A Near-Infrared View of Galaxies & Quasars with the 2 Micron All Sky Survey

Stony Brook Open Night
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Outline

- Part 1 - 2MASS survey (general details)
- Part 2 - 2MASS Quasars
“Normal” massive galaxy types – elliptical & spiral galaxies

- Bulge of old stars
- Large black hole
- Very little gas & dust

- Bulge of old stars + large black hole
- Disk of young stars & gas
## Wavelengths

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>Wavelength</th>
<th>Peak Emission for</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV to Blue</td>
<td>&lt;0.4 µm</td>
<td>Hot, Luminous Stars, Quasars</td>
</tr>
<tr>
<td>Optical</td>
<td>0.55 µm</td>
<td>Sun</td>
</tr>
<tr>
<td>Near-Infrared</td>
<td>1.6 µm</td>
<td>Cool, less-luminous Stars</td>
</tr>
<tr>
<td>Mid-Infrared</td>
<td>10 µm</td>
<td>300 Kelvin dust, humans</td>
</tr>
<tr>
<td>Far-Infrared</td>
<td>60-100 µm</td>
<td>~30 Kelvin dust</td>
</tr>
</tbody>
</table>
The benefits of the near-infrared

- Tracing low luminosity stars
  - these stars emit most of their light at 1.6µm
  - Most of the luminous mass in the galaxy is contained within these stars
The benefits of the near-infrared

- Near-infrared light is less affected by dust extinction than visible light.
- E.g., if the visible light from a source has been diminished by a factor of 10, the 2.2µm light is only diminished by 1.3.
The benefits of all sky surveys

- Completeness (all objects down to a particular brightness)
- Photometry
- Interesting and sometimes unexpected classes of objects are found
2MASS: Scientific Objectives

- Milky Way galaxy in light less extinguished by dust
- Mass distribution of luminous objects
- Galaxies with $2.2\mu m < 14$ magnitudes
- Low luminosity cool stars
- Heavily dust-enshrouded Quasars
2MASS Survey

- Two automated telescopes
- All Sky at 1.25, 1.6, and 2.2µm simultaneously
- 256x256 Infrared optimized array with 