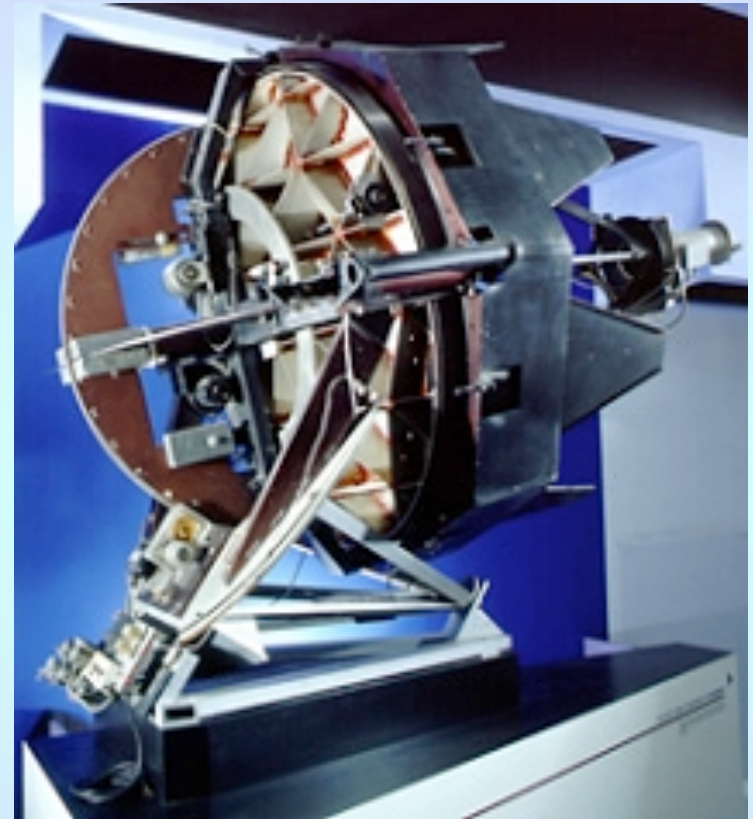


1968: Two Micron Sky Survey

The first large-area near-IR survey of the sky, the Two Micron Sky Survey, is made at the Mount Wilson Observatory by Neugebauer & Leighton using liquid nitrogen cooled PbS detectors which were most sensitive at $2.2 \mu\text{m}$. The survey covers approximately 75% of the sky and finds about 20,000 IR sources, which include star-forming regions, galaxies, our galactic center and numerous stars. The brightest 5,500 of these sources make up the first catalog of IR stars ($K < 4$). The data were recorded on strip charts and reduced by hand.



Two-Micron All-Sky Survey (2MASS)

- Two 1.3 m telescopes in Chile and Arizona
- 1997-2001
- 99.998% of the sky was imaged
- J, H, and K_s filters (1.25, 1.65, 2.17 μm)
- 2" pixels; resolution improved via sub-pixel dithering
- Purpose:
 - Study stellar sources that are cool or obscured by dust (e.g., brown dwarfs, Galactic plane)
 - Infrared census of the sky for supporting current and future telescopes on the ground and in space (Keck, HST, Spitzer, JWST, etc.)

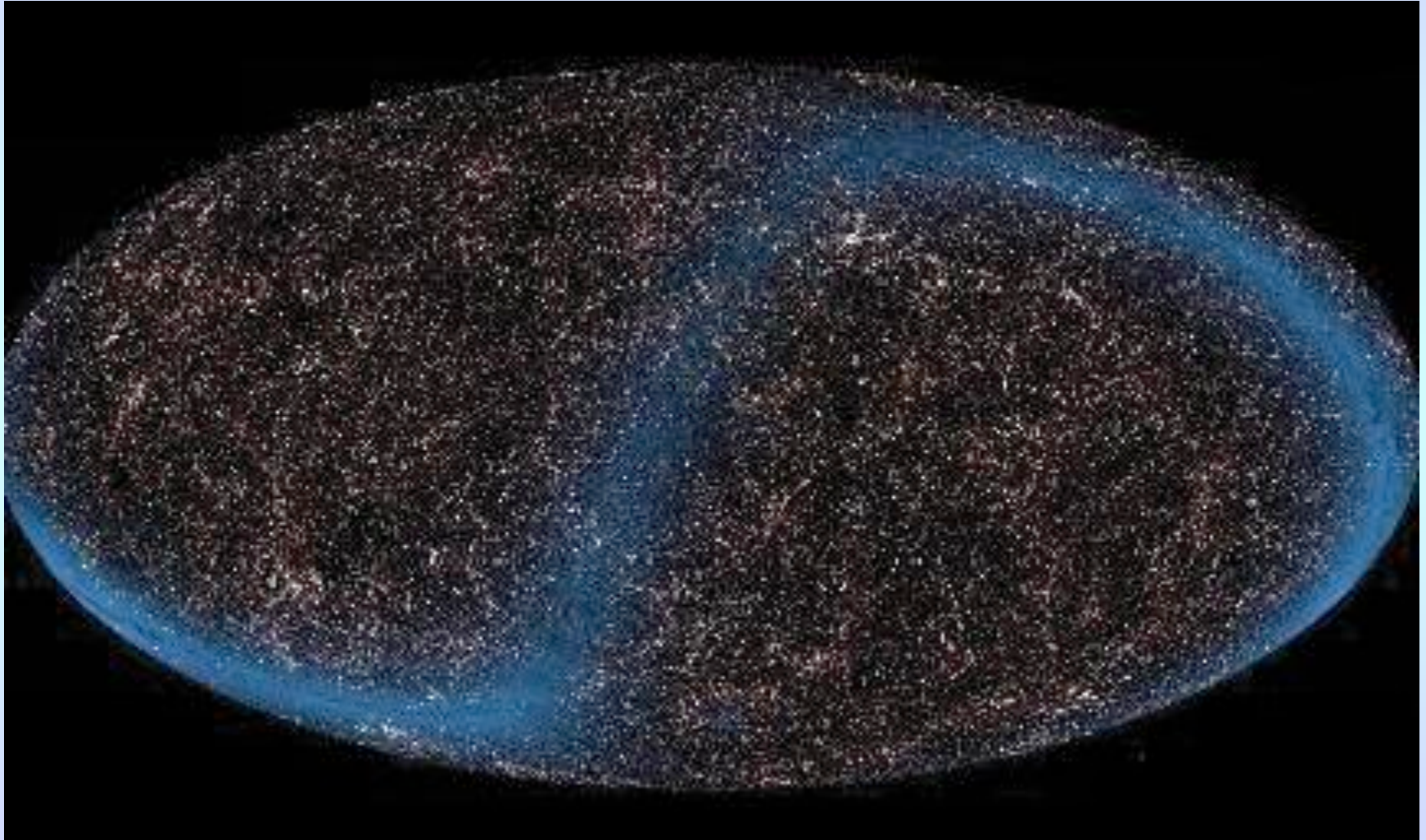
Two-Micron All-Sky Survey (2MASS)

- Total exposure times of 7.8 s for a given position
- 6x longer exposure for 590 deg² toward interesting fields (star-forming regions, Magellenic Clouds)
- Sensitivity: SN=10 at JHK_s=15.8, 15.1, 14.3
- Astrometric accuracy of ~0.2''
- Data products:
 - Images
 - Point Source Catalog
 - 470,000,000 point sources
 - Mostly Galactic stars; ~5,000,000 unresolved galaxies
 - Extended Source Catalog
 - 1,600,000 extended sources; galaxies, open/globular clusters, nebulae, comets

