UKIDSS and VISTA:
Surveying the sky in the near-IR

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Equipped with his five senses, man explores the universe around him
and calls the adventure Science

E.P. Hubble, 1954
I. Data processing activities at CASU
A bit of history

Automate Plate Measurement machine, IoA, Cambridge
The APM photographic sky survey

- ~10GB/day
- ~1000 plates/year
- UKST, AAT, KPNO, CFHT, CTIO
- Object extraction and parameterization
- ~4h/plate scanning and processing (UKST)

Irwin 1985
McMahon & Irwin 1992
Irwin 1994
McMahon et al 2001
Modern day technology

1st light CCD on 1m telescope in KPNO (1979)

one of the four WFCAM infrared detectors

Omegacam@VST
Optical processing at CASU

• APM Photographic Sky Survey Catalogue

• WFC @ INT (4 2k x 4k)

• Mosaic1 @ KPNO, Mosaic2 @ CTIO (8 2k x 4k)

• MegaCam @ CFHT (36 2k x 4.5k)

• SuprimeCam @ Subaru (10 2k x 4k)

• WFI @ 2.2m ESO (8 2k x 4k)

• OmegaCam @ VST (32 2k x 2k)
Near-IR processing at CASU

- CIRSI @ INT (4 1k x 2k)
- WFCAM @ UKIRT (4 2k x 2k)
- Hawk-I @ VLT (4 2k x 2k)
- VIRCAM @ VISTA (16 2k x 2k)
Data processing steps

- Reset/Bias correction
- Linearity correction
- Dark and reset anomaly
- Flatfield
- Destripe
- Cross talk removal
- Persistence
- Background sky/Defringing
- Dithering
- Catalogue generation
- Astrometric calibration
- Photometric calibration
- Stacking
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% Distortion vs. Degrees on sky
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II. Past and present surveys
The IPHAS Survey
The IPHAS Survey

- $r$, $i$, $H\alpha$ using the WFC@INT

- $\sim1800$ deg$^2$ in the Northern Galactic Plane

- $\sim300$ million objects

- Early Data Release world public (VO compliant)

Drew et al. 2005
Gonzalez-Solares et al. 2008
The UKIDSS Survey

Observing dates range
20050401 - 20081031

Last updated: 23/11/08 00:29:23 GMT
The UKIDSS Survey

- UKIRT: UK Infrared Telescope
  - 3.8m primary mirror, wide field infrared telescope
  - Located in Mauna Kea, Hawaii
  - Several instruments: UFTI, UIST, Michelle, CGS4, WFCAM
- Photometry good to 0.02 mag
- Astrometry 50 - 100 mas
- Average seeing 0.8 arcsec
The WFCAM camera

- 4 chips 4k x 4k
- A tile (4 pointings) covers 0.8 x 0.8 deg
- ~17000x17000 pixels per tile
- UKIDSS uses WFCAM to observe ~7000 sq. deg. of sky in the near-IR
- Raw data travels from Hawaii to CASU (100 - 200GB per night)
- Pipeline processing done at CASU producing fully astrometrically and photometrically calibrated science products.
Pretty pics

NGC891

Orion

M17

M104

M104
The UKIDSS Survey

Observing dates range
20050401 - 20081031

(C) 2008 CASU

Last updated: 23/11/08 00:29:23 GMT
## The UKIDSS Survey

<table>
<thead>
<tr>
<th>Survey</th>
<th>Area (sq. deg.)</th>
<th>Depth*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Area (LAS)</td>
<td>4000</td>
<td>18.4</td>
</tr>
<tr>
<td>Galactic Plane (GPS)</td>
<td>1800</td>
<td>19.0</td>
</tr>
<tr>
<td>Galactic Clusters (GCS)</td>
<td>1400</td>
<td>18.7</td>
</tr>
<tr>
<td>Deep Extragalactic (DXS)</td>
<td>35</td>
<td>21.0</td>
</tr>
<tr>
<td>Ultra Deep (UDS)</td>
<td>0.77</td>
<td>23.0</td>
</tr>
</tbody>
</table>

(*) K band, Vega, 5 sigma
The UKIDSS-LAS Survey

LAS DR4: 25m objects, 13m galaxies (~11000 deg$^{-2}$) in YJHK
The UKIDSS-DXS and UDS
The UKIDSS Survey - Comparison with 2MASS
The UKIDSS Survey - Comparison with 2MASS

(*) Comparison w.r.t. DXS (subtract ~2 mag for LAS)
The UKIDSS Survey: Scientific Results

• Too many to describe. See www.ukidss.org

• Evolution of red and blue galaxies to z~2 (Cirasuolo et al 2007)

• Superclusters at z~1 (Swinbank et al 2007)

• IR properties of SDSS quasars (Chiu et al 2007)


• High (z~6) QSOs (Venemans et al 2007, Mortlock et al 2008)
20pc Brown Dwarf

- ULASJ0034-00
- Coolest known dwarf (T8.5)
- T~600K
- M~15-36 MJup

Warren et al 2007
Lodieu et al 2008
First z~6 QSO from UKIDSS

- ULASJ0203+0012
- z=5.86
- VLT/FORS2
- 1 QSO in 110 deg² DR1 (consistent with SDSS - Fan et al 2004)
First $z \sim 6$ QSOs from UKIDSS

