The INT/WFC Photometric Hα Survey of the Northern Galactic Plane

(IPHAS)

Janet Drew
Imperial College London

The astrophysical significance of Hα emission

Hα emission $\leftrightarrow$ environs of luminous and/or accreting and/or compact objects ….shocked gas …. chromospheres

L > 1000 L :

many massive star types, post AGB objects

Accreting and/or compact objects:

young stars, accreting WDs, NSs, BHs

Active late-type stars (dMe stars)

…plus extended flows/nebulae, diffuse Hα

The astronomical significance of Hα

- Point-source and diffuse Hα emission

→ star-formation indicator/measure

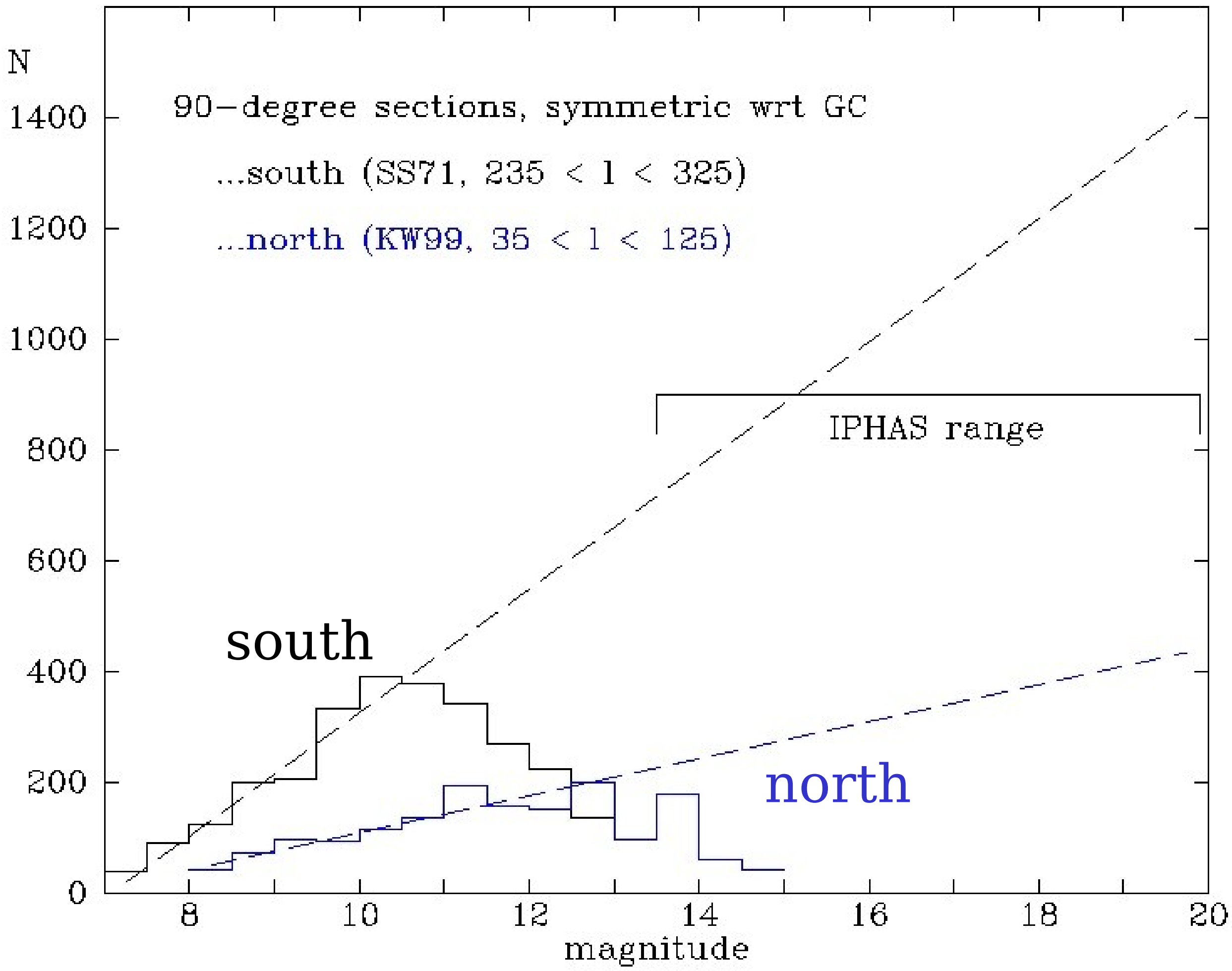
→ spiral arm tracer

2. Point source Hα narrow-band measurement, along with r’,i’ broad-band

→ (unlooked-for) spectral type sensitivity, giving photometric discrimination of stellar content

→ Galactic archaeology, extinction mapping

Numbers of catalogued emission line stars – by magnitude, north (Kohoutek/Wehmeyer) and south (Stephenson/Sanduleak):



→ a factor of ~1000 in depth to explore

Definition of IPHAS:

Survey area: all northern Plane longitudes; latitude range $-5^{o} < b < +5^{o}$ (1800 sq deg)

Magnitude limit (10σ): $r' = 20$

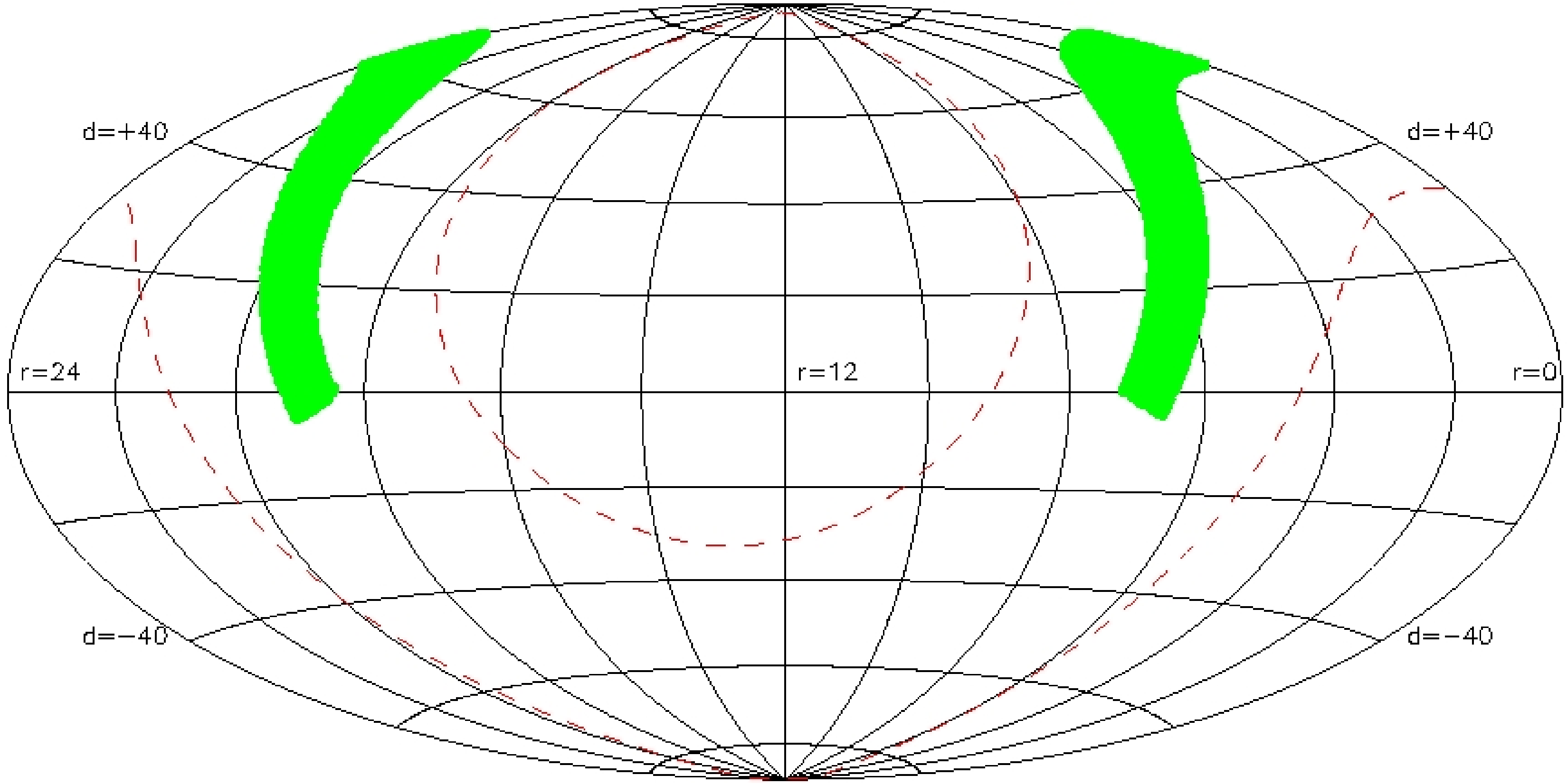
Required observations:

