UKIDSS and the VO

- The UKIRT Infrared Deep Sky Survey
- UKIDSS science highlights
- Future: all sky NIR?
- UKIDSS data access and the VO

(live demo...)
The UKIRT Infrared Deep Sky Survey

- ESO public survey
- 1000 nights UKIRT over 7yrs
- UKIDSS = 50 × 2MASS
- near-ir SDSS
- began 2005 May 13
- data available at http://surveys.roe.ac.uk/wsa

CPI A. Lawrence
CSS Steve Warren
plus 130 others

Core Reference
Lawrence et al 2007
## UKIDSS design

<table>
<thead>
<tr>
<th>Survey</th>
<th>LAS</th>
<th>YJHK</th>
<th>18.4K</th>
<th>4000 s.d.</th>
<th>262n</th>
<th>ExGal</th>
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</thead>
<tbody>
<tr>
<td>Large Area Survey</td>
<td>LAS</td>
<td>YJHK</td>
<td>18.4K</td>
<td>4000 s.d.</td>
<td>262n</td>
<td>ExGal</td>
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<tr>
<td>Deep Extragalactic Survey</td>
<td>DXS</td>
<td>JK</td>
<td>21.0</td>
<td>35</td>
<td>118</td>
<td>ExGal</td>
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<tr>
<td>Ultra Deep Survey</td>
<td>UDS</td>
<td>JHK</td>
<td>23.0</td>
<td>0.77</td>
<td>296</td>
<td>ExGal</td>
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<td>Galactic Plane Survey</td>
<td>GPS</td>
<td>JHK</td>
<td>19.0</td>
<td>1800</td>
<td>186</td>
<td>Gal</td>
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<td>Galactic Clusters Survey</td>
<td>GCS</td>
<td>ZYJHK</td>
<td>18.7</td>
<td>1600</td>
<td>84</td>
<td>Gal</td>
</tr>
</tbody>
</table>

![Graph showing distribution of surveys](image)
- 4x2048x2048 Hawaii II arrays
- 0.4 arcsec pixels
- 0.21 sq.degs / exposure
- 2x2 microstep to sample
- 2x2 macrostep to tile
- Filters: Z, Y, J, H, K, H₂-S(1), Br-g
UKIDSS Coverage

about 40% done

as of
Sep 2008
scary amounts of data

0.8 degree mosaic
(17000 x 17000 pixels)
- data rate at telescope: 12 MB/s
- saved data:
  - peak: 400 GB/nt
  - average: 150 GB/nt
- full archive growth: 20 TB/yr
- ten year archive:
  - Raw data: 200 TB
  - Survey maps: 50 TB
  - Catalogs: 5 TB
### Releases

<table>
<thead>
<tr>
<th></th>
<th>Europe</th>
<th>World</th>
<th>area</th>
<th>any filter</th>
<th>UDS depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR1</td>
<td>Jul 2006</td>
<td>Jan 2008</td>
<td>1238 sq.deg.</td>
<td></td>
<td>K=21.5</td>
</tr>
<tr>
<td>DR4</td>
<td>Jul 2008</td>
<td>Jan 2010</td>
<td>3832 sq.deg.</td>
<td></td>
<td>K=22.0</td>
</tr>
</tbody>
</table>

- ... about every nine months thereafter
Roaming the UKIDSS sky

- Gallery of GPS images
- GPS zoomable mosaic
- UDS zoomable mosaic
- UDS-south BiK image
Multi-wavelength data

- **GPS**: many other Milky Way Surveys
- **GCS**: 10 well known large open clusters
- **LAS**: large overlap with SDSS
  - well matched in depth
- **DXS**: four legacy fields
  - XMM-Subaru
  - Lockman Hole
  - ELAIS N1
  - SA22
- **UDS**: centre of XMM-Subaru
UKIDSS Highlights
opposite ends of the Universe

high-z and low-temp:
i and Y drop out

Y-J separates
T-dwarfs and quasars
Four z~6 quasars in 900 sq.deg. SDSS : two quasars in same area

Warren, Mortlock, Patel, Venemans et al in prep
**z = 4-6 massive gals**

- Select LBGs by i or z dropout
- Larger area than HST study => higher luminosities

**Clear evolution z = 5-6**

McLure et al 2008
• 50,000 galaxies with \( K(AB) < 23 \)
• photo-z from UDS + Subaru
• Needs both density and lum evoln

