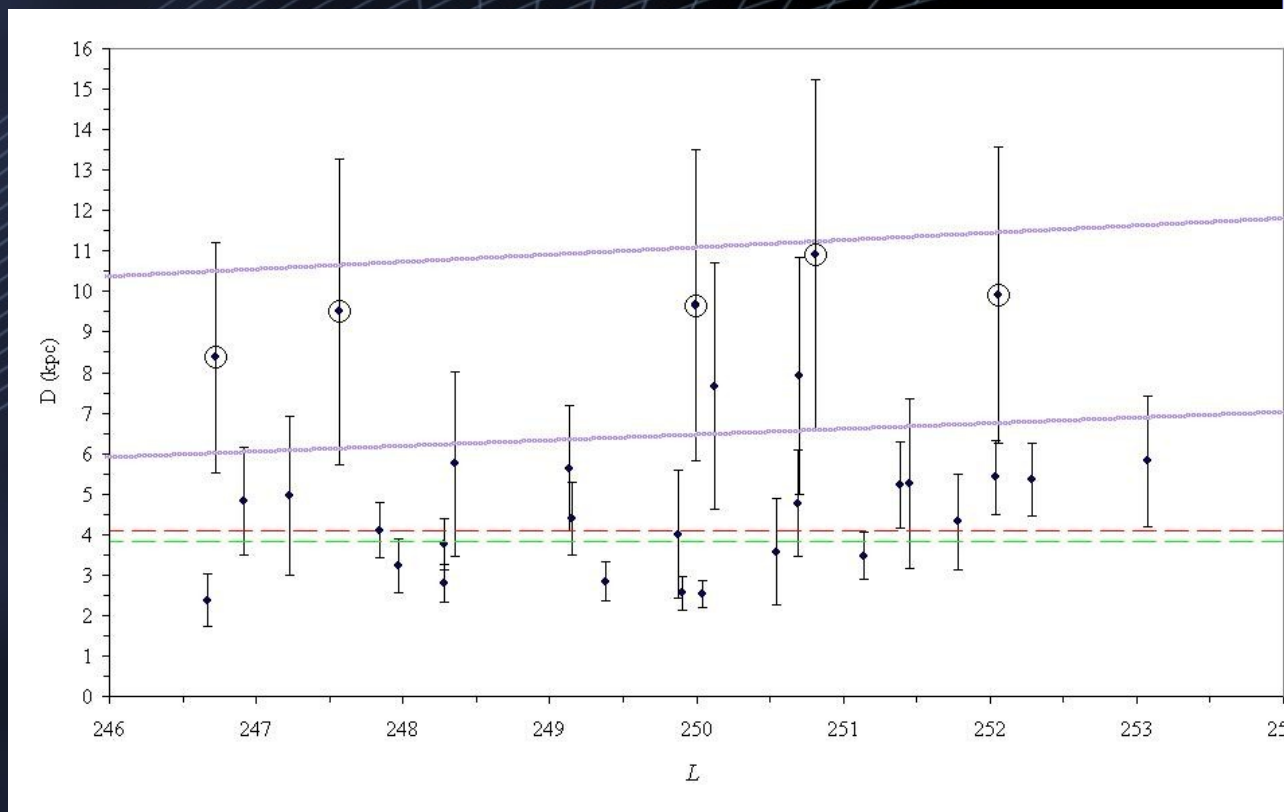


Early-A Reddening Line



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
 - reddenings 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)