Point Source Catalog



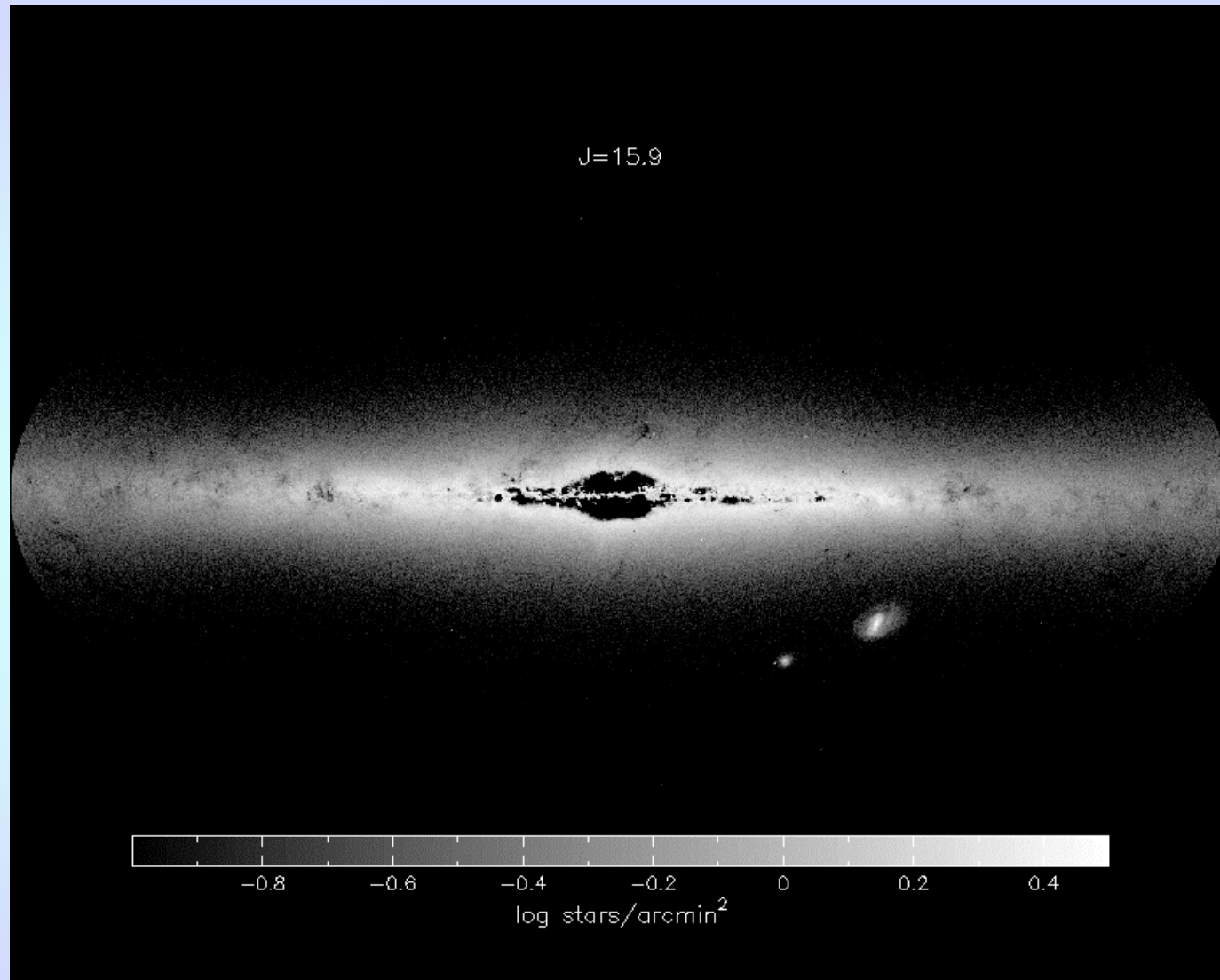
Extended Source Catalog



Comparison of low and high galactic latitude

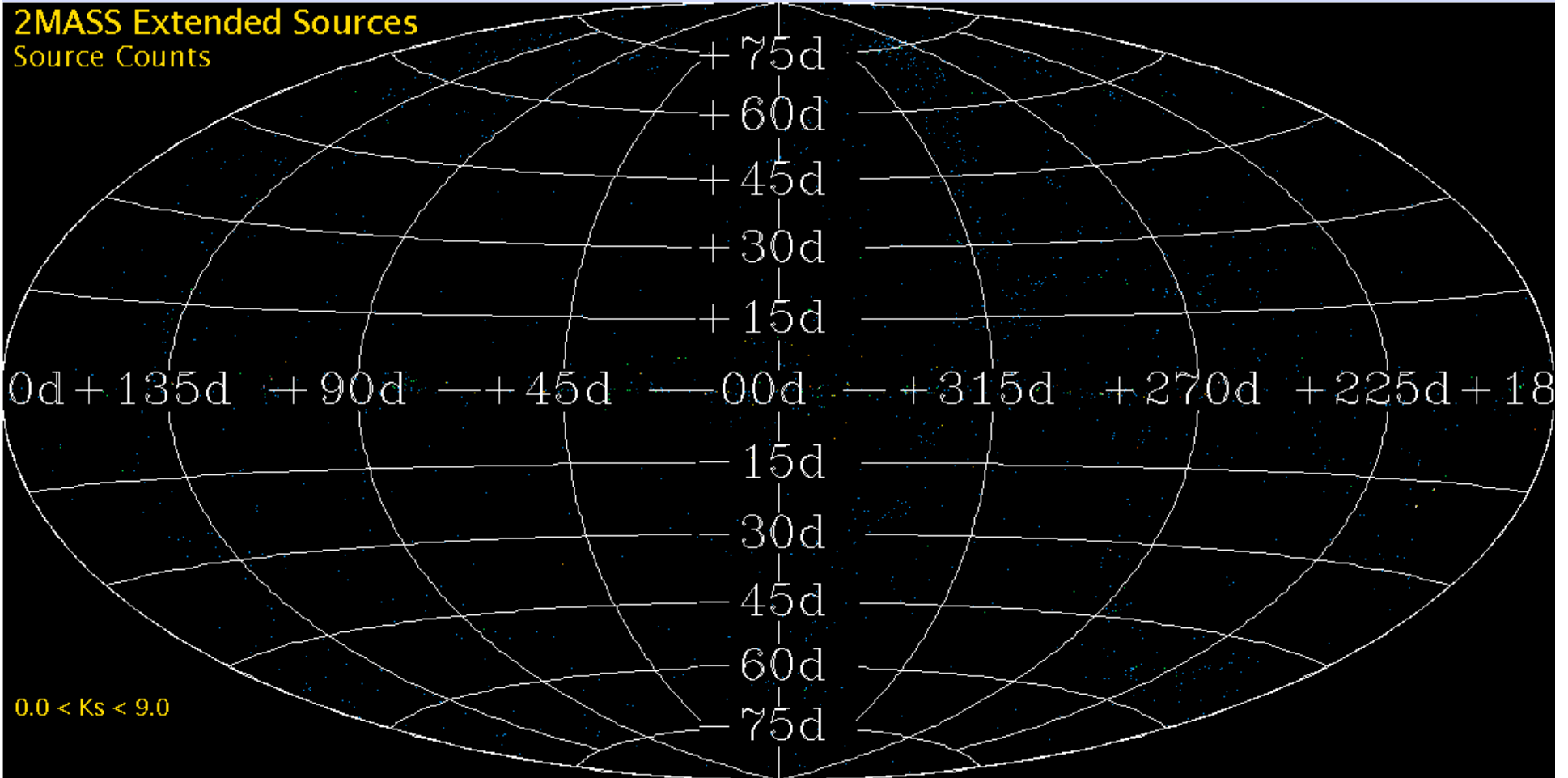


Density of sources in Point Source Catalog for $J < 15.9$



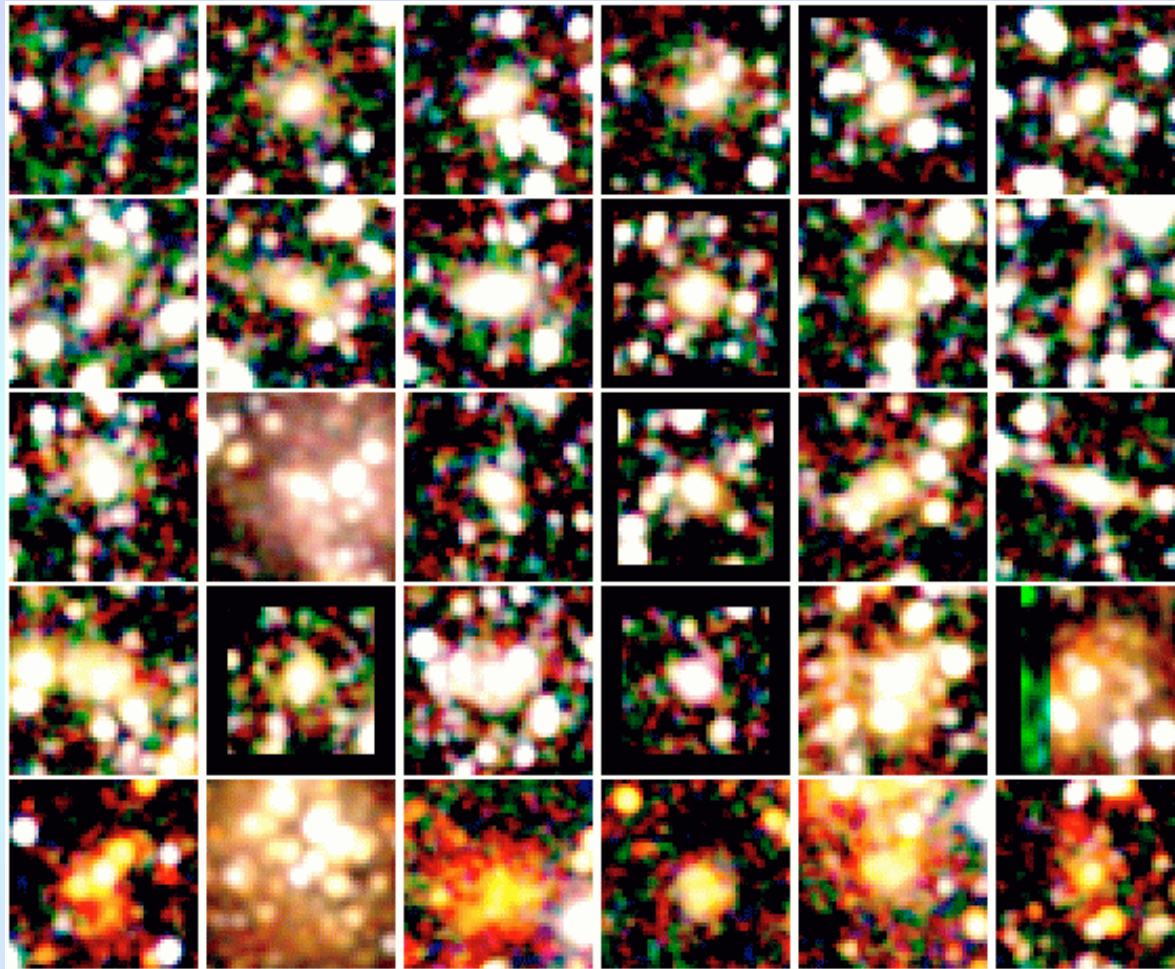
Completeness worse near Galactic Center because of confusion

Galaxy counts as a function of magnitude



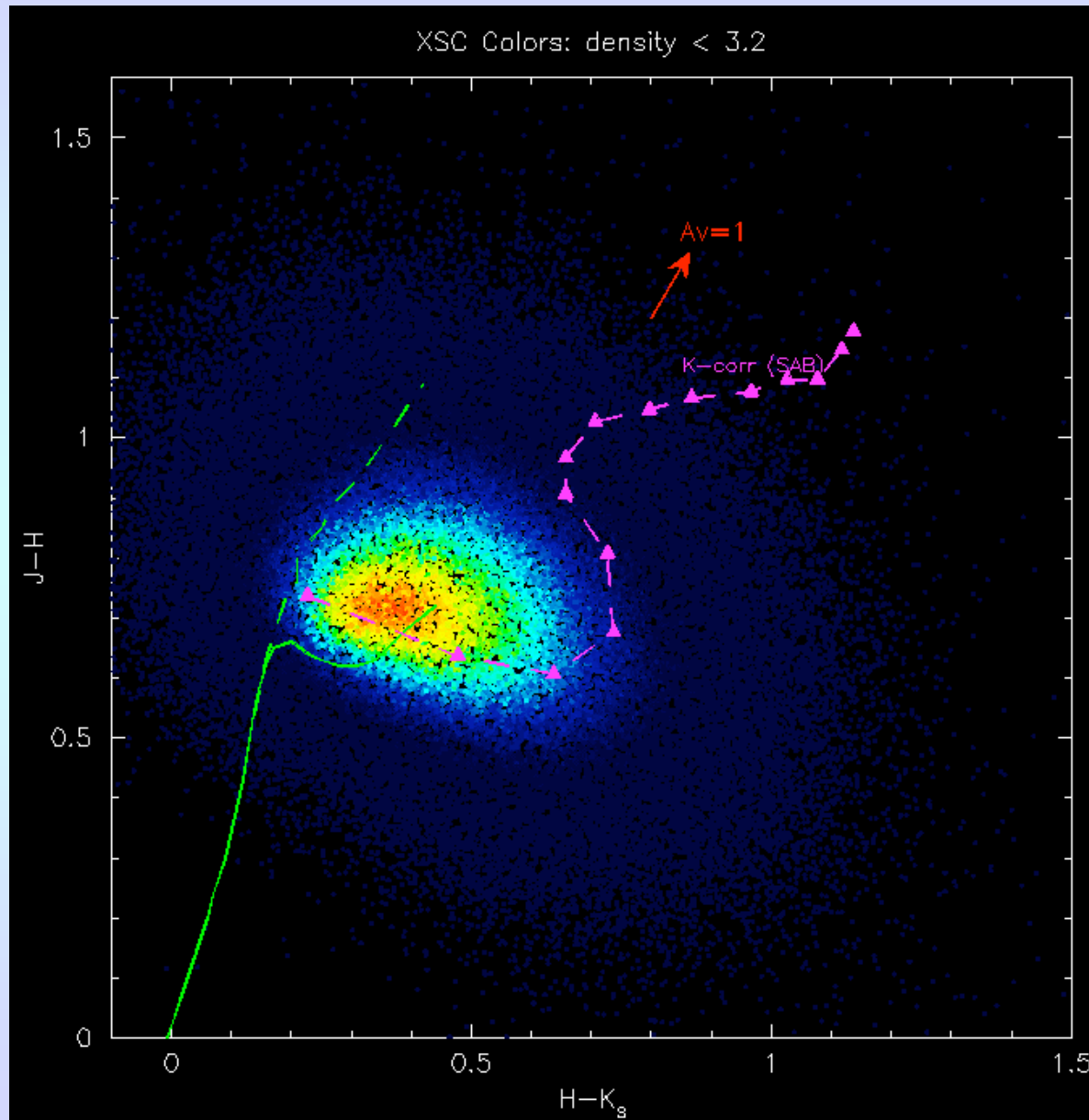
Because of low extinction at IR wavelengths, 2MASS detects galaxies through much of the Galactic plane

Galaxies seen through Galactic plane



Because of low extinction at IR wavelengths, 2MASS detects galaxies through much of the Galactic plane