- Hα (120 sec),
- Sloan r' (30 sec) and i' (10 sec)
- at 2 overlapping pointings

Seeing: < 1.7 (or 2?) arcsec

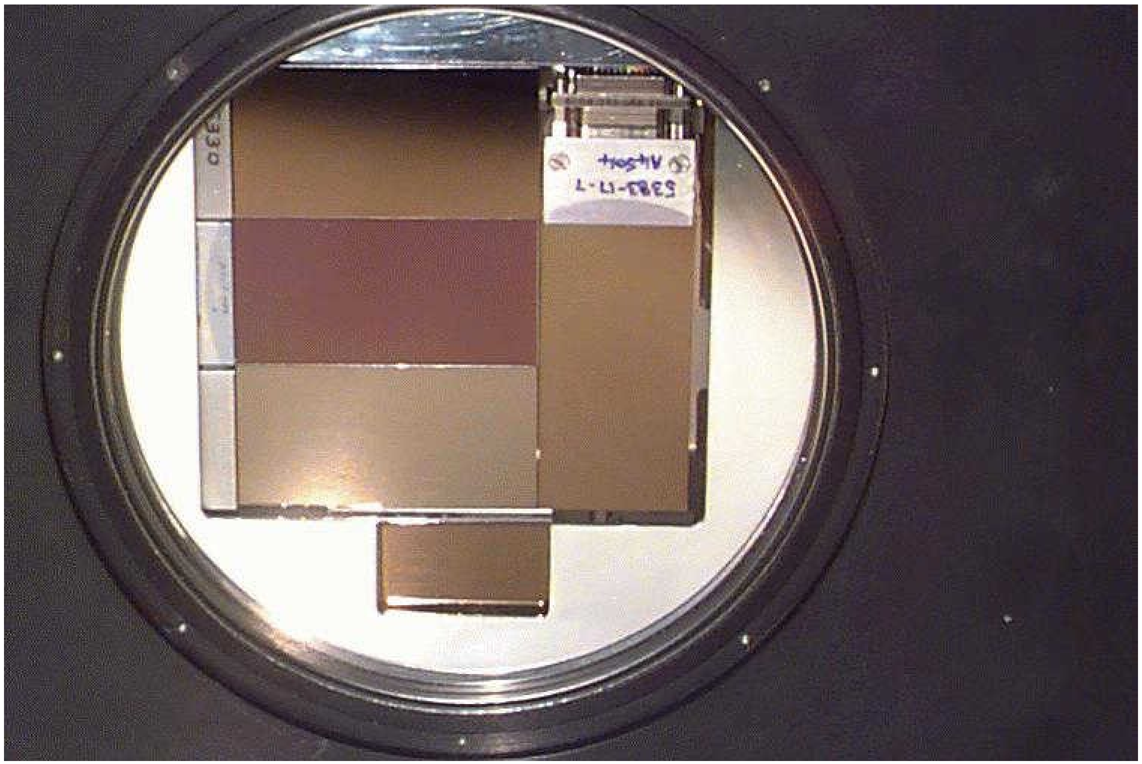
....mainly INT bright time used

A map of the sky: IPHAS survey area shown in green



The Isaac Newton Telescope Wide Field Camera:

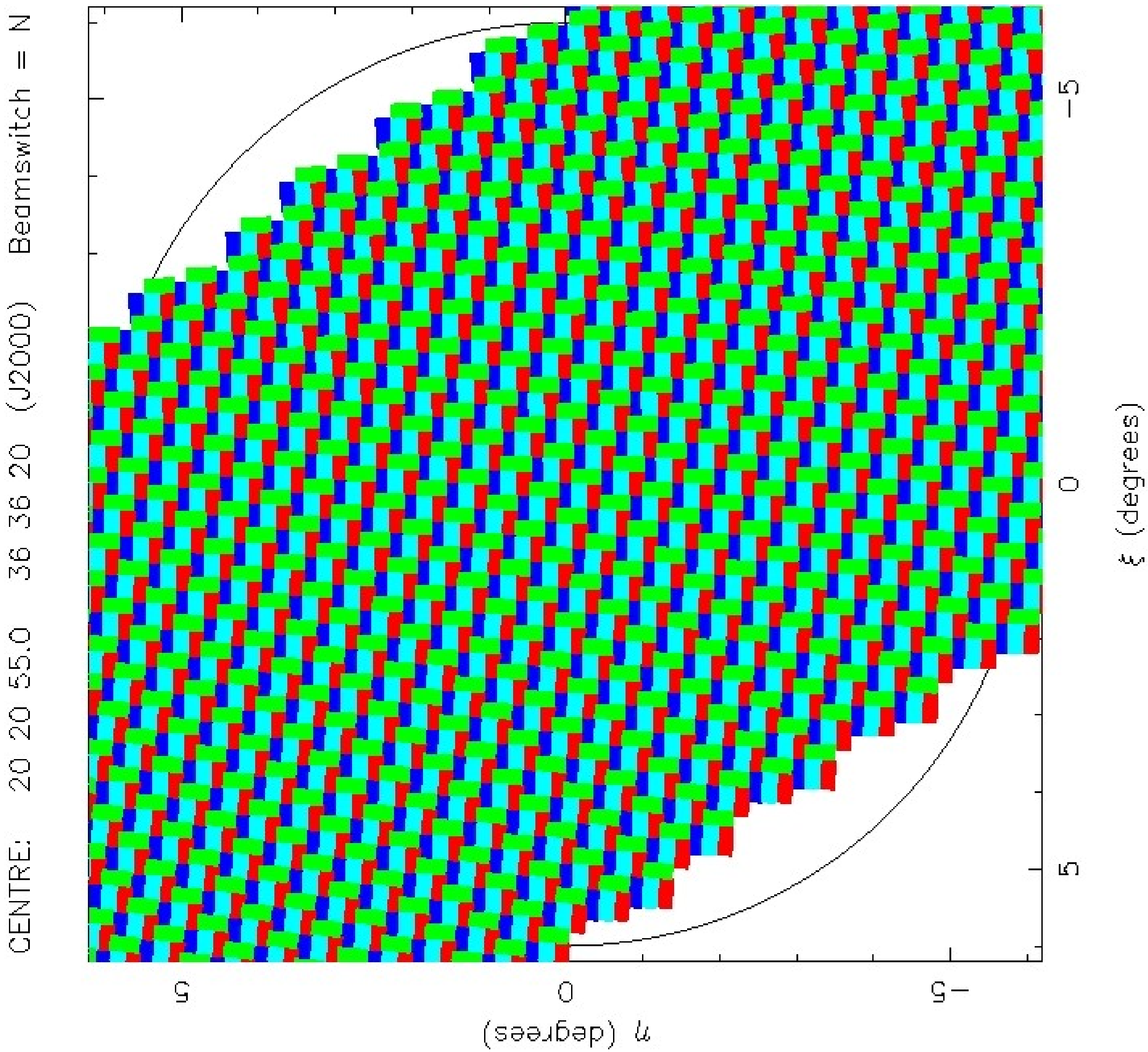
Mosaic of 4 CCDs – pixel size 0.33”x0.33” – area imaged ~0.25 sq deg



→ ~7600 x 2 pointings (5 mins/pointing)