$z > 6.5$ QSOs detection requires IR wavelengths
Multi-wavelength approach

- Surveys powerful when combined across spectrum range
  - FIRST/APM
  - SDSS/2MASS
  - SDSS/UKIDSS
- Many areas with radio, optical, near-, mid- and far-IR, sub-mm, X-ray
III. (Near) future surveys
ESO Public Surveys

- ESO program for large surveys in the optical and near-IR

- Optical: VST (VLT Survey Telescope) 2.6m telescope fitted with OmegaCam (32 CCDs) and a f.o.v. of 1 sq. deg. u’ g’ r’ i’ z’ and Ha

- Near-IR: VISTA 4m telescope equipped with a 16 detector camera covering a f.o.v of 1.5 sq. deg. per tile. Z Y J H K
VST public surveys
VISTA public surveys
VST and VISTA surveys

### VST survey observing strategies

<table>
<thead>
<tr>
<th>Survey</th>
<th>Area (deg$^2$)</th>
<th>Filters and Depth (mag, 10σ, AB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIDS</td>
<td>1500</td>
<td>$u'=24.8$ $g'=25.4$ $r'=25.2$ $i'=24.2$</td>
</tr>
<tr>
<td>ATLAS</td>
<td>4500</td>
<td>$u'=22.0$ $g'=22.2$ $r'=22.2$ $i'=21.3$ $z'=20.5$</td>
</tr>
<tr>
<td>VPHAS+</td>
<td>1800</td>
<td>$u'=21.8$ $g'=22.5$ $Hα=21.6$ $r'=22.5$ $i'=21.8$</td>
</tr>
</tbody>
</table>

### VISTA survey observing strategies

<table>
<thead>
<tr>
<th>Survey</th>
<th>Area (deg$^2$)</th>
<th>Filters and Depth Measure (mag, 10σ, AB)</th>
<th>Depth (mag)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-VISTA</td>
<td>0.73 (ultra-deep)</td>
<td>5α, AB</td>
<td>Y=26.7 J=26.6 H=26.1 $K_s=25.6$ NB=24.1</td>
</tr>
<tr>
<td>VIKING</td>
<td>1500</td>
<td>5α, AB</td>
<td>Z=23.1 Y=22.3 J=22.1 H=21.5 $K_s=21.2$</td>
</tr>
<tr>
<td>VMC</td>
<td>184</td>
<td>10α, Vega</td>
<td>Y=21.9 J=21.4 $K_s=20.3$</td>
</tr>
<tr>
<td>VVV</td>
<td>520</td>
<td>5α, Vega</td>
<td>Z=21.9 Y=21.2 J=20.2 H=18.2 $K_s=18.1$</td>
</tr>
<tr>
<td>VHS</td>
<td>20 000</td>
<td>5α, AB</td>
<td>Y=21.2 Y=21.2 J=21.2 H=20.6 $K_s=20.0$</td>
</tr>
<tr>
<td>VIDEO</td>
<td>15</td>
<td>5α, AB</td>
<td>Z=25.7 Y=24.6 J=24.5 H=24.0 $K_s=23.5$</td>
</tr>
</tbody>
</table>
Visible and Infrared Survey Telescope for Astronomy (VISTA)

- 4.1m primary mirror, wide field survey telescope
- 1.5 deg diameter f.o.v
- Designed for both optical and infrared
- Located in Paranal near the VLT site
- Now IR camera only [16 detectors 2k x 2k]
- >75% of time dedicated to large scale public surveys
# VHS Limiting Magnitudes

[AB system; 5σ]

<table>
<thead>
<tr>
<th>VHS Component</th>
<th>deg²</th>
<th>Y</th>
<th>J</th>
<th>H</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHS-ATLAS</td>
<td>5000</td>
<td>20.9</td>
<td>20.9</td>
<td>20.3</td>
<td>19.8</td>
</tr>
<tr>
<td>VHS-DES</td>
<td>5000</td>
<td>22.3</td>
<td>21.2</td>
<td>20.8</td>
<td>20.2</td>
</tr>
<tr>
<td>VHS-GP</td>
<td>8200</td>
<td>20.9</td>
<td></td>
<td></td>
<td>19.8</td>
</tr>
<tr>
<td>UKIDSS-LAS</td>
<td>2000</td>
<td>20.8</td>
<td>20.5</td>
<td>20.2</td>
<td>20.1</td>
</tr>
</tbody>
</table>
VHS Science Goals

- Nearest and lowest mass stars
- Evolution of LSS in the Universe
- Nature and evolution of Dark Energy
- Physics of the epoch of reionization; the discovery of the first $z>7$ quasar(s)
  - 100 times the volume of 2MASS
  - 10 times the volume of UKIDSS
- Support for ESA missions: XMM-Newton, Herschel, Planck, GAIA
Summary

- Photometric surveys are the base for spectroscopic followup

- WFCAM now and VST and VISTA soon providing large amounts of scientific data to be exploited both in the Galactic and extragalactic domain

- Multiwavelength data available in many fields allowing a detailed study of objects and sample selection for spectroscopic followup observations e.g. ELAIS/SWIRE areas