IPHAS: Surveying the Northern Galactic Plane in H\(_\alpha\)

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H\(_\alpha\) emission is ubiquitous in our Galaxy. It traces ionised gas of assorted nebulae such as HII regions, planetary nebulae, Wolf-Rayet nebulae, and supernova remnants. It is a strong signature of active stars, interacting binaries, very massive stars (especially supergiants, Luminous Blue Variables and Wolf-Rayet stars), Be stars, post-AGB stars, pre-main-sequence stars and so on. These objects represent important evolutionary phases which are generally short lived, and are hence few in number and difficult to find. Their discovery is therefore well worth the effort of a concerted programme and in August 2003 a major new survey project was started using the Wide Field Camera (WFC) on the Isaac Newton Telescope (INT) to do just that. It is called the INT Photometric H\(_\alpha\) Survey of the Northern Galactic Plane, or IPHAS for short.

IPHAS is a collaborative UK/NL/ES venture led by Janet Drew in UK, Paul Groot in The Netherlands, and Antonio Mampaso in Spain. Its goal is to conduct an H\(_\alpha\) survey of the entire northern Galactic Plane in the latitude range \(-5^\circ < b < +5^\circ\), a sky area of 1800 sq. deg, covering the magnitude range 13<\(r'\)<20. That such a survey is needed can be deduced from Figure 2, and when complete it will represent an enormous improvement over previous work. For example it is expected that in excess of 10,000 new emission line stars alone will be discovered, an order of magnitude increase on known sources.

Survey Details

The 1800 square degrees will be tiled with 7635 pointings of the WFC, each of which is paired with a second pointing at an offset of 5 arcmin W and S. The purpose of the offset field is to ensure that we cover stars in the gaps between detectors, but also means that the majority of sources are observed at least twice. Each field is to be observed with the Sloan \(r'\) and \(i'\) filters, plus a narrow band H\(_\alpha\) filter, with exposure times of 30s, 10s and 120s respectively. The use of a guide star is not necessary for such short exposure times and is dispensed with to save on overheads, while for each H\(_\alpha\)–\(r'\)–\(i'\) sequence at a given pointing the CCD readout, filter movements, and final telescope movement, are overlapped for additional savings. Finally, human
Not all emission line objects are as easily discovered however and it is crucial that effort is put into understanding the IPHAS colour-colour plane so that future object selections can be made with some confidence. This problem has been attacked on two fronts; through the construction of synthetic photometry using a library of observed flux-calibrated stellar spectra, and by conducting spectroscopic surveys of selected fields as a visual check on predicted spectral types. Figure 4 illustrates the result of this process for a sample field in Cygnus. Several thousand spectra in a number of selected fields have now been amassed using Hectospec on the MMT and AF2 on the WHT. In general this demonstrates that the synthetic photometry is well matched to the observations, although detailed studies of this field, and additional test fields indicate that some further investigation of the calibration for very red objects is required.

IPHAS is also producing new discoveries of nebulae, one of the first to be discovered has been named after the wedding of Su Alteza Real El Príncipe de Asturias Don Felipe de Borbón with Doña Letizia Ortiz Rocasolano which took place around

Figure 2. The left-hand panel illustrates the effect of a simple extrapolation of numbers of catalogued emission line stars from previous Hα surveys of Kohoutek & Wehmeyer (1999) in the north, and Stephenson & Sanduleak (1971) in the south. Based on a rough extrapolation of these earlier surveys it is estimated that of order $\sim 10^4$ emission line stars will be discovered. The central and right-hand panels compare the quality of the current IPHAS colour-colour diagrams with those for the same sky area taken from the UK Schmidt southern Hα photographic survey. Notice the superb delineation of the field population of normal stars and M dwarfs in the IPHAS data (cf. Figure 3).

Figure 3. Sampling the Hα zoo as discovered by IPHAS. Clockwise from top left: a typical Be star, a cataclysmic variable, a potential luminous blue supergiant in Cygnus and a low redshift QSO (the QSO was detected as a peculiar outlier in the colour-colour plane).
the time of the PN’s discovery. PNG 126.62+1.32 is a rare quadrupolar nebula, and it was spectroscopically confirmed as a PN in 2004 using the WHT. A deeper image, compared to the discovery image, is shown in Figure 5, which illustrates the initially undetected faint lobes of the nebula.

Besides looking for new nebulae, IPHAS has proved to be exceptionally useful for taking a new look at previously known nebulae; ING users may be familiar with the image of the Wolf-Rayet NGC6888 which adorned the ING Christmas card in 2004 (Figure 1). However Figure 6 shows the spectacular 5°×3.5° mosaic of images covering the supernova remnant S147. Bear in mind that this image, which is binned for the purposes of this article, has immense detail on the arcsecond scale.

To date the survey is approaching its half-way point in terms of completed fields. However as we look forward to the completion of the northern hemisphere survey it’s clear that we are already seeing new discoveries, and generating additional exciting ideas for follow-up science and data mining. For example the colour-colour plane morphologies across the Galactic Plane will provide useful insights into the structure of the northern Milky Way, while linking IPHAS photometry with JHK survey data from 2MASS and the UKIDSS Galactic Plane Survey will add further powerful diagnostic capabilities.

We thank the many observers who have contributed to this programme. Finally, for more complete details interested parties should refer to the first survey paper which is currently in preparation (Drew et al., 2005, to appear in MNRAS), and to the IPHAS home page at http://astro.ic.ac.uk/Research/Halpha/North/.

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