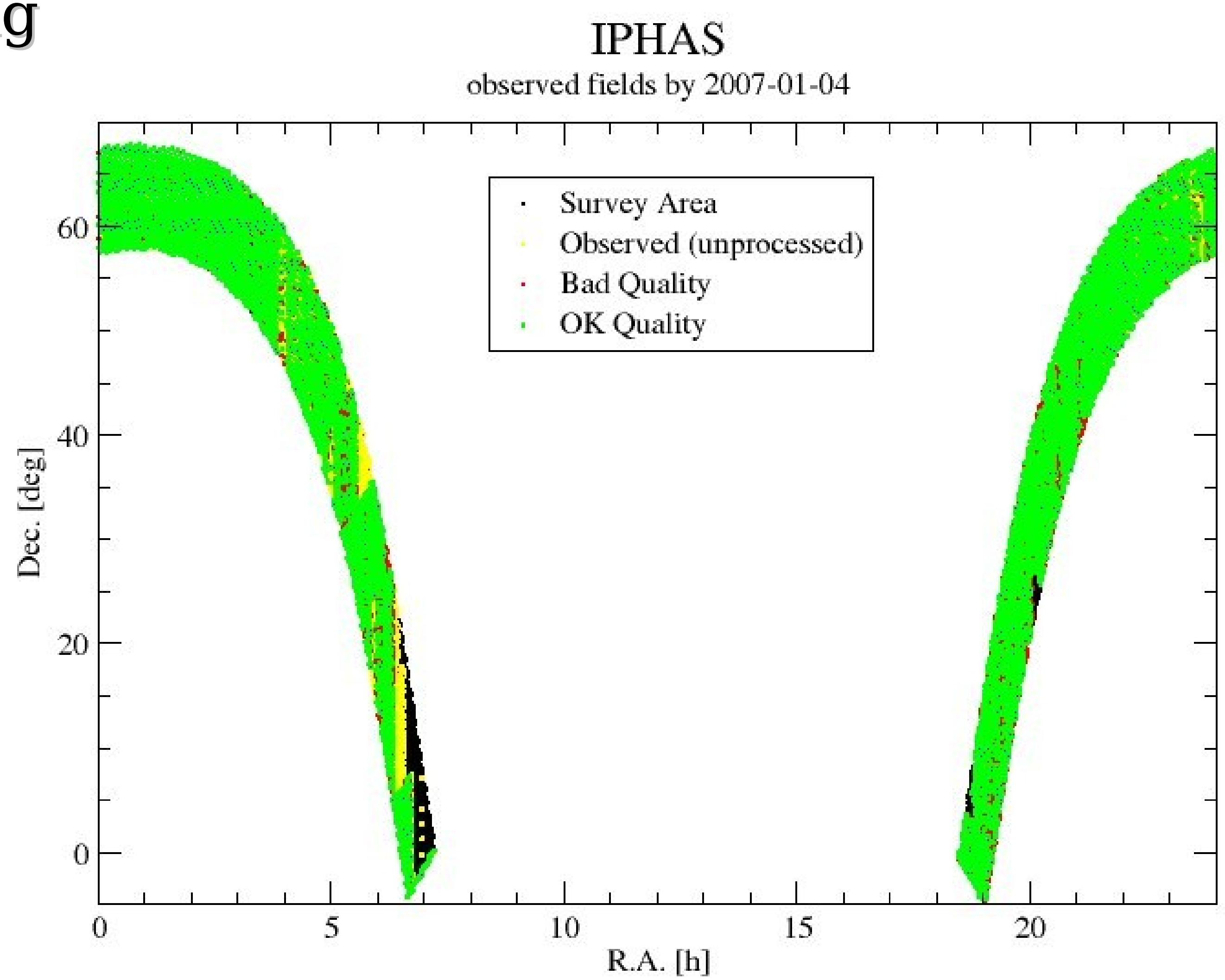
→ 8+ months observing so far

…filling the northern Plane:



(a section of the IPHAS pointing map at l = 75°)

Status:- 72 % at <1.7 arcsec seeing



Hoped-for completion: end 2007

Release of IPHAS data

- ✓ Reduced images already available from CASU
- ✓ Early release of point source catalogue scheduled for June 2007 – all data calibrated against nightly standards (only)
- ✓ Ultimate aim – photometrically uniform catalogue and image mosaics

IPHAS point-source colours

(r’ – Hα) versus (r’ – i’)

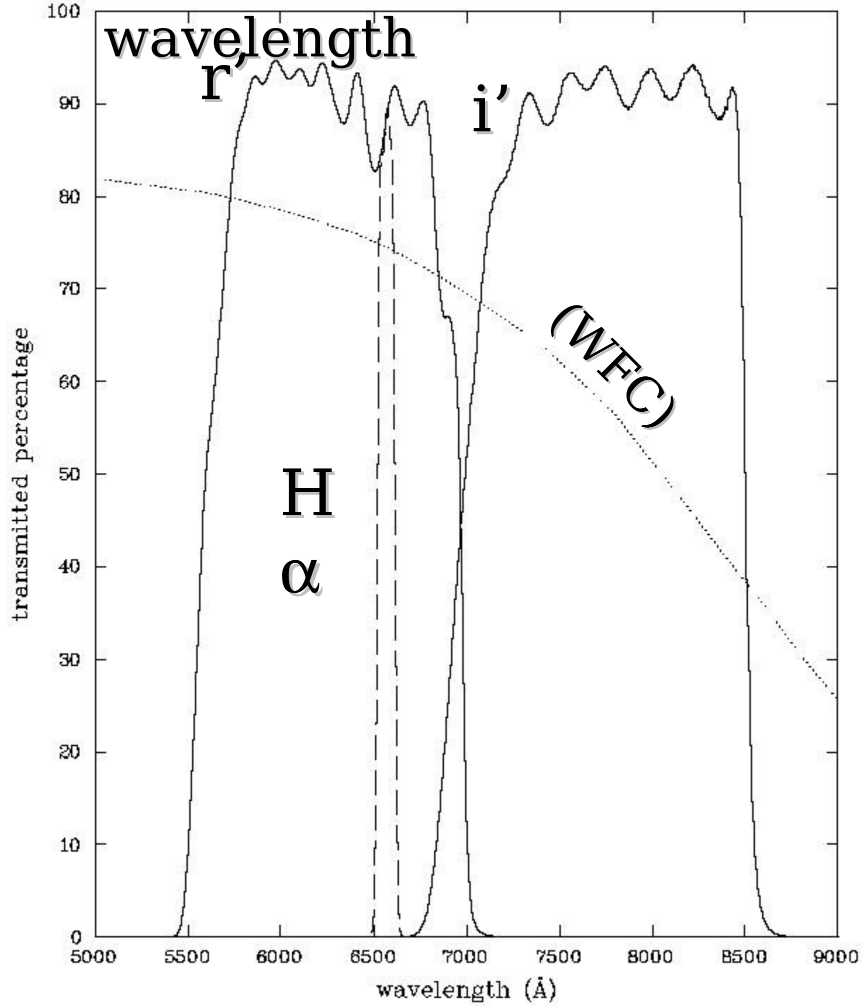
(Drew et al 2005, MNRAS, 362,753)

IPHAS filters:

	λ_c	FWHM
r’	6240	1347
Hα	6568	95
i’	7743	1519

units: Angstrom

Transmission % v. wavelength

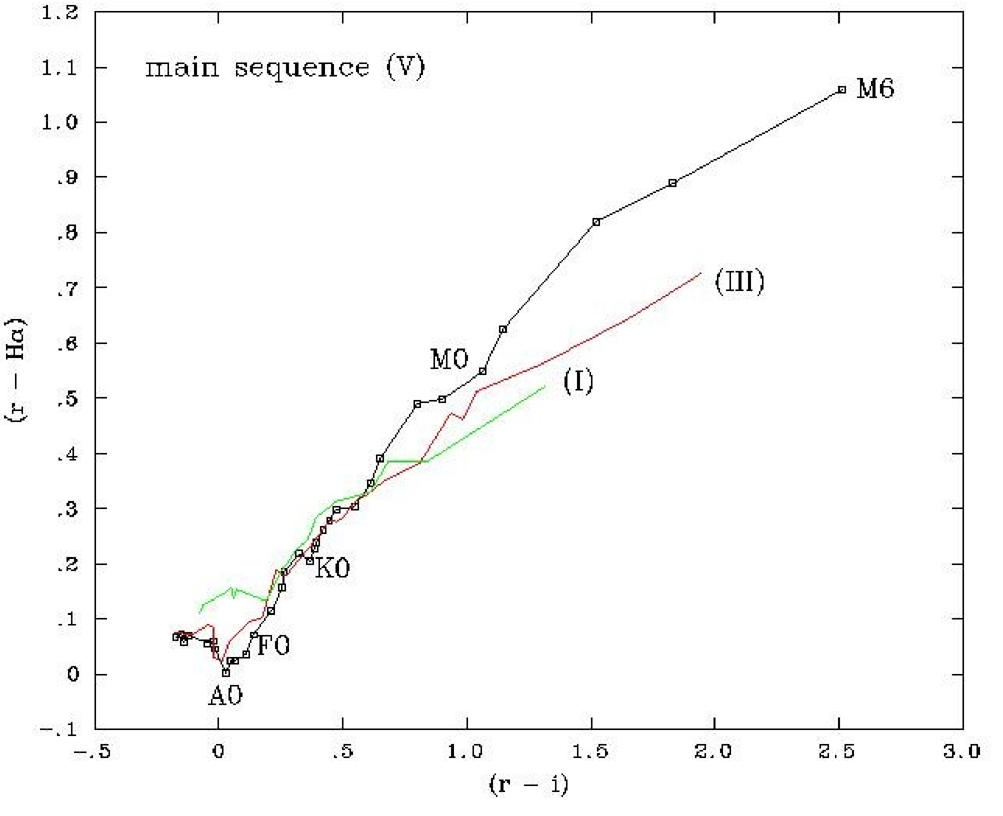


To interpret IPHAS

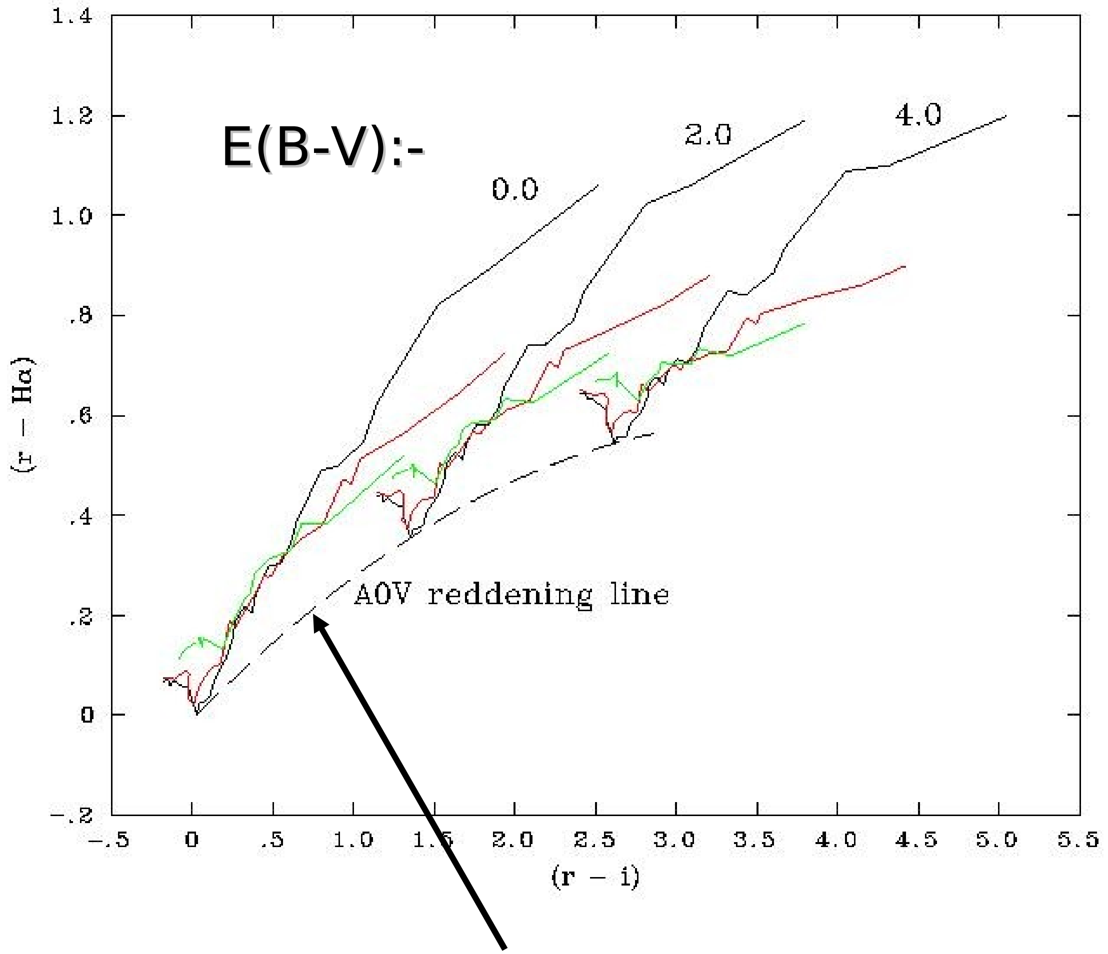
(r' – Hα) v (r' – i'):

A main sequence, from synthetic photometry:

(folded filter profiles with Pickles, 1998, library of flux-calibrated stellar spectra)

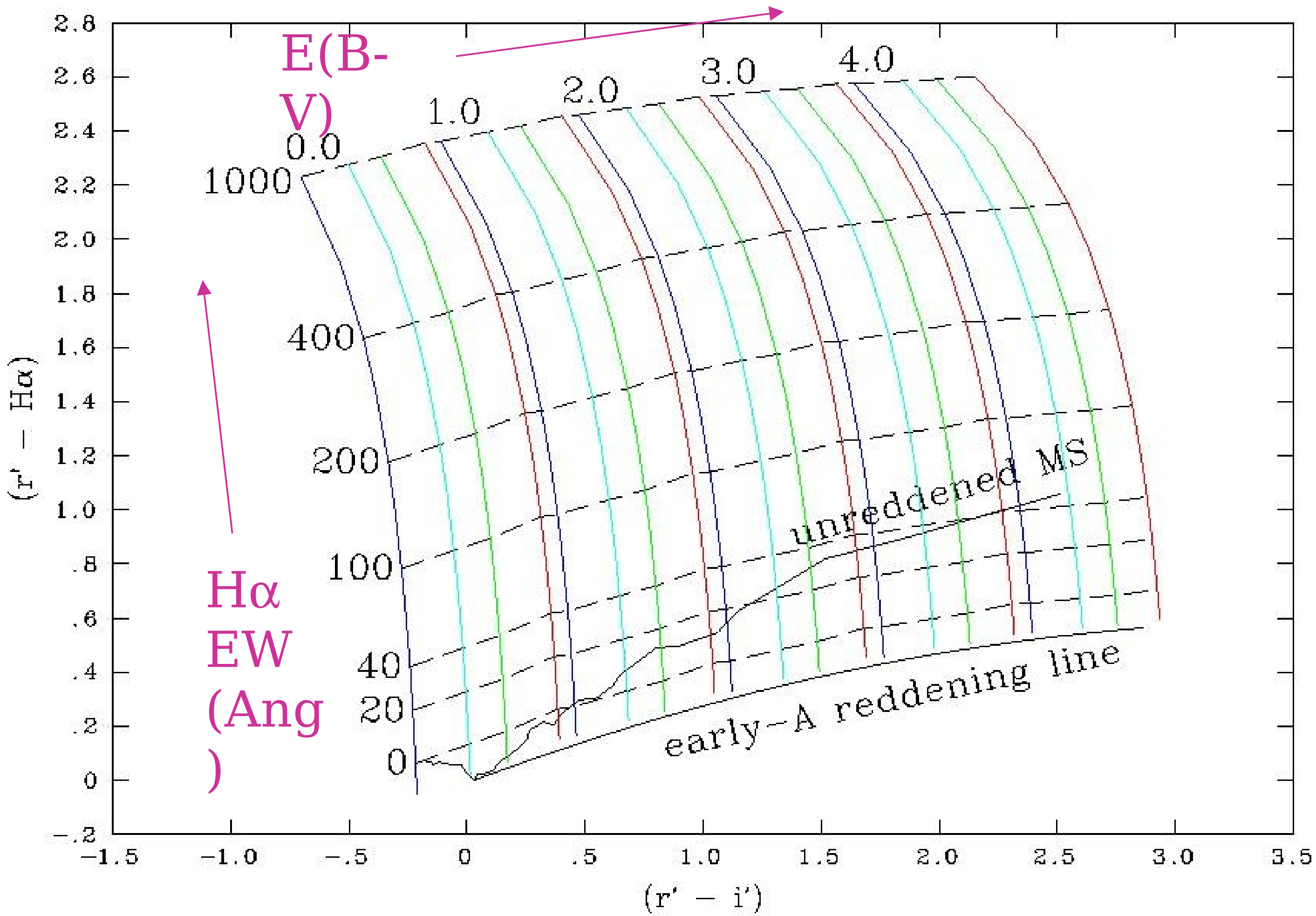


... effects of progressive interstellar extinction:



dashed line: early-A reddening line ~ lower limit for main sequence stars

Changes in (r' – Hα) as Hα emission EW is grown on top of a continuum:



blue lines: R-J SED assumed, red lines: G2V SED

IPHAS science

Science exploitation underway:

-- systematic search for northern plane PNe

-- automatic/conservative emission line star search

-- CV search and follow-up

-- search for A-dwarf debris/dust disks (using IPHAS/GLIMPSE overlap)

Beginning:

-- search for the ‘missing’ white dwarfs in the plane

-- classical Be stars as spiral arm indicators

-- extinction mapping….

Nebulae

IPHASX J012507.9+635652: The Prince's Nebula

Hα r' i'

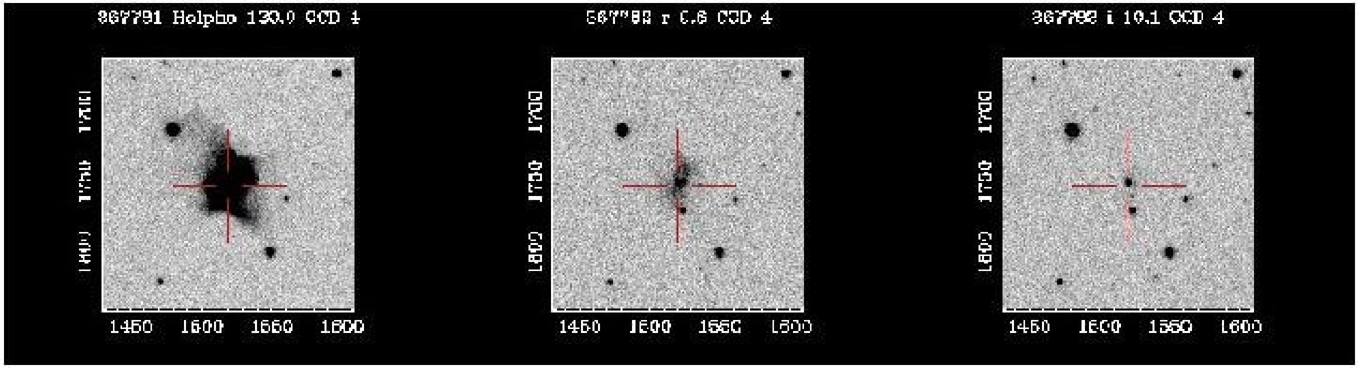


Fig. 1. Discovery images of the planetary nebula IPHASX J012507.9+635652 in Hα, r', and i' with exposures of 120, 10, and 10 seconds, respectively. Note that the Hα filter of IPHAS includes the [N II] lines at 6548 and 6583 Å which are more intense than Hα in this object (see text). Images are 1 arcmin on each side; North is up and East to the left.

