

# The Southern Near-IR AGN Survey: spectroscopic observations from 6dF

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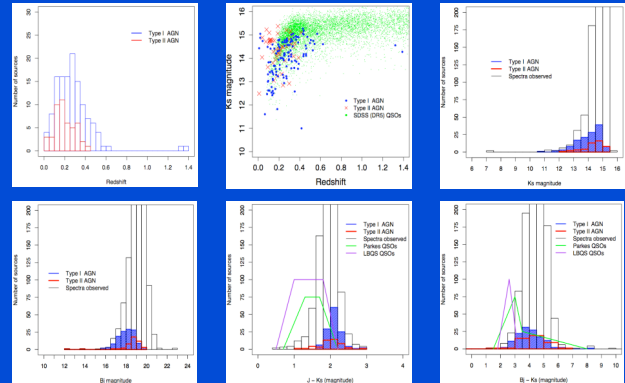
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## Goals

- Following the success of the 2MASS in revealing large numbers of previously unknown, optically red AGN and QSOs (e.g., Cutri et al. 2002), we have extended the search to the Southern equatorial sky using the Six Degree Field (6dF) multi-fiber spectrograph.
- Near-IR selected AGN candidates were selected as auxiliary targets for the 6dF Galaxy Redshift Survey (6dFRS). The 6dFRS will obtain ~90,000 redshifts over 15,000 sq. deg. with galaxy candidates selected from 2MASS and DENIS.
- Historically, surveys for AGN have been conducted at blue optical wavelengths. Unfortunately, any survey with a blue flux limit will be relatively insensitive to objects whose (i) emission peaks at other wavelengths; (ii) whose environment is dusty and causes the optical emission to be attenuated and reddened.
- Therefore, how seriously do blue optical flux limited surveys bias AGN samples?
- A census of AGN in the Universe will allow firmer constraints on the formation and evolution of galactic spheroids, super-massive black holes, duty cycles, clustering of the highest density peaks, and the hard X-ray background.
- We have conducted a new survey for red AGN in the South by selecting candidates with red near-infrared colors from the 2MASS Point Source Catalog (PSC).
- Here we present the results of the classification of the 6dF spectra. We quantify the AGN content, types, and compare their properties to those discovered at other wavelengths.



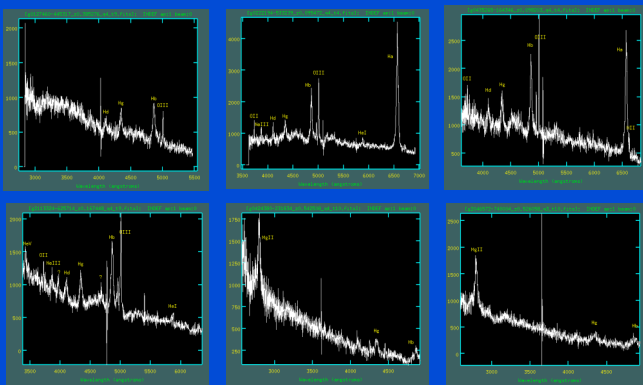
## Selection Criteria

- A single color cut from the 2MASS PSC of  $J - K_s > 2$  mag down to  $K_s \sim 15.5$  mag.
- Galactic latitude  $|b| > 30$  deg.
- This resulted in ~24,500 AGN candidates.
- A sub-sample of 6386 candidates with  $B_j < 19$  and  $R_f < 18$  were then selected for spectroscopic follow-up to enable good signal-to-noise and reliable identification.
- Spectra were obtained for 1182 objects of which 745 were of sufficient quality to identify the objects in question.
- The sample is distributed over a sky area of ~9620 sq. deg.
- Note: our initial color cut of  $J - K_s > 2$  was performed on the internal 2MASS working database. Subsequent recalibration and merging of 2MASS extractions from repeated observations for the final release catalog resulted in some colors having  $J - K_s < 2$ .