Cirasuolo et al 2008
• Blue vs red luminous gals evolve differently

Cirasuolo et al 2007
$z=2$ clustering

star-forming galaxies cluster much less strongly than passive galaxies

Hartley et al 2008
z=1 supercluster

Swinbank et al 2007

redshift distbn of candidate clusters
structure 30 Mpc across

colour selected surface density map
z=0-2 KX quasars

Blue=quasar model track
black = stars
red = galaxies
crosses = quasars

gJK selects quasars cleanly
even for reddened objects

Maddox et al 2008
Heat from the Heavens - Opening up the Infrared Sky

The image on the left shows a region about 9,000 light years from Earth in the Constellation of Aquila. This image in the visual wavelengths was taken by the Palomar Sky Survey in the 1950s. In comparison, the image on the right shows the same area in the infrared, taken as part of the UKIDSS DR1 release. The infrared image reveals the presence of the globular cluster of stars, first seen by the Spitzer Space Telescope, which is about 6 light years across with a mass of 300,000 suns. The brightness of the stars varies dramatically between the visible and infrared wavelengths due to interstellar extinction. (JAC-PR-08-01)
1.5 kpc star forming regions

Heat from the Heavens - Opening up the Infrared Sky

The image on the left shows a region called IRAS 20376 about 5,500 light years from Earth in the Constellation of Cygnus. This image in the visual wavelengths was taken by the Second Digital Sky Survey in the 1980s. In comparison, the image on the right shows the same area in the infrared, taken as part of a future UKIDSS public release. The infrared image reveals the presence and structure of an HII starforming region. (JAC-PR-08-01)
Molecular outflows in N1333

Figure 11. WFCAM H$_2$ 2.122$\mu$m (blue) - Spitzer 3.6$\mu$m (green) - Spitzer 4.5$\mu$m (red) colour composite image of L1448. Jørgensen YSOs are numbered.

Lucas et al 2008
X-ray sources in the bulge

dots = UKIDSS sources
coloured spots = Chandra
colour = X-ray hardness

Lucas et al 2008
134 pc substellar MF

- Pleiades GCS-DR1
- 5 band selection
- 73 new BDs
- MF Gaussian

Lodieu et al. 2007
60 pc Black Dwarf

ULAS J0922+1037 compared to M8.5

Casewell et al 2008 in prep

41 mas/yr

T=2350 Black Body

=> pure He atm. WD
20 pc Brown Dwarf

- ULAS J0034-00
- Coolest known dwarf (T8.5)
- T~600K
- M~15-36 M-Jup

blue = Z
green = Spitzer 3.6um
red = Spitzer 4.5 um

Warren et al 2007
Future
IR survey future

UKIDSS++?

WISE

PanSTARRS

Science from *combination* of all these
NIR all sky?

- **UKIDSSS LAS+GPS+GCS**
  - underway: complete by 2010ish
  - 7000 sq.deg. ZYJHK

- **VISTA Hemisphere Survey (VHS)**
  - 20,000 sq.deg. YJHK
  - approved: starts 2009: PI McMahon

- **UKIRT Hemisphere Survey (UHS)**
  - everything at Dec<60
  - 12,500 sq.deg JHKK: 800 nights needed
  - proposed Nov 2006: deferred
selected goals

- Ionisation history and spatial structure
  - 50 quasars at $z>6.4$, 10 quasars at $z>7.2$

- Galactic Archaeology
  - M-dwarfs to 1kpc; M giants throughout the Galaxy

- Extreme brown dwarfs & free floating planets
  - first sight of $T<400K$ and maybe $T<200K$ objects

- Phase space picture of solar neighbourhood
  - proper motions of $10^5$ L-dwarfs

- Dark energy: Large scale / high-z clustering
  - $10^5$ LRGs at $z=2-4$: Gpc clustering
  - thousands of rich clusters $z<1.5$
Sky survey comparisons: Extragalactic

- WISE
- UHS
- PS1

quasar z=2

LRG z=2

quasar z=7
Sky survey comparisons: Brown dwarfs

WISE

UHS

PS1

$T=1000 \text{K}$
$D=30 \text{pc}$

$M=10 \text{MJ}$, $T=5 \text{Gyr}$
$D=1 \text{pc}$
Majewski et al 2003
2MASS filtered in narrow lum/colour range
showing Sagitarrius stream
i and Y drop out
Y-J separates
T-dwarfs and quasars

predict 45 quasars
z=6.4-7.2
quasars become redder in Y-J
confused with T-dwarfs
.... need J-K

predict 11 quasars
$z=7.2-8.0$

note also some
Y dwarfs with extreme Y-J...
brown dwarf colour vs temp

Oldest/smallest stars will have very distinctive Y-J colours

2MASS : T > 700
LAS : T = 400-700K
UHS+PS : T < 400

- PSy deeper than LAS
- 5 x area
- proper motions

predictions from Burrows et al