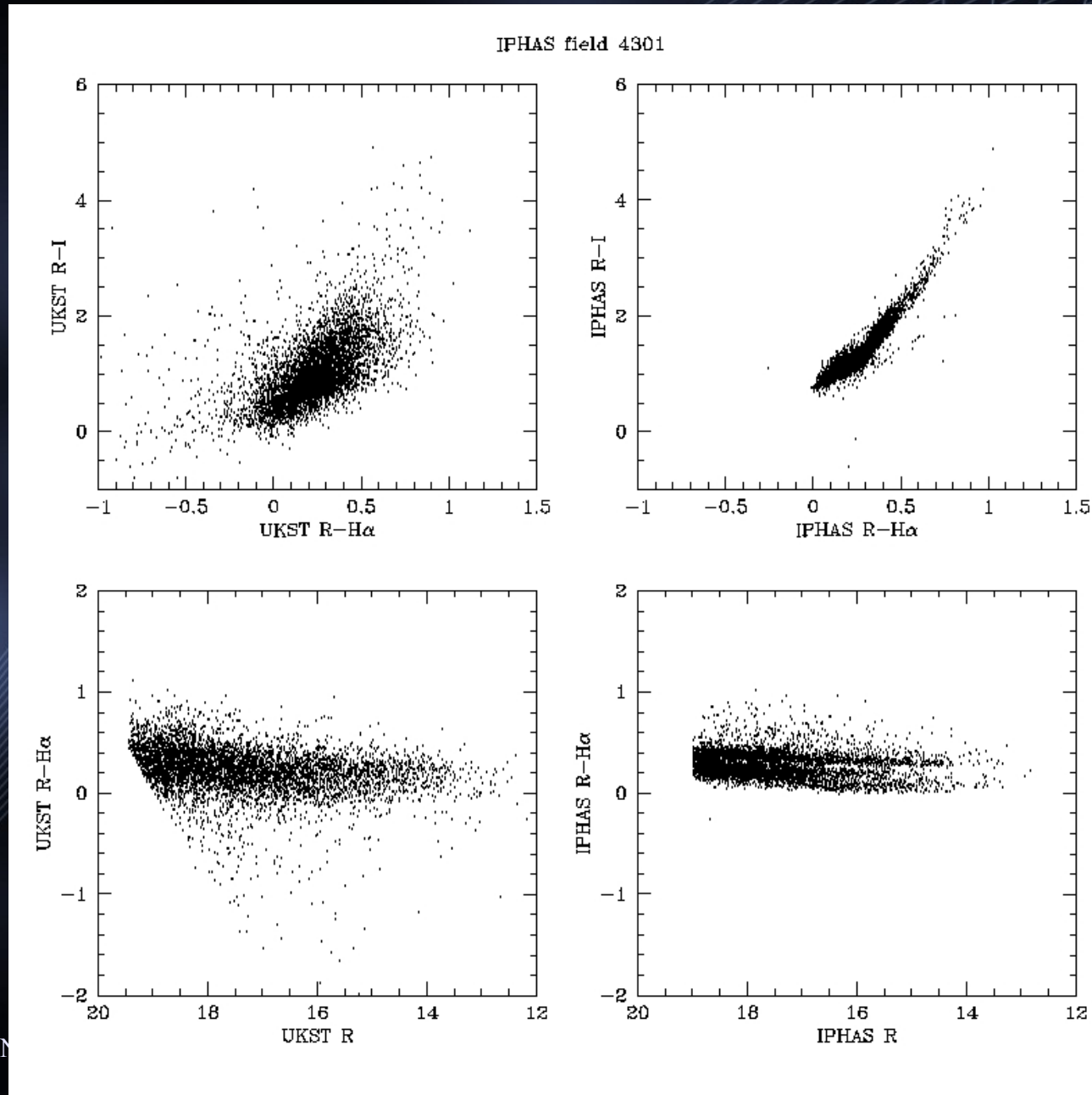
Result in agreement with Vallee (2005) concordance model