Hα point source (CS)

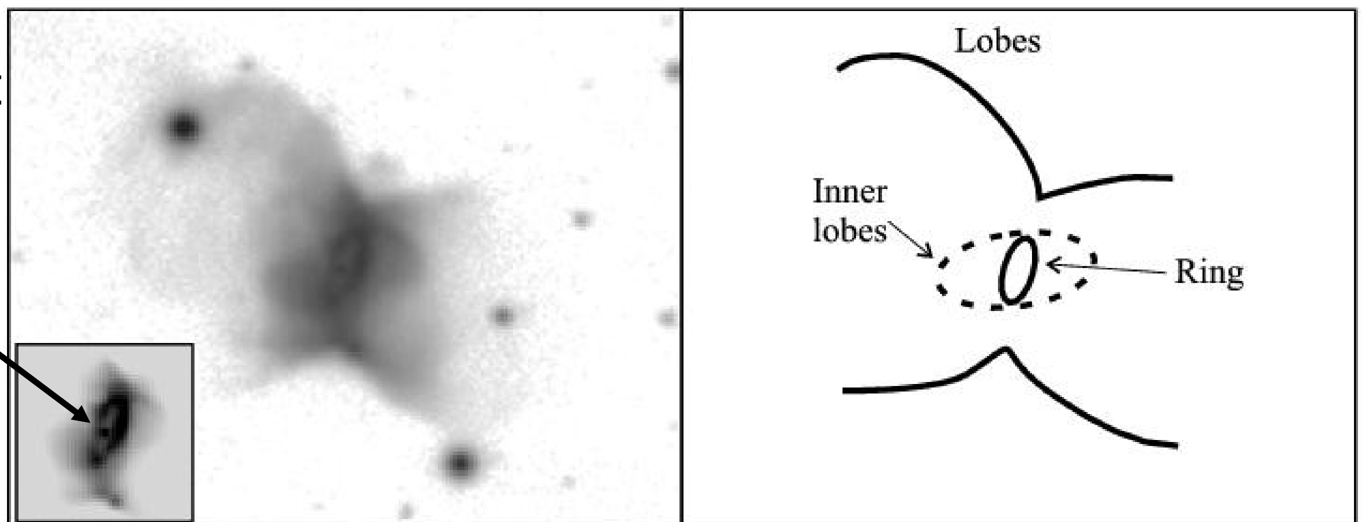


Fig. 2. (*Left*) Inner regions of IPHASX J012507.9+635652 in Hα, displayed with a logarithmic scale. The central star and elliptical ring are shown in the insert with a linear scale. (*Right*) Sketch showing the central elliptical ring, the main lobes and waist, and the tilted ellipsoidal inner lobes.

Corradi, Mampaso, Viironen, Sabin, Parker, Morris…

First aim: to get out an RA 18—20 hrs list of nebulae

…mainly finding low surface brightness resolved nebulae, including interesting anticentre candidates

Another PN discovery: IPHAS + [OIII] combined ~100x100 arcsec^2 image

(Nick Wright,

Point sources

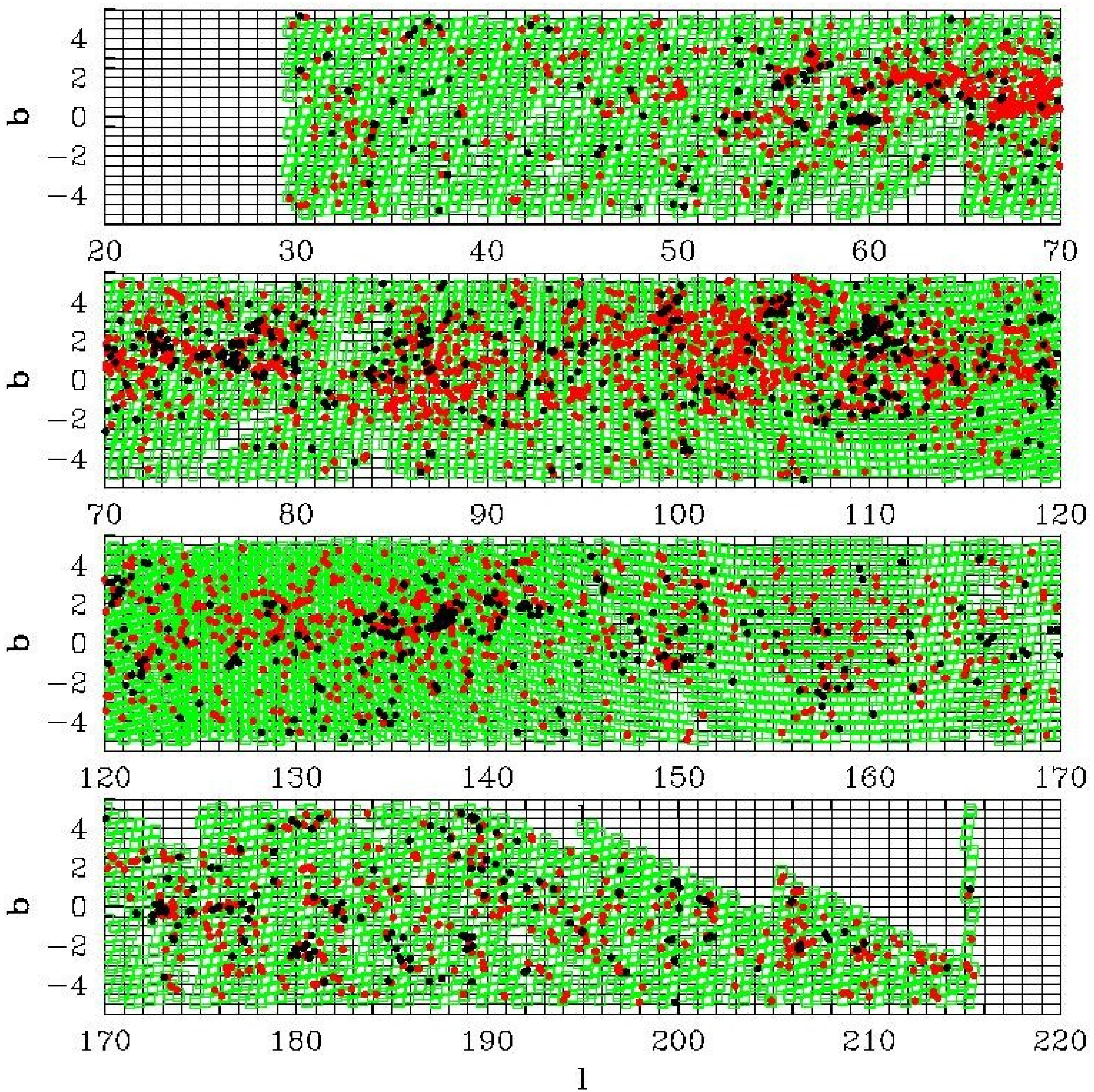
Distribution of conservatively selected emission line objects:

Black: r’ > 18

Red: r’< 18

Green: area surveyed so far

~5000 objects (number changing!)