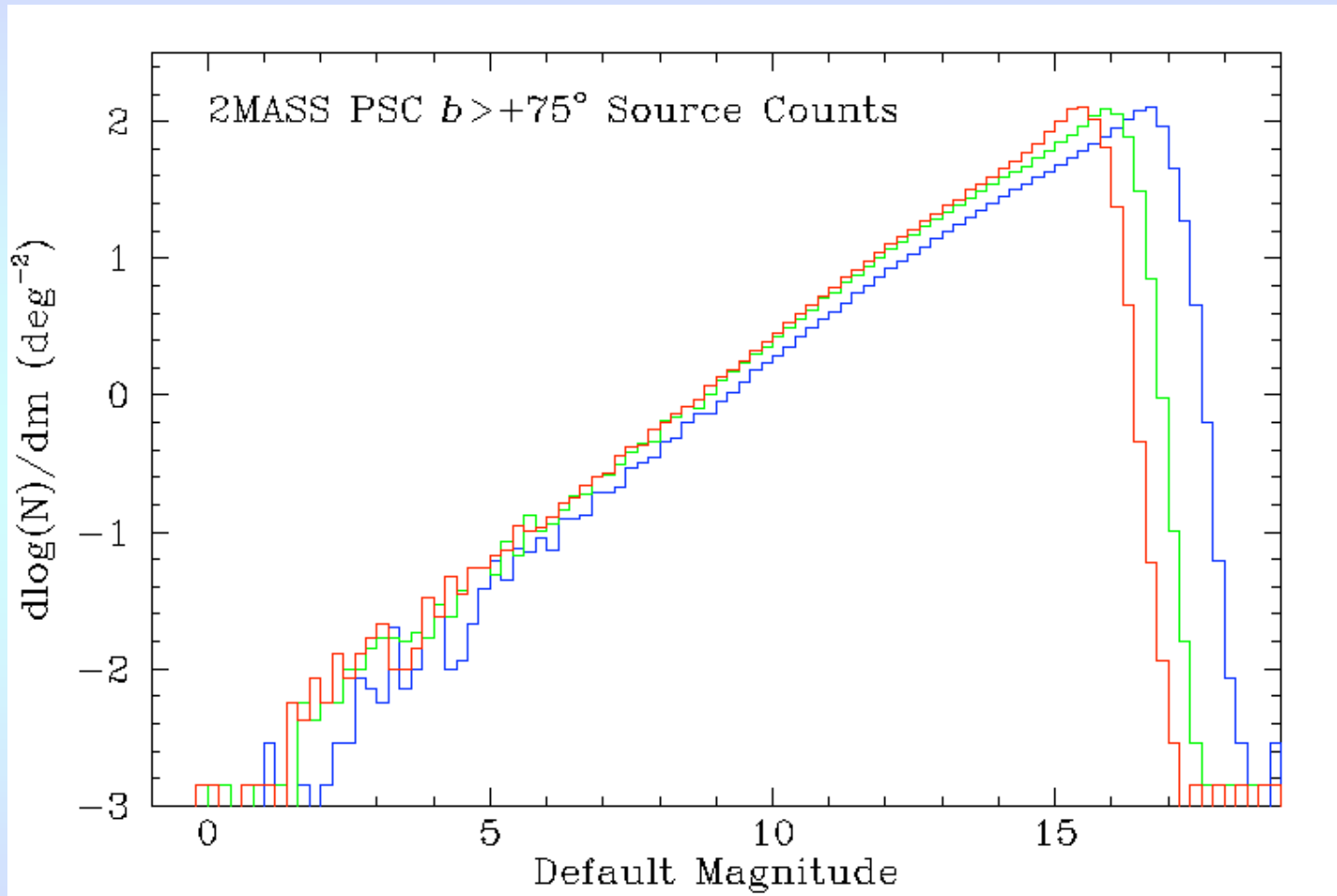
2MASS colors of galaxies



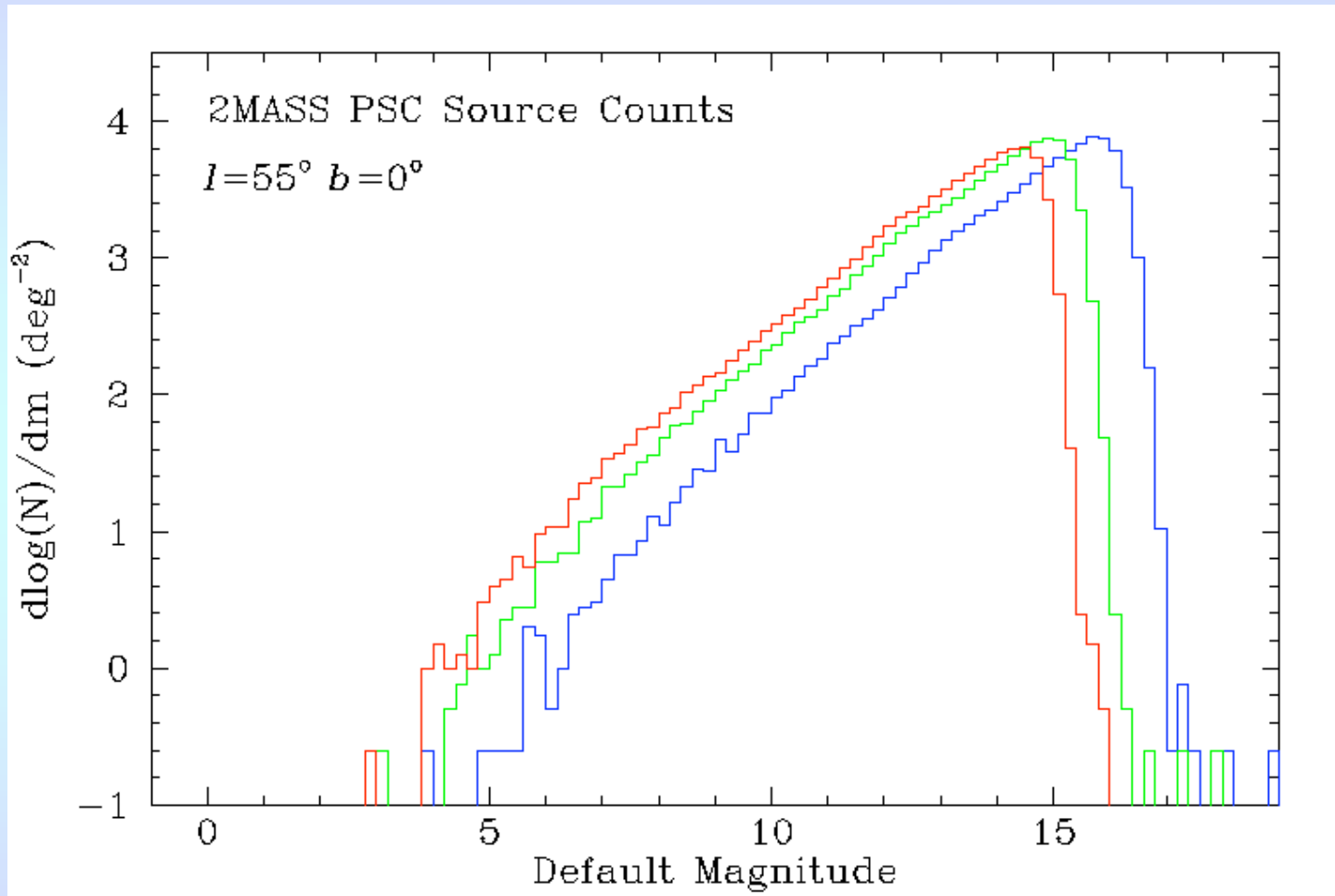
2MASS movie of galactic plane



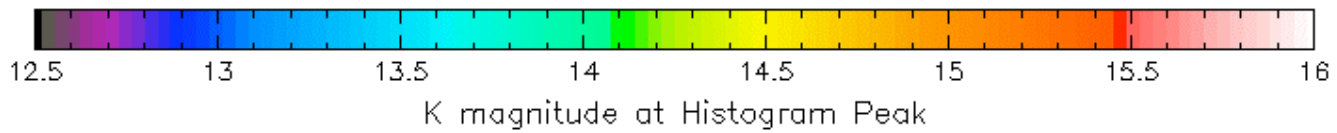
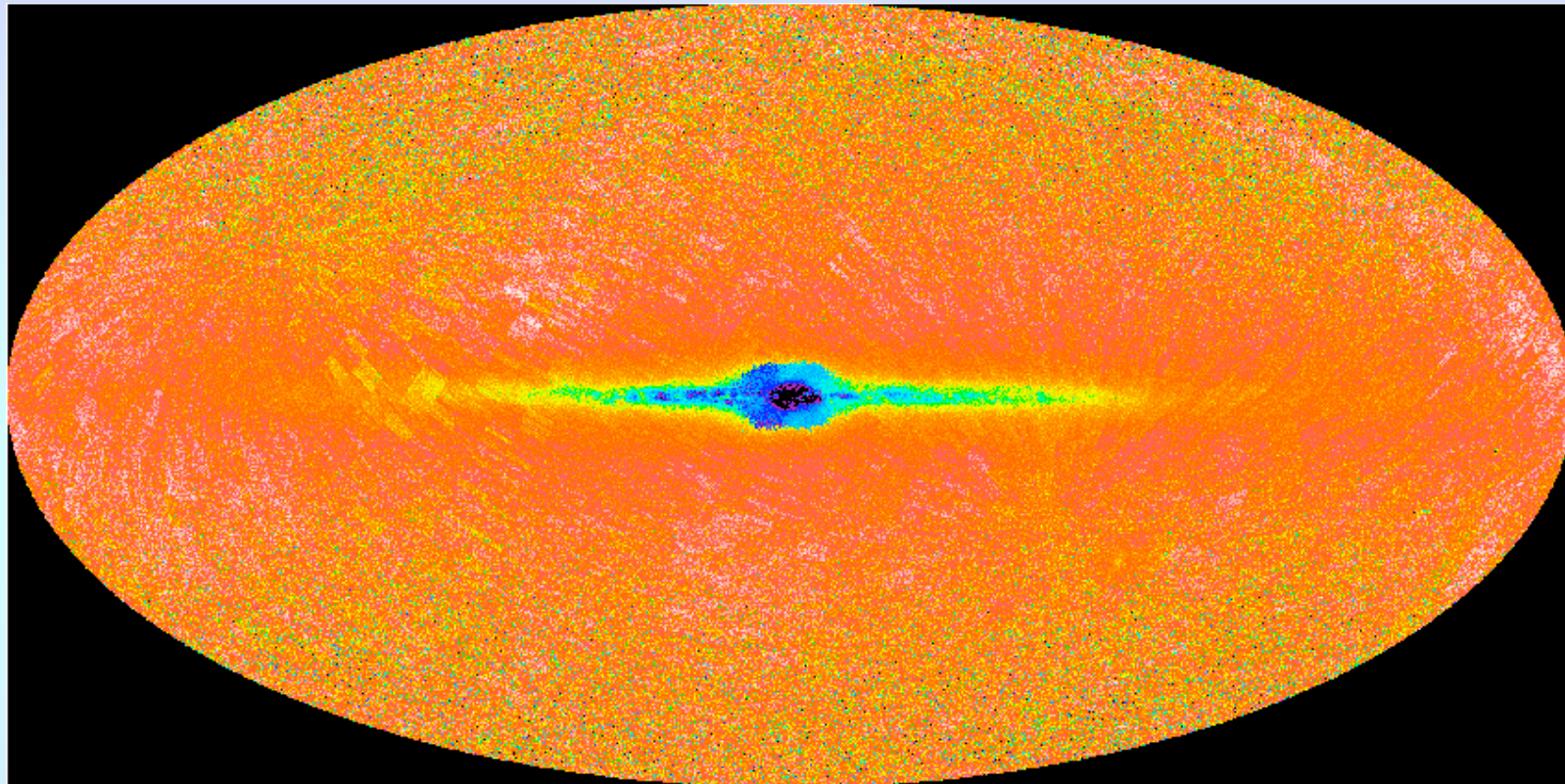
Completeness at high galactic latitude



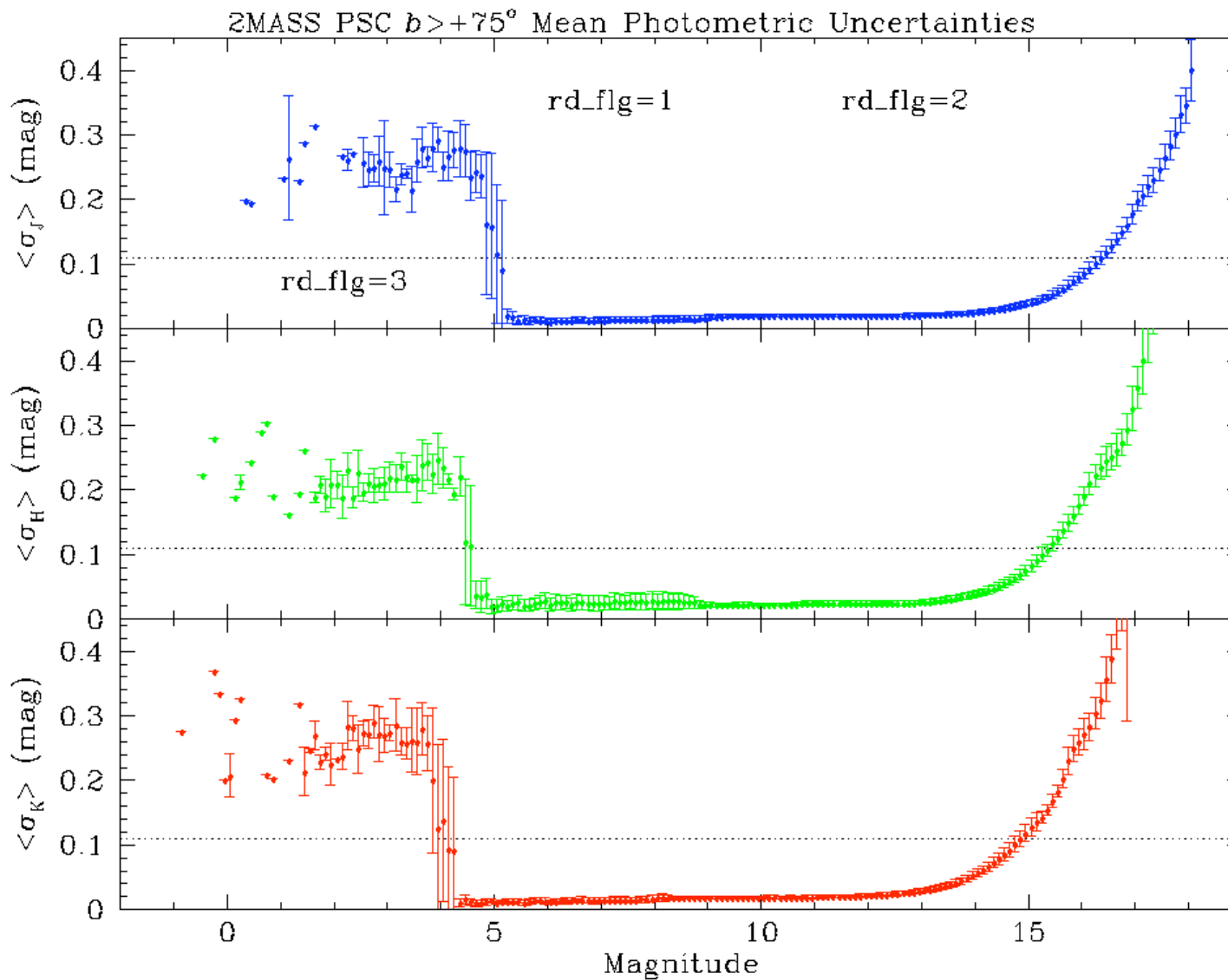
Completeness at low galactic latitude



Map of completeness

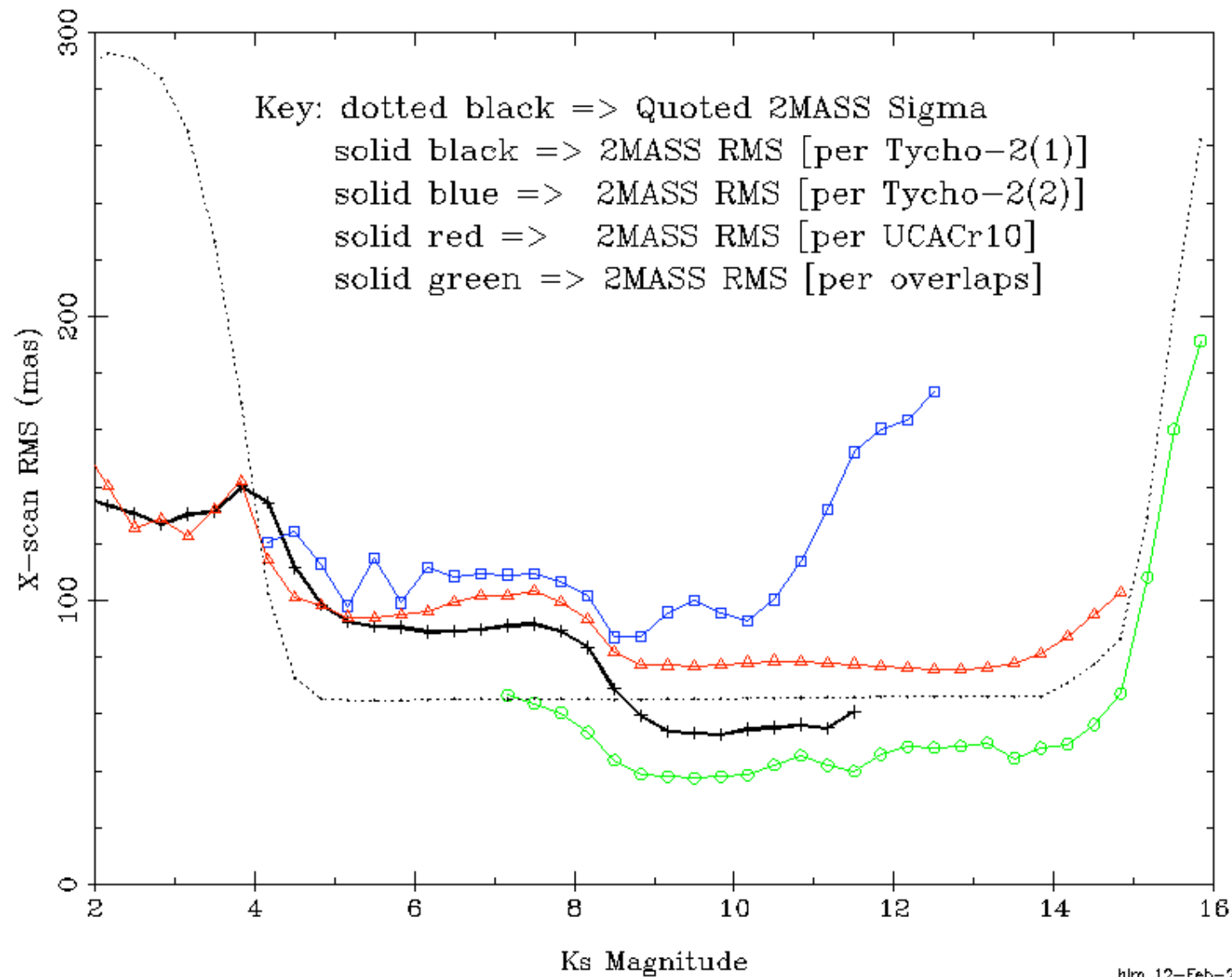


Photometric errors

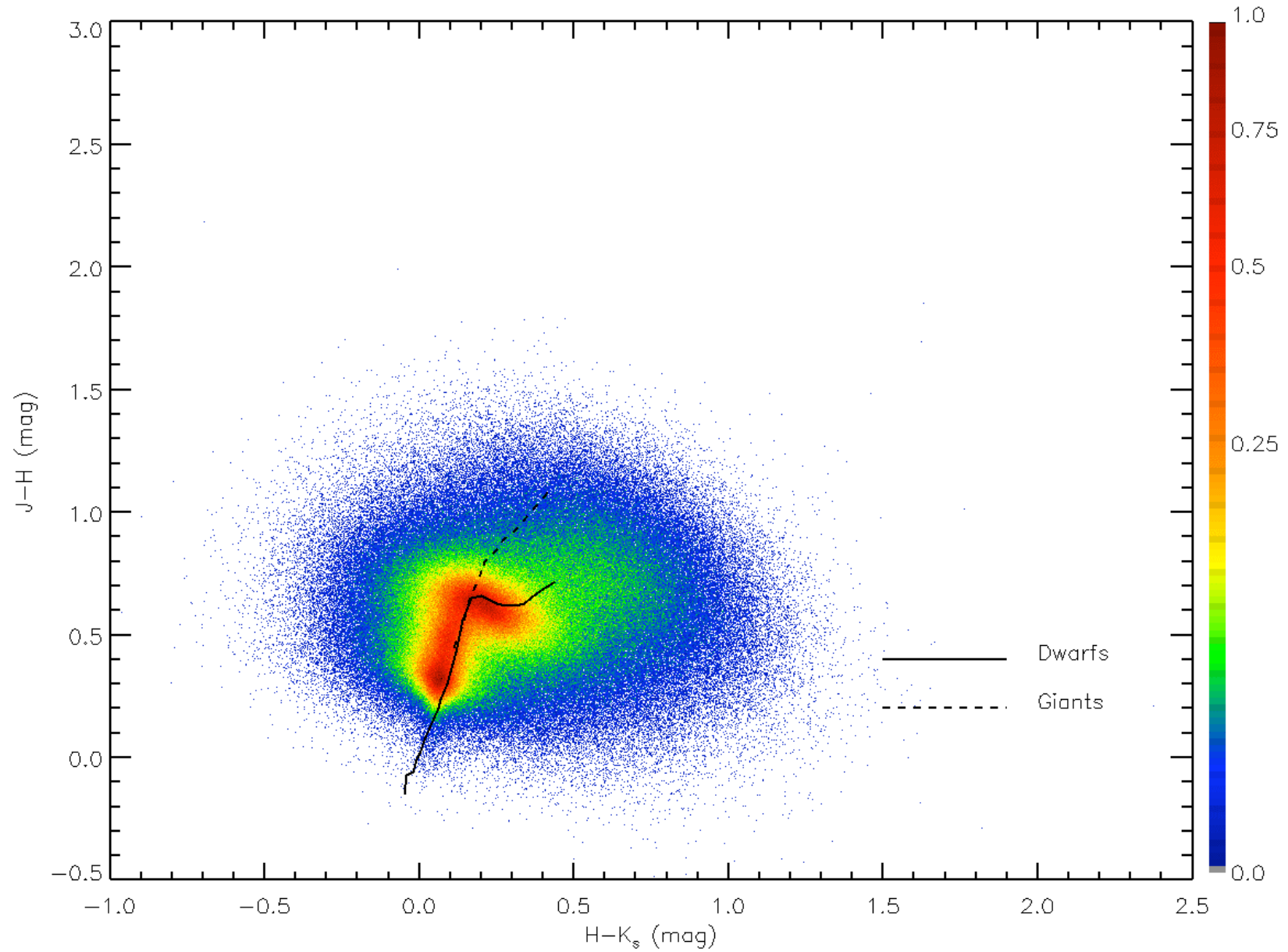


Astrometric errors

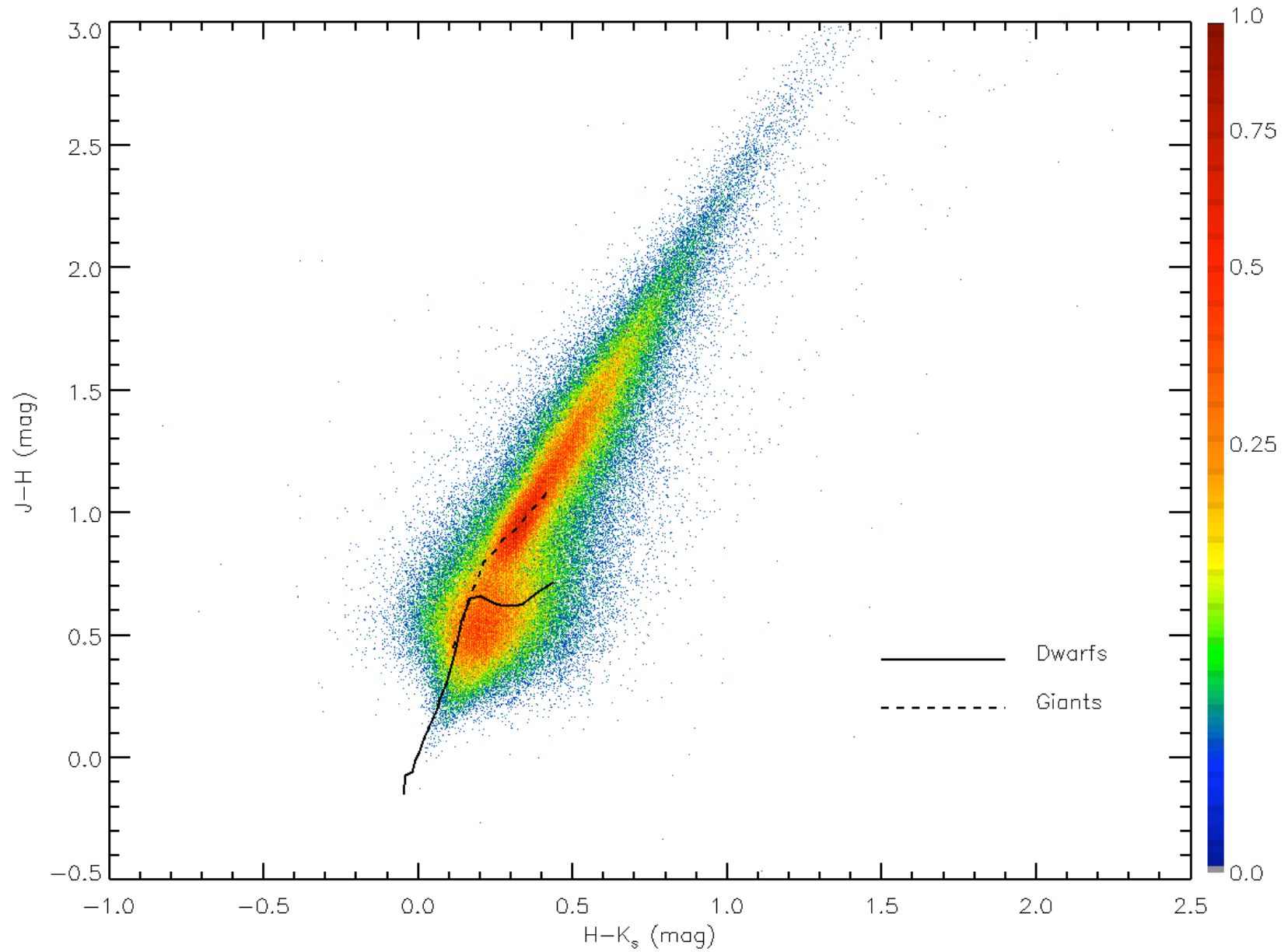
Northern Derived 2MASS X-scan RMS vs Ks Magnitude



Color-Color diagram at high latitude



Color-Color diagram at low latitude



Final comments on 2MASS

- For any area of sky, IR photometric calibrators available from 2MASS
- Spectroscopic limit of SpeX is roughly similar to detection limit of 2MASS
- 2MASS discovered most of the known T dwarfs (remainder found by SDSS and DENIS)

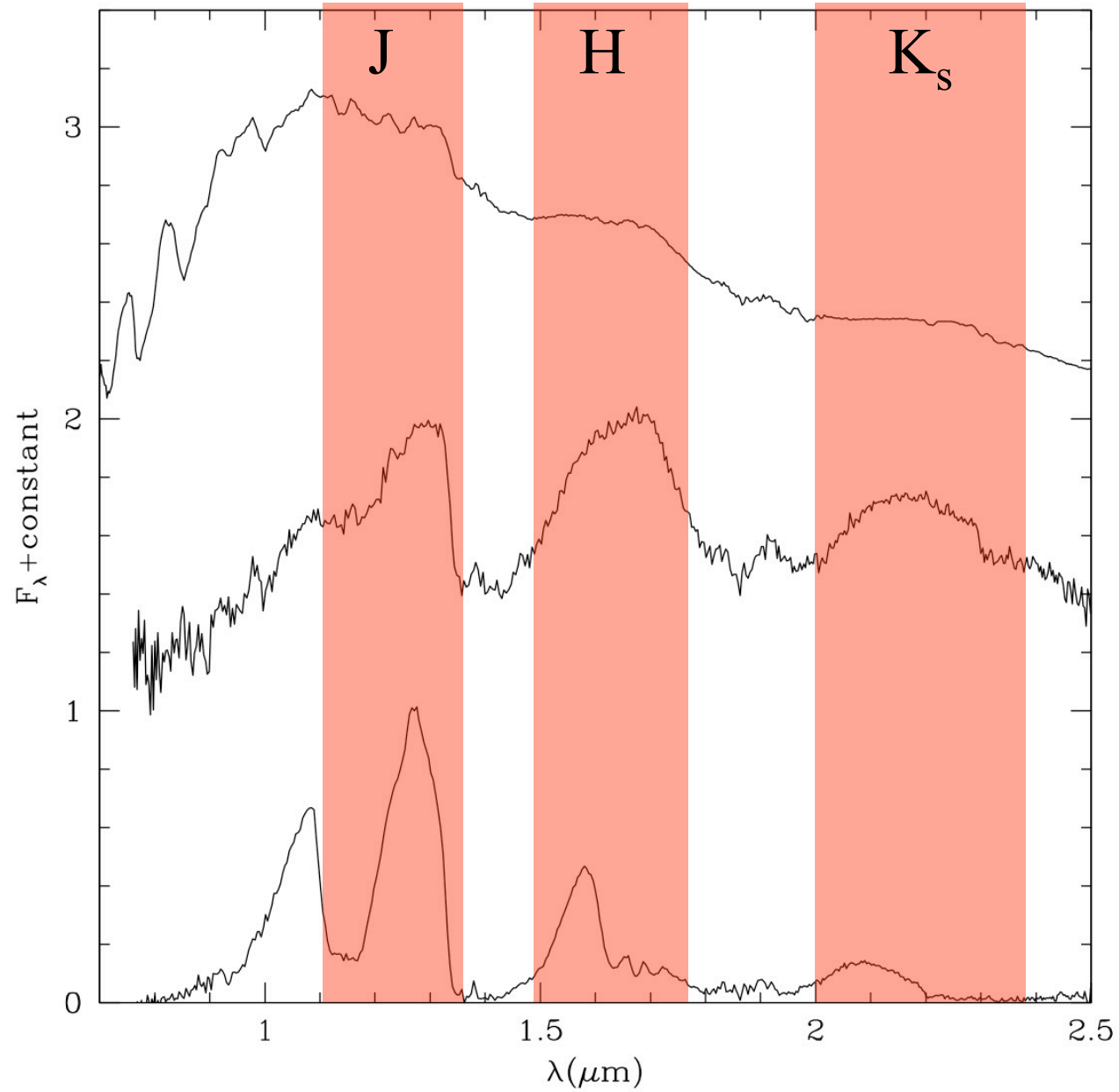
(DEep Near Infrared Survey of the Southern Sky) DENIS

- 1 m telescope at La Silla, Chile
- 1996-2001
- southern sky
- I, J, and K_s filters (0.8, 1.65, 2.17 μm)
- Limit magnitudes of I \sim 18.5, J \sim 16.5, $K_s\sim$ 14.0
- Latest data release in 2005; 355,000,000 sources
- No final catalog yet
- Far less documentation and data tools than 2MASS
- Some brown dwarfs found with 2MASS; easier to identify with combination of optical and IR filters than with only 2MASS filters

M6

L6

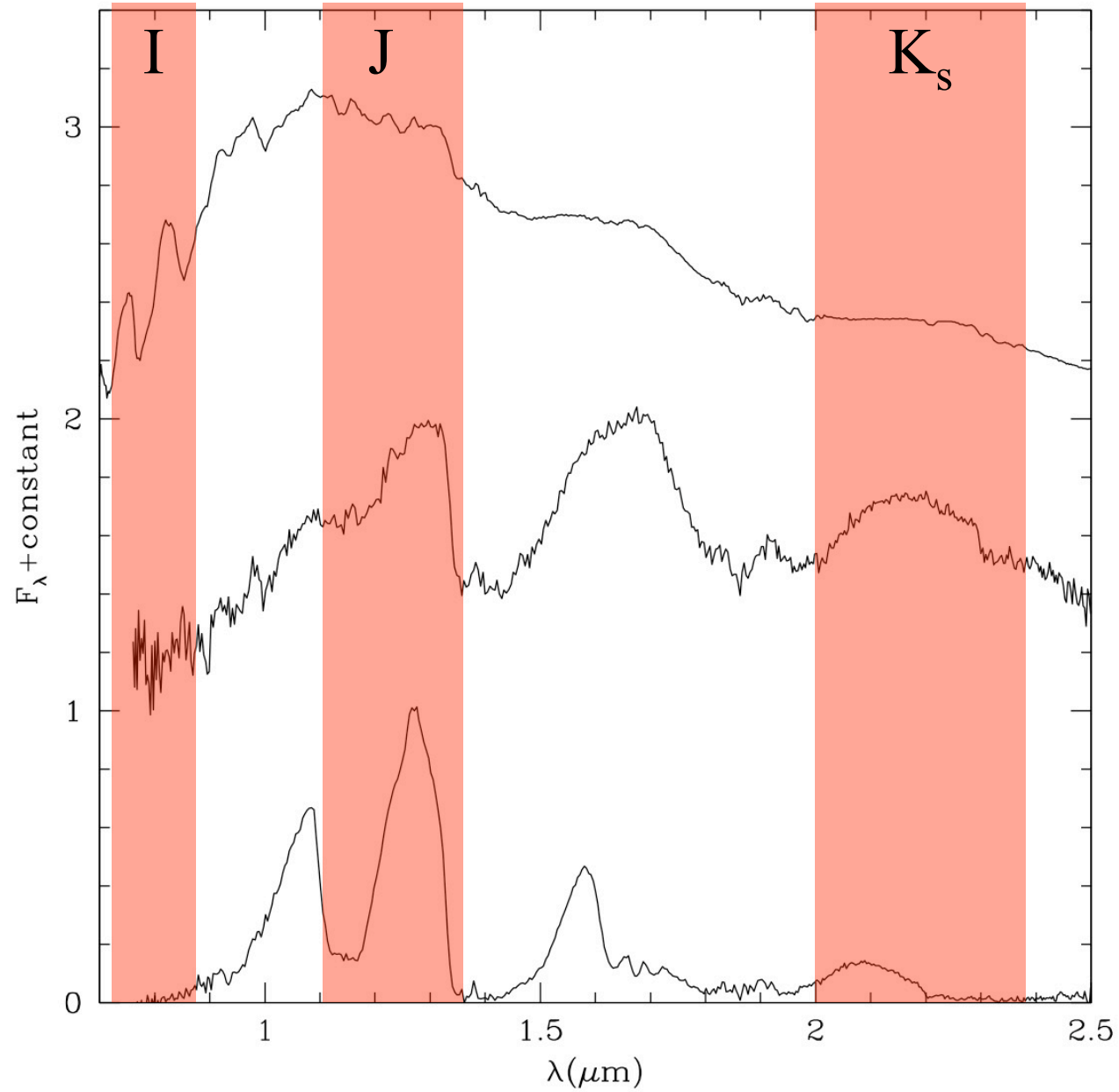
T6



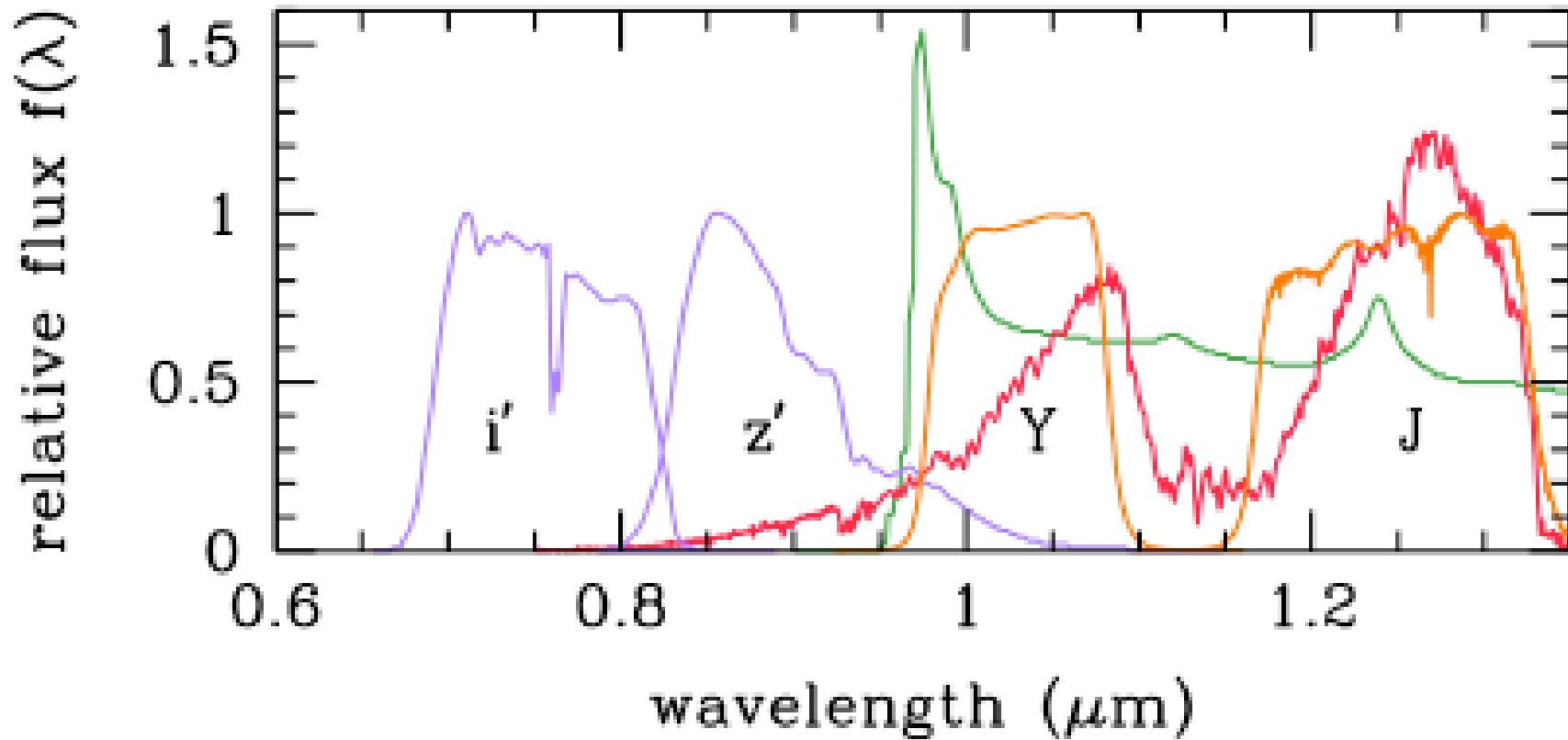
M6

L6

T6



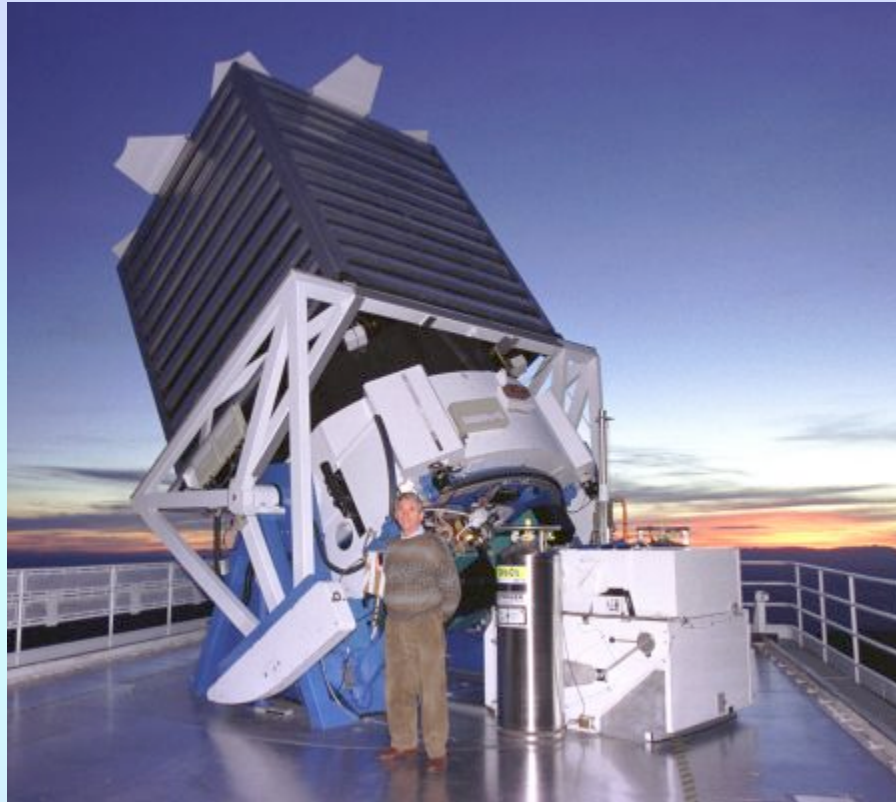
Quasars and brown dwarfs: optical-drop outs



Sloan Digital Sky Survey (SDSS)

- 2.5 m telescope at Apache Point, New Mexico
- 2000-2008
- Images of 25% of sky in u, g, r, i, z
 - focus on north galactic pole
 - 287 million sources
- spectra of 1 million galaxies, 100,000 quasars
- science: galaxy formation and evolution; also BDs

SDSS telescope

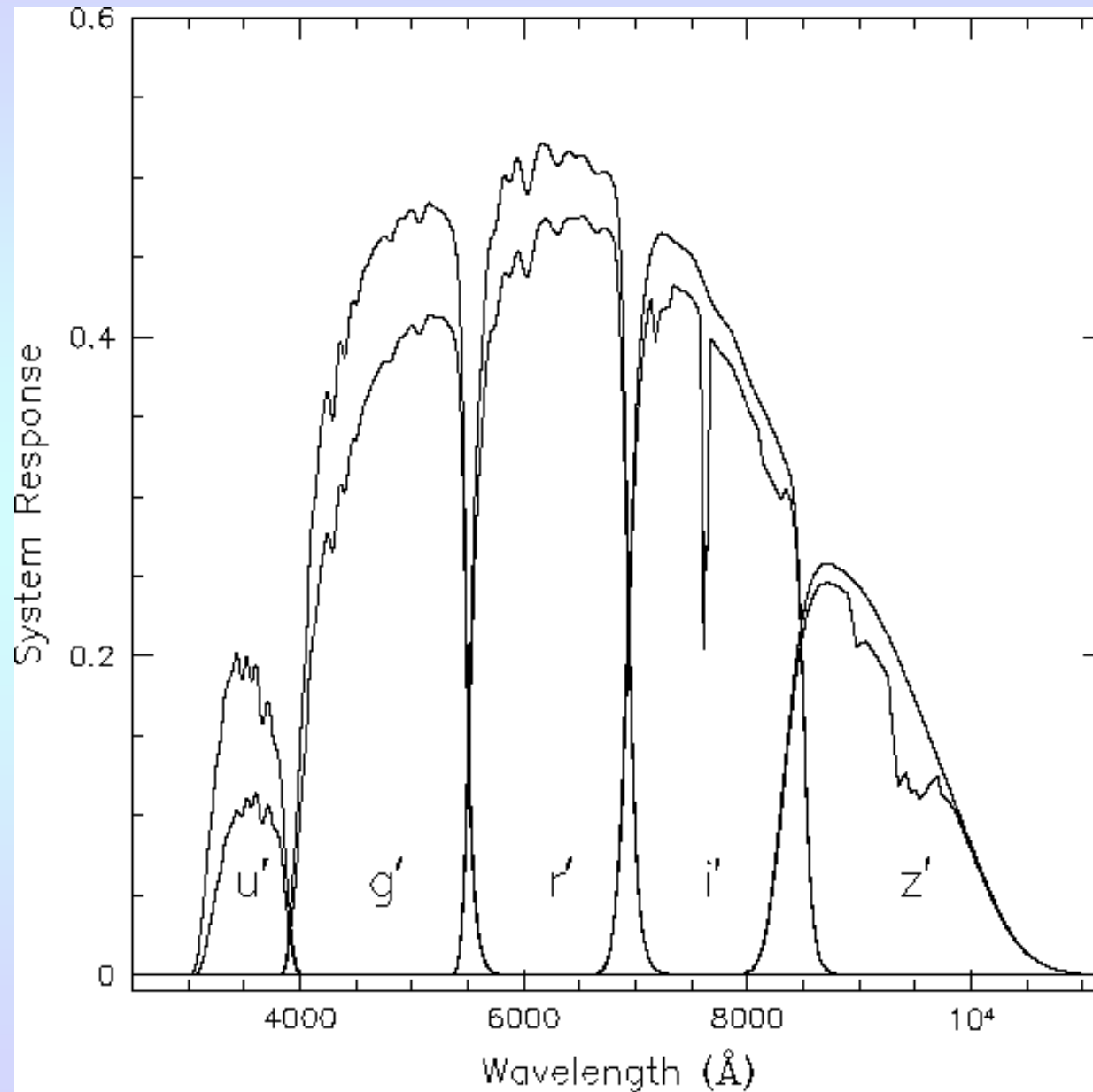


- Modified Ritchey-Chretien design with 3 degree field of view.
- Alt-azimuth mount. Roll-off enclosure.
- Independently mounted wind and light baffles.

SDSS data

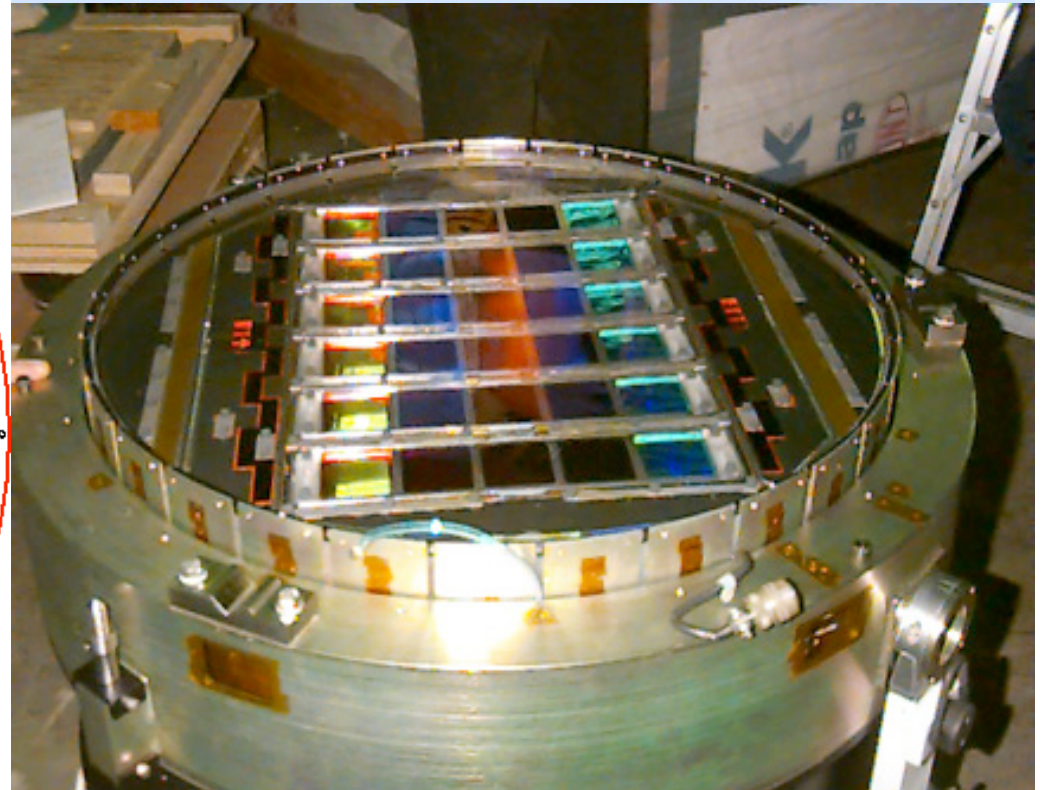
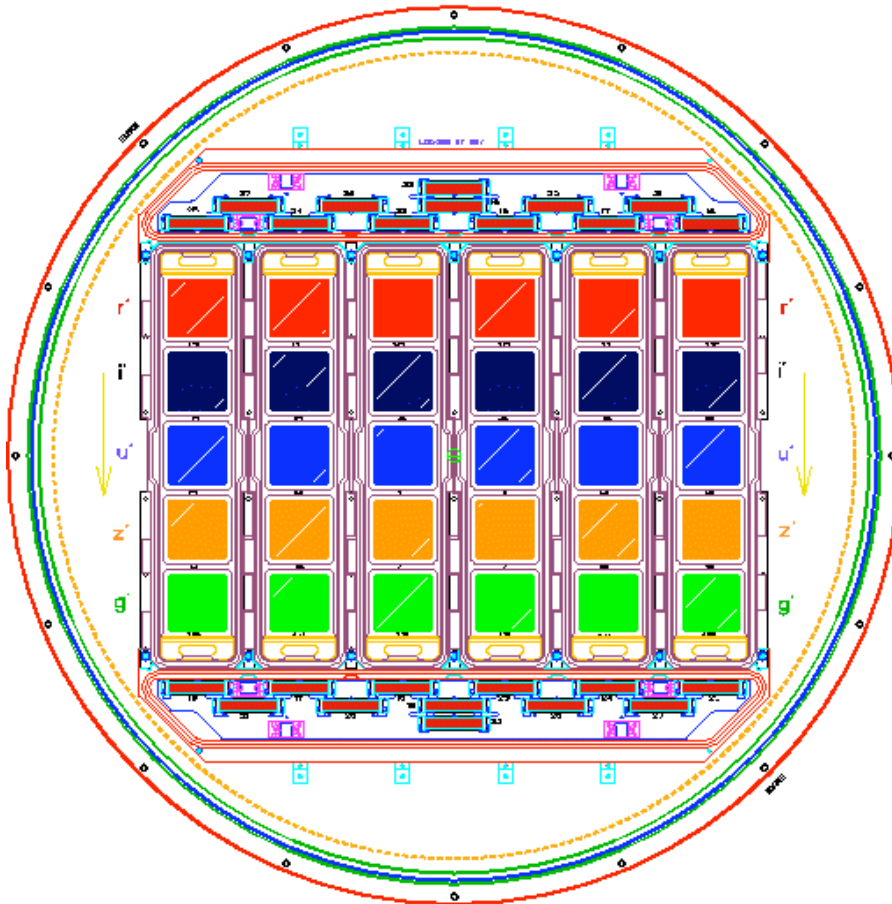
- Imaging
 - near-simultaneous imaging in five passbands (*ugriz*) to $u \sim 22$, $g \sim 22$, $r \sim 22$, $i \sim 21$, $z \sim 20.5$ via *drift scanning*
 - Uses best observing conditions (no cloud or moon, seeing < 1.5 arcsec)
- Spectroscopy
 - 640 fibre multiplex system
 - Targets based on imaging data
 - Uses poorer observing conditions

SDSS filters



SDSS camera

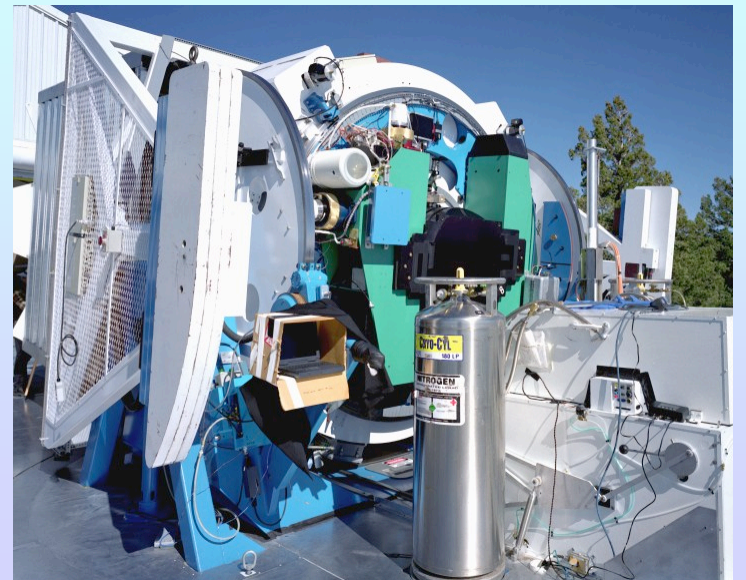
SDSS CAMERA



6 x 5 x 2048 x 2048 0.4'' pixels: 120 Mpix

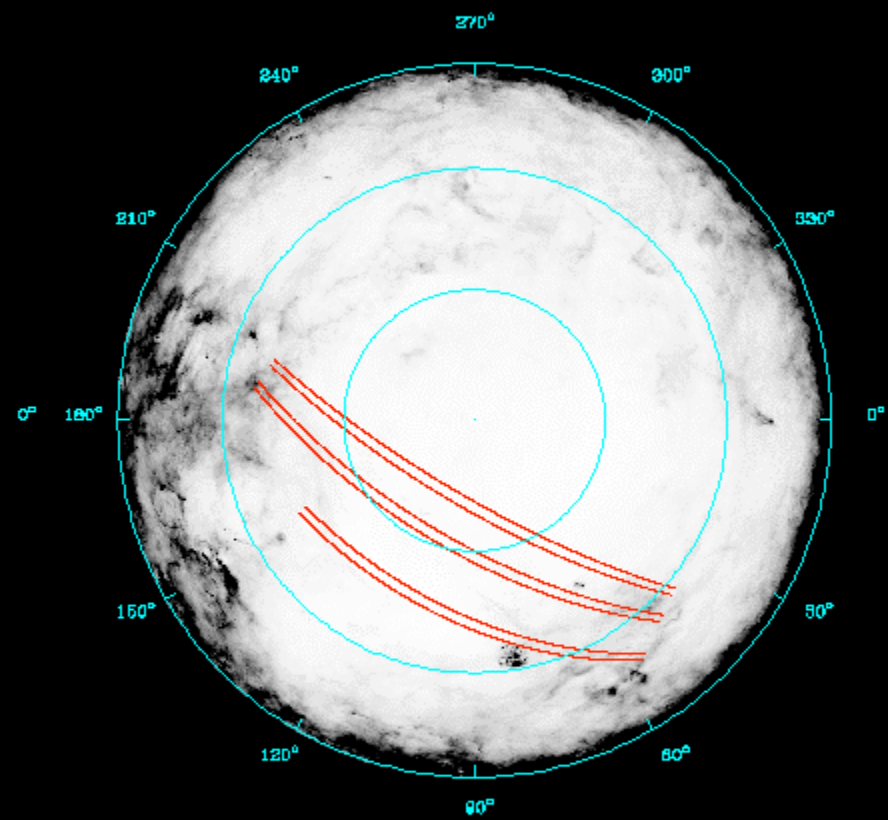
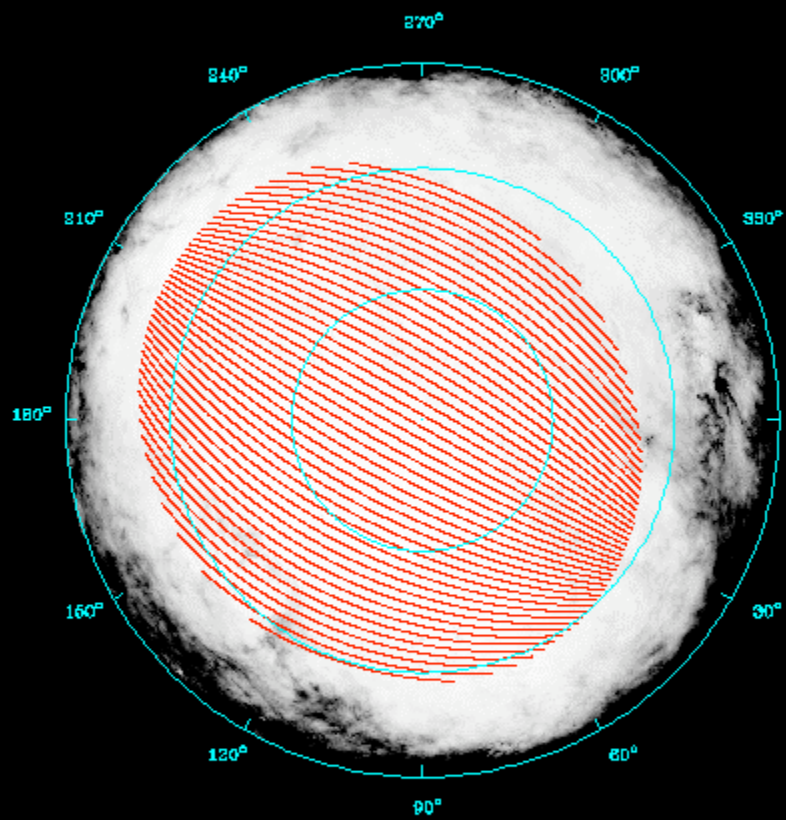
SDSS spectroscopy

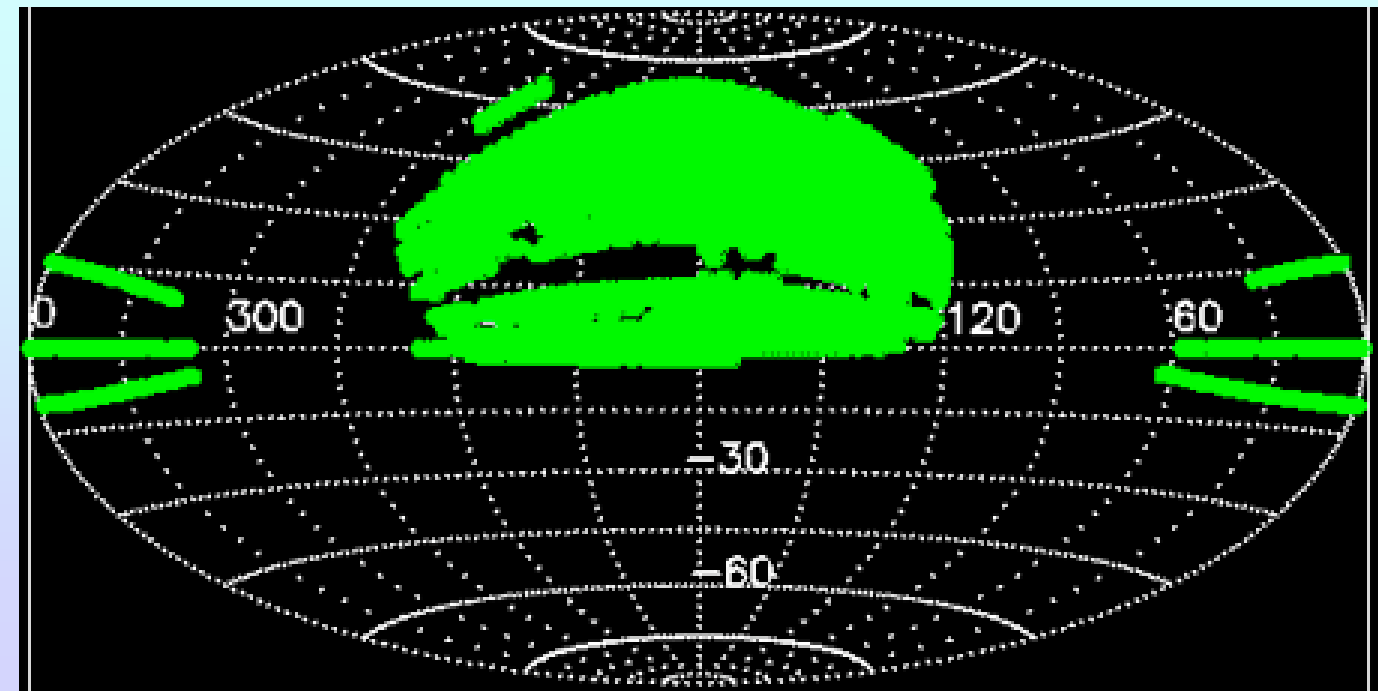
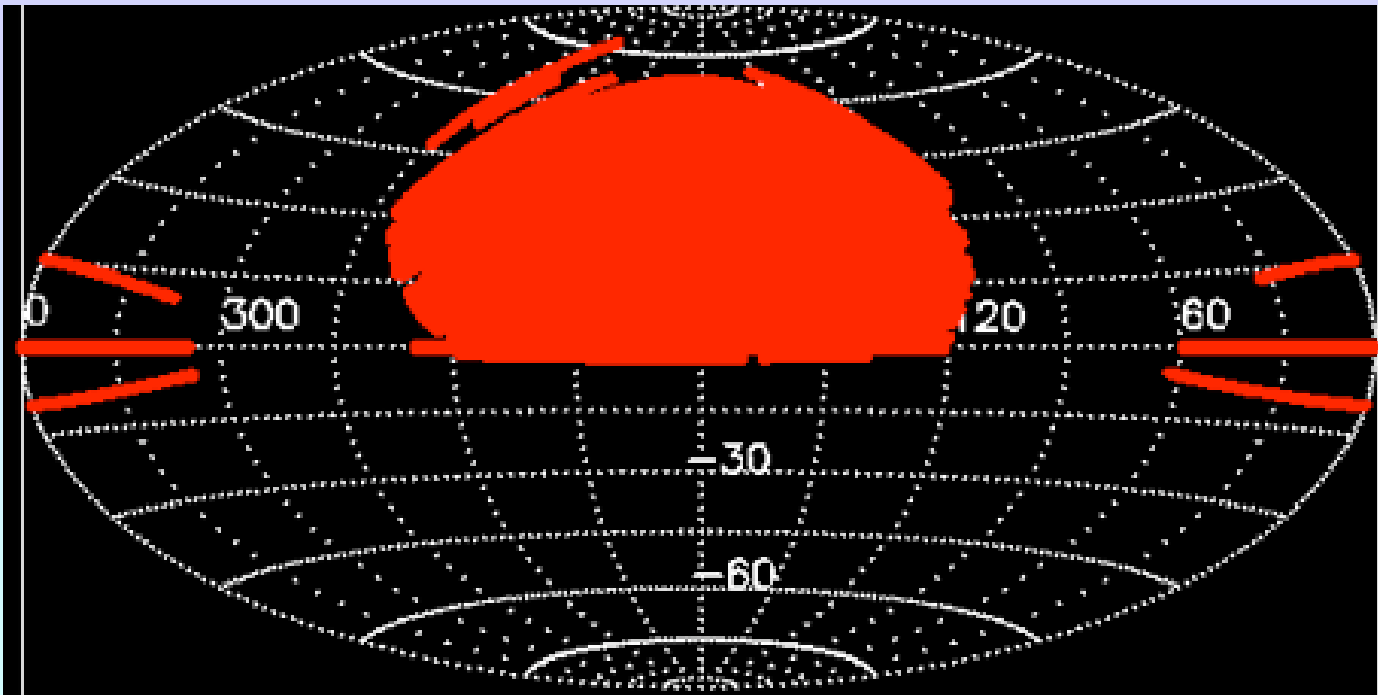
- 2 Dual-beam spectrographs (red & blue cameras)
- 320 fibres per spectrograph, hand plugged
- Wavelength range 3900-9100 Å
- Resolution $\lambda/d\lambda = 2000$
- Total throughput 20% in blue, 25% in red



SDSS spectroscopic samples

- Main galaxy sample
 - Flux-limited
 - 900,000 galaxies to $r = 17.77$
- Luminous red galaxies (LRGs)
 - Approx volume limited to $z = 0.4$
 - 100,000 galaxies selected by colour and photo- z to $r \sim 19.5$.
- Quasars - 100,000 selected by colour/radio
- Stars & Serendipity

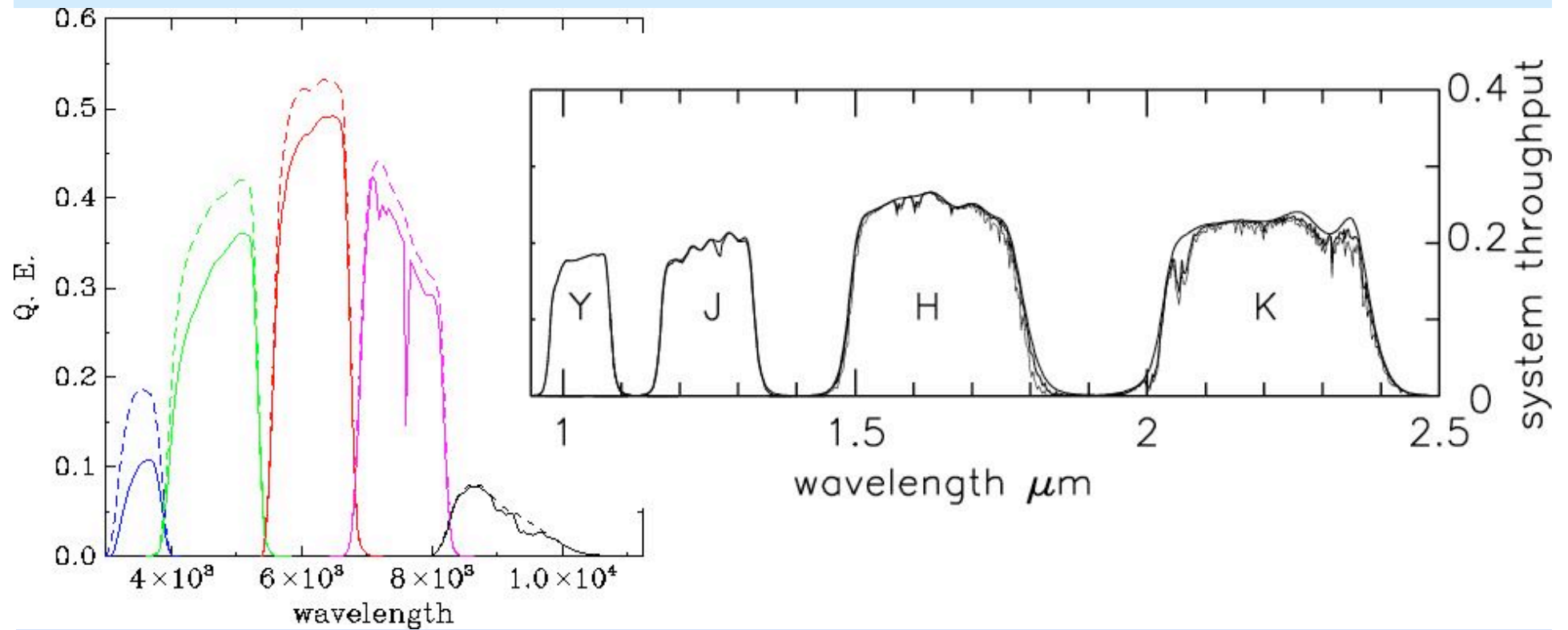









United Kingdom Infrared Deep Sky Survey (UKIDSS)

- UKIRT 3.8m telescope plus WFCAM (4x2048² Hawaii-II arrays, 0.21 deg²)
- Etendue of 2.38 m² deg² largest of any IR camera until VISTA
- Imaging 2700 deg² of northern sky
- *zYJHK* filters (0.9-2.5 μm)
- 5 surveys, 3 extragalactic
- Significantly deeper than 2MASS
- 2005-2012
- Data available to ESO community immediately; everyone after 18 months

UKIDSS filters



UKIDSS surveys

	Large Area Survey (LAS)	4000 sq. degs	K=18.4	extraGalactic
	Galactic Plane Survey (GPS)	1800 sq. degs	K=19.0	Galactic
	Galactic Clusters Survey (GCS)	1400 sq. degs	K=18.7	Galactic
	Deep Extragalactic Survey (DXS)	35 sq. degs	K=21.0	extraGalactic
	Ultra Deep Survey (UDS)	0.77 sq. degs	K=23.0	extraGalactic