IPHAS Extension

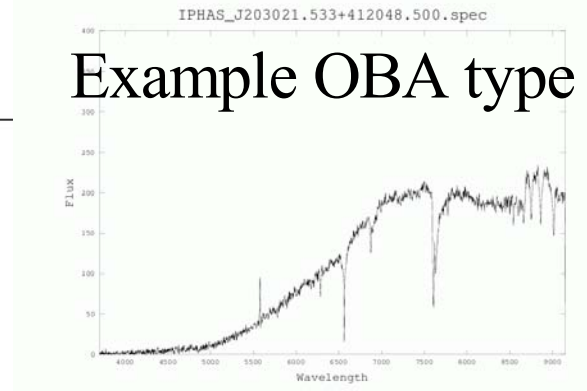
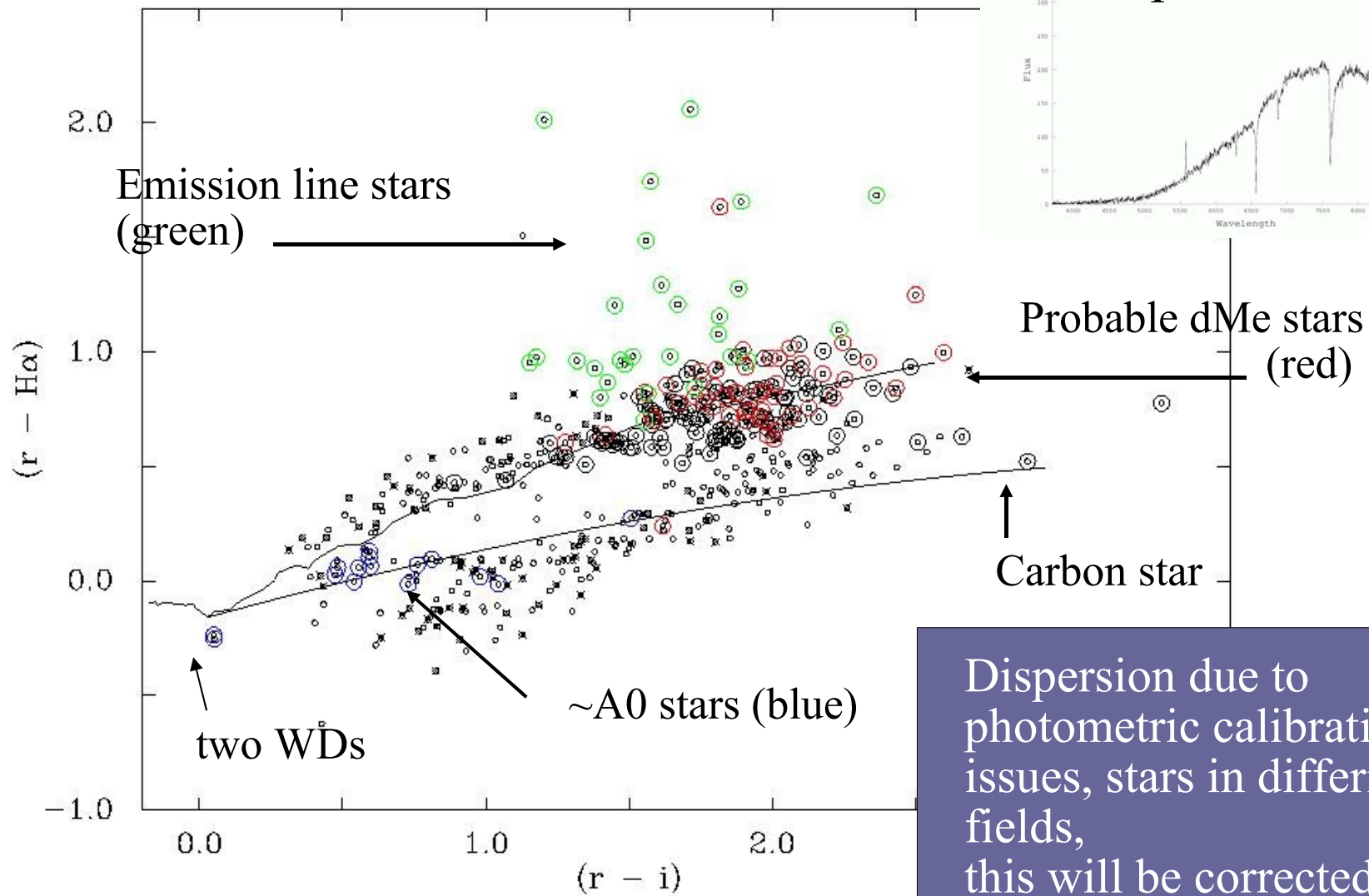
- Selection of A-stars based on colour criteria
 - issue: selection of A-type stars – young (A0V) and old (BHB's)
 - use u-g, g-r colours to distinguish between two types
 - also addition of IR data from UKIDSS Galactic Plane Survey
- Thus with the IPHAS and IR data
 - confirmation of early A SEDs
 - reddenings
 - 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



Dispersion due to photometric calibration issues, stars in differing fields, this will be corrected in upcoming data release

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