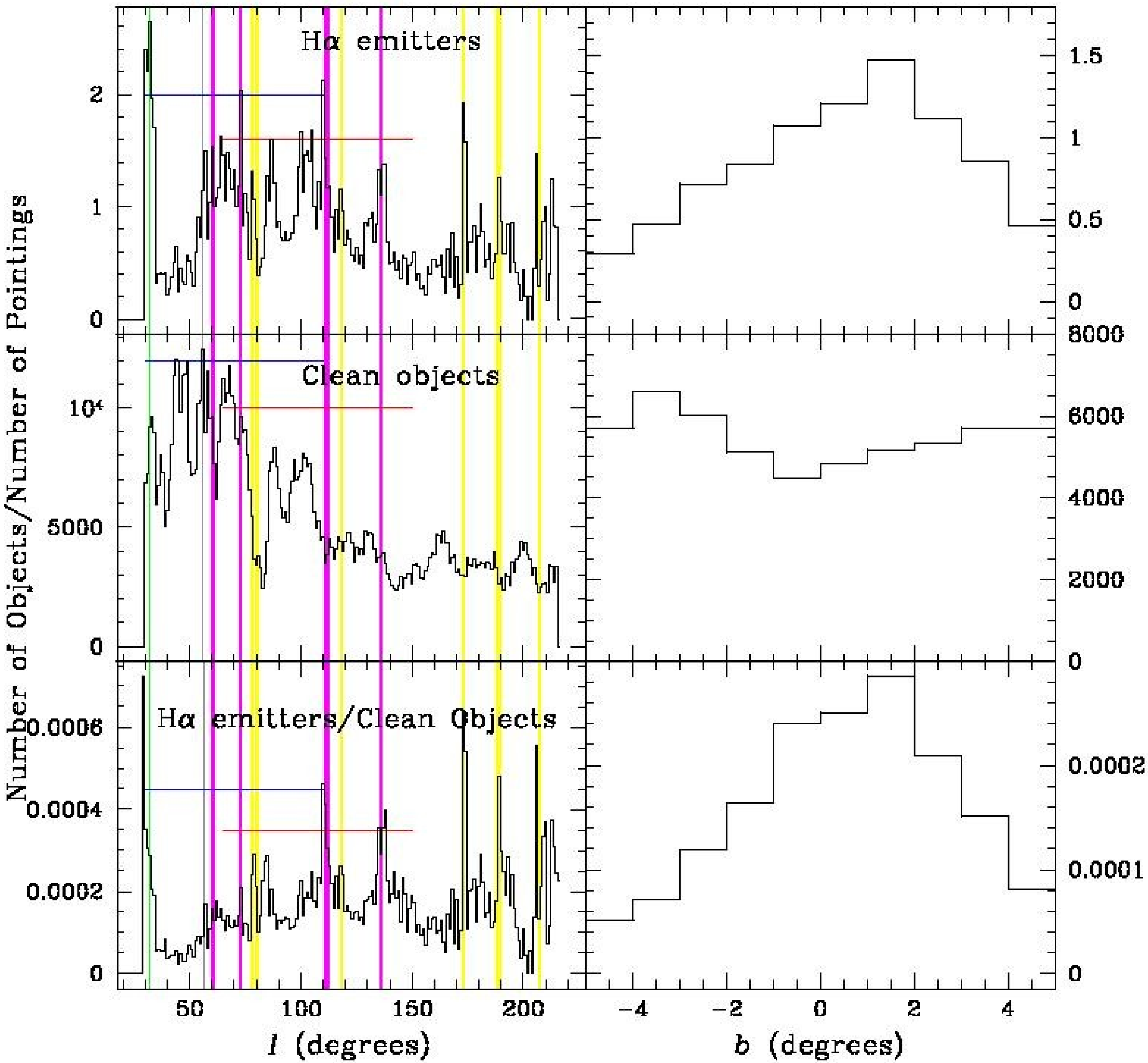


(Andrew Witham, Southampton)

Emission line objects in the northern plane (viewed a different way):

Left panels: longitude distribution

Right panels: latitude distribution



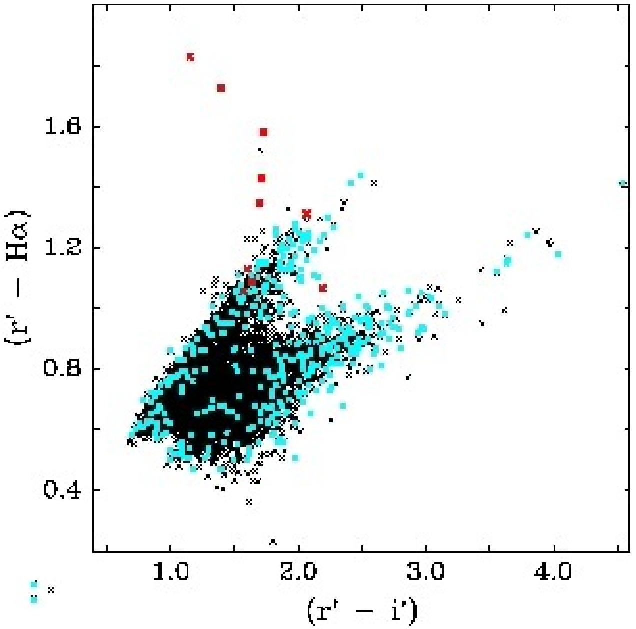
(‘clean object’ = Witham-speak for ‘star’)

Looking more deeply for emission line stars

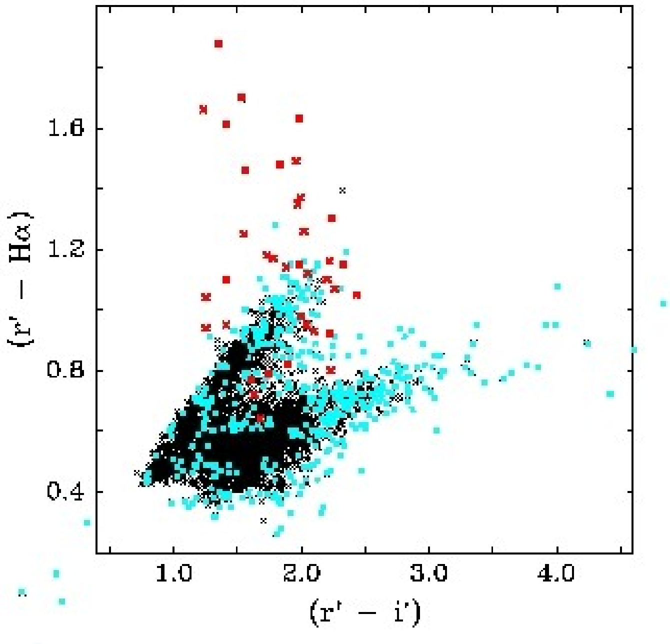
Spectroscopic follow-up in Cyg OB2, via MMT/HectoSpec:-

…up to 300 fibres per configuration over a 1-degree field

→6 A resolution over 3800 - 9300 A, 17 < r' < 20



(~centre Cyg OB2)



(~0.7° south of centre)

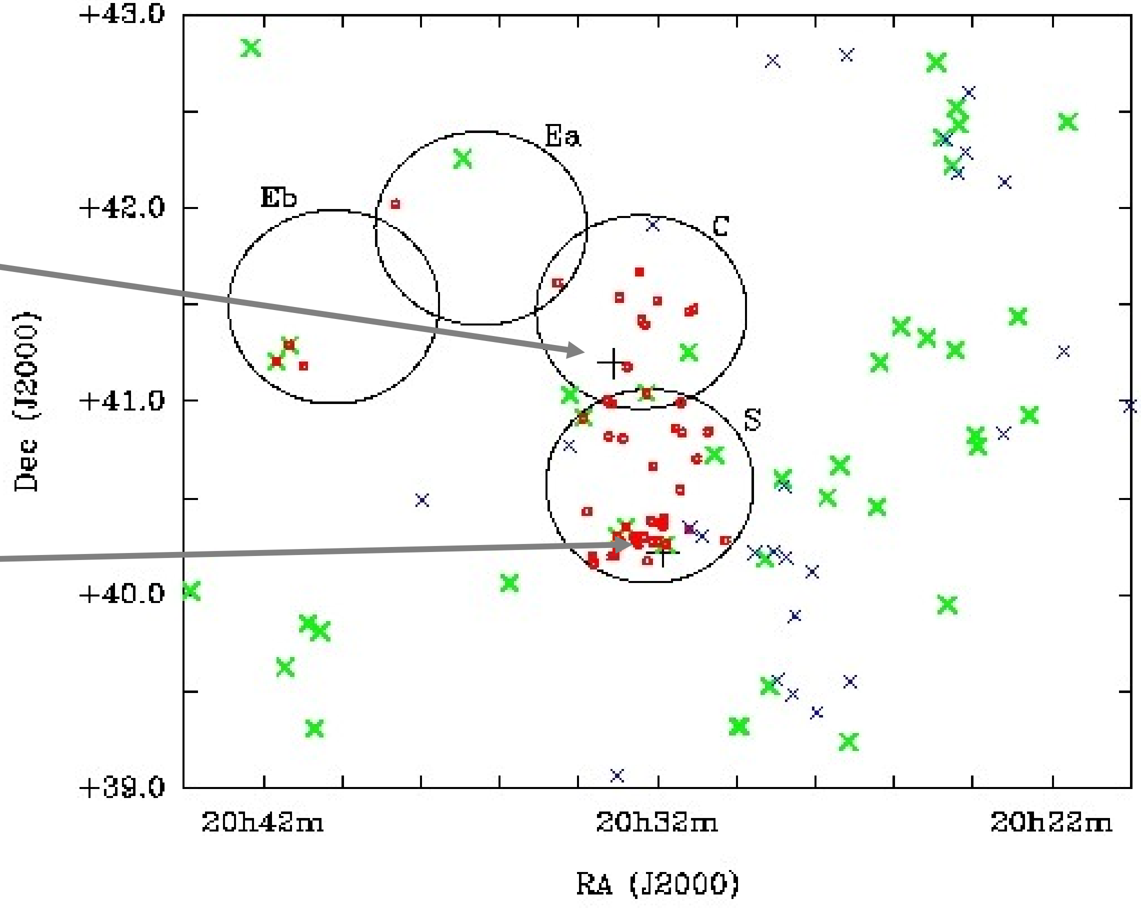
black: all stars – blue: MMT targets – red: confirmed emission line stars

Where the spectroscopically confirmed emission line stars are: the red dots

(blue/green crosses: candidate emission line objects from conservative search)

Centre Cyg OB2

DR 15 cluster

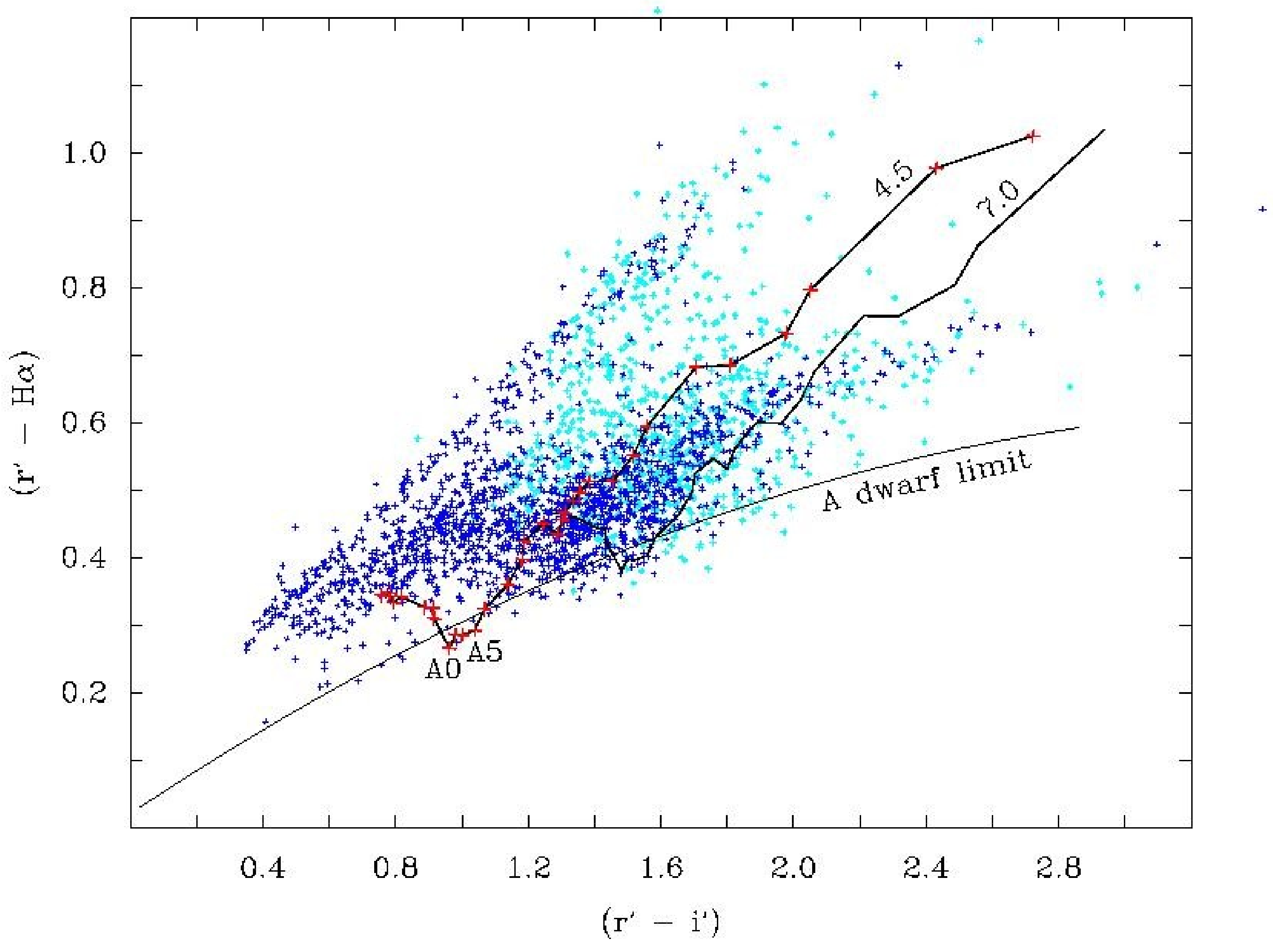


Centre of Cyg OB2: selecting unconfused A0-5 dwarfs for mapping

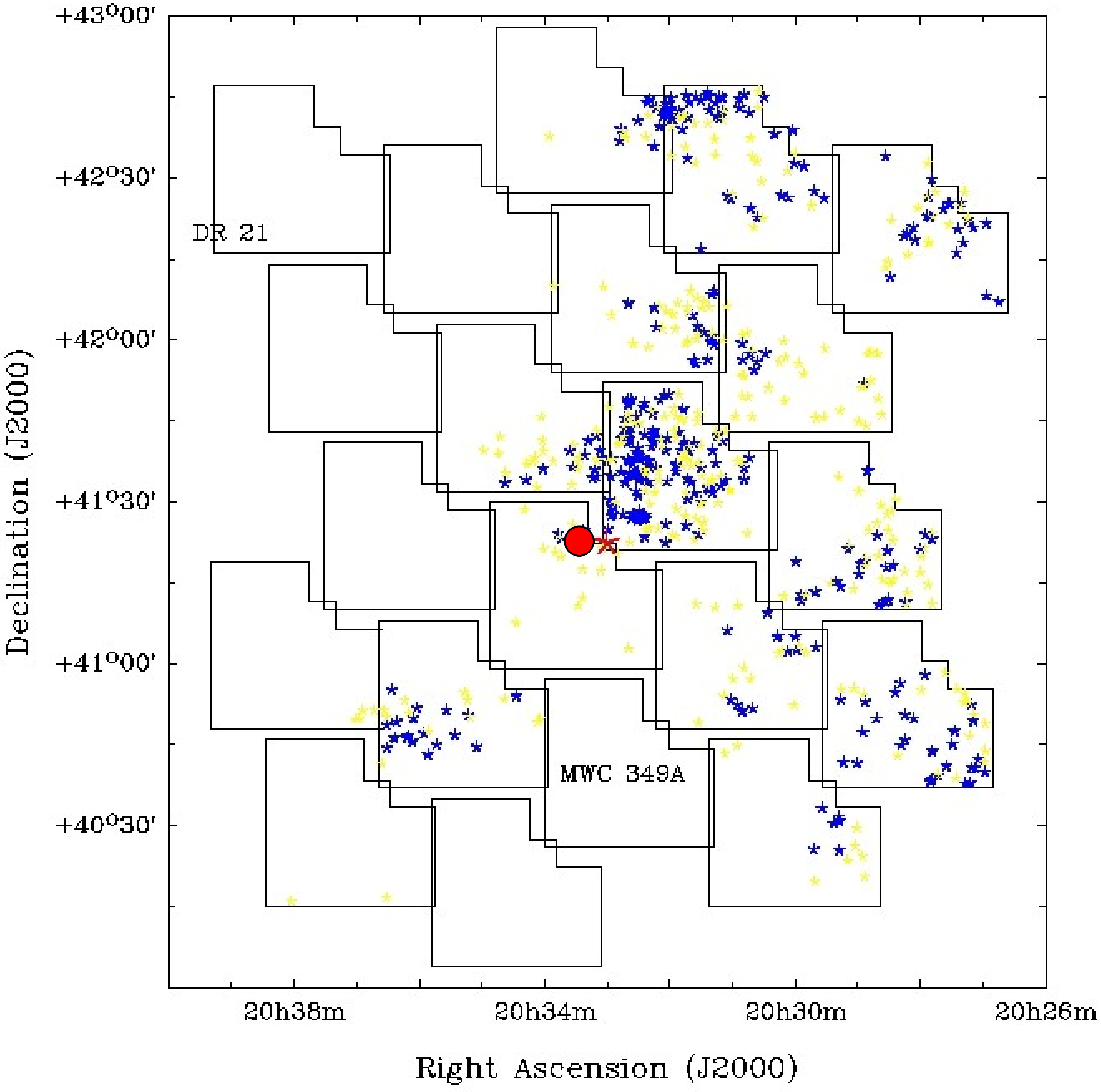
A(V)=4.5 and A(V)= 7.0 main-sequence tracks, on top of IPHAS data

Dark blue: r'<19

Light blue: 19<r'<20



A0-5V stars across the CygOB 2 region:



DM ranges:

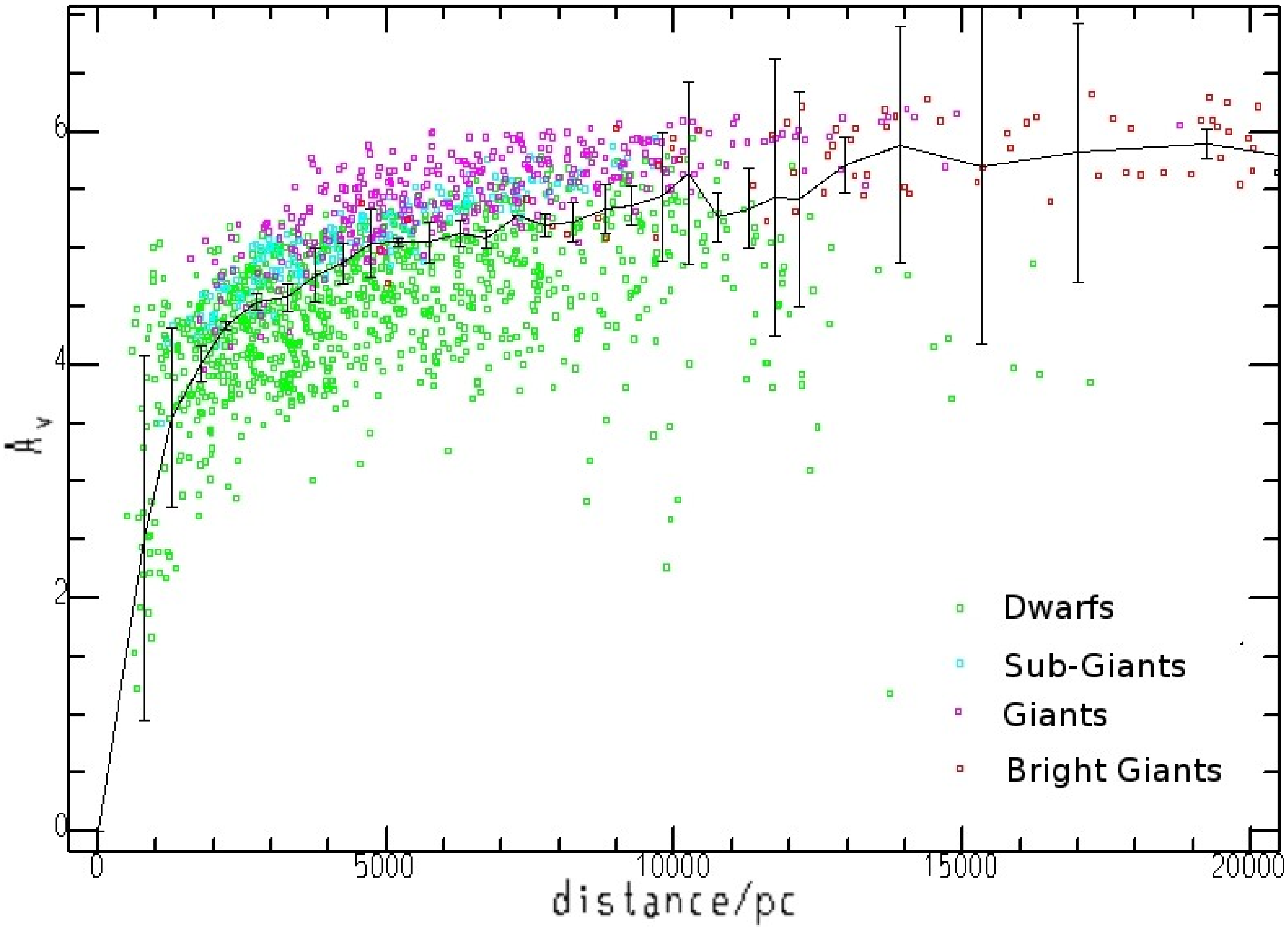
10.3 – 10.8

10.8 – 11.3

11.3 – 11.8

>11.8

Making a start on general extinction mapping, with IPHAS:- *disentanglement of 10'x10' arcmin² at l,b = 34,+4*



(Stuart Sale, Imperial)

Summarising Remarks

- New generation (CCD) Hα survey is going nearly 1000x fainter
- In the north, IPHAS nearing completion
- …efficient emission line star detection
- … search for new nebulae underway
- … major resource for extinction mapping and other studies of structure/populations in the Plane

Acknowledgments:

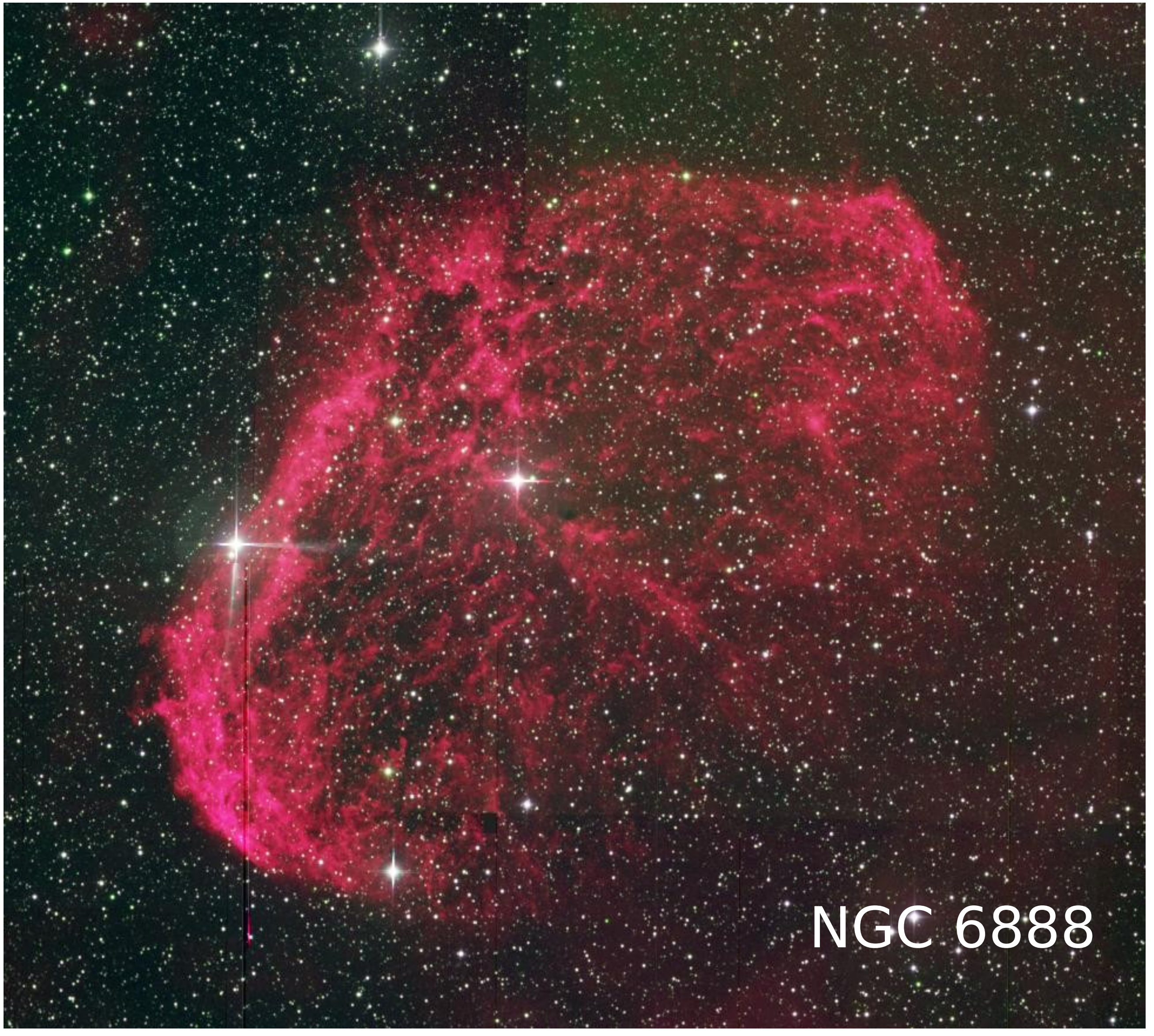
Robert Greimel

Mike Irwin, Nic Walton

The IPHAS and VPHAS+ collaborations in the UK, Netherlands, Spain, USA, Australia, Germany, France

(see iphas.org and vphas.org)

Public Website at Imperial: –
http://www.iphas.org/



To start in 2008 (?)

VPHAS+

The VST photometric Hα survey of the southern Galactic Plane (plus....)

u’ g’ r’ i’ and Hα, to ~21st magnitude

IPHAS database → photometry on ~ 300 million objects

....expect VPHAS+ to bring this to ~ one billion

Added u'g' capability →

-- pick out nearby compact objects and more distant luminous/blue objects

-- more metallicity discrimination

-- improve extinction mapping capability