## Summary

- Type I (broad-line) AGN were identified from spectra showing  $H\alpha$  and/or  $H\beta$  emission lines with velocity widths (FWHM)  $> 1000$  km s<sup>-1</sup>, or, broad  $MgII$  emission when present.
- Type II, liners, starbursts and composites (as well as probable candidates) were identified using line ratio diagnostics involving the  $H\alpha$ ,  $H\beta$ ,  $[NII]$ ,  $[SII]$ ,  $[OIII]$  and  $[OII]$  lines.
- All Type I AGN down to spectral SNR~3 and  $EW(H\alpha \text{ and/or } H\beta) > 5\text{\AA}$  have been identified.
- The current numbers identified are: 127 Type I (with 15 probable); 47 Type II's (+composites) which may increase since ID's are incomplete; 61 star-forming/early type galaxies; 17 stars.
- 493 of the 'reasonable' quality spectra (non-Type I AGN) are yet to be classified.
- Our Type I AGN detection rate is therefore ~17%. For comparison, Cutri et al. 2002 found ~58% in the Northern 2MASS red AGN survey to  $K_s \sim 15.5$  over the same  $z$  range. The difference is primarily due to a brighter optical flux limit required for our 6dF targets.
- The ratio of Type I to II's is ~3, similar to X-ray surveys, but the inverse of that seen in IRAS.
- Interestingly,  $B_j - K_s$  color marginally correlates with  $H\alpha$  and  $[OIII]$  EW (plots below). This suggests anisotropic obscuration of the central AGN with the bulk of the line-emission originating beyond the BLR. This dependence is not seen with  $H\beta$  since it originates from the BLR and dust reddens its emission and the central continuum source by equal amounts.
- Our near-IR selected Type I AGN are not dramatically different from those found in optical surveys (plots below). However, they mostly lie at low  $z$ , have low luminosities (similar to our Type II's) and would be discarded from optical samples due to host galaxy contamination.

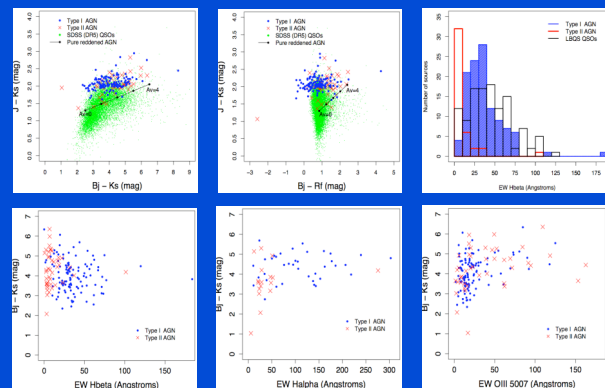
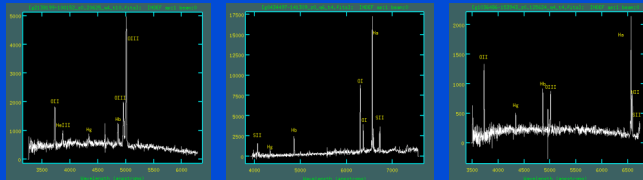
## Some New Type I (broad-line) AGN



## New Type II AGN

## Liner/Starburst

## Starburst/HII SF



## Further reading / references

- 6dF Galaxy Survey: <http://www.aao.gov.au/local/www/6df/>
- The Two Micron All Sky Survey: <http://www.ipac.caltech.edu/2mass/>
- The 2MASS Red AGN Survey: Cutri, Nelson, Francis & Smith, 2002, ASP Conf. Ser. 284
- An Unbiased Census of AGN in the Two Micron All Sky Survey: Francis et al. 2004, AJ, 127, 646
- The X-Ray Properties of 2MASS Red Active Galactic Nuclei: Wilkes et al. 2002, ApJ, 564, L65
- The FIRST-2MASS Red Quasar Survey: Glikman et al. 2007, ApJ, 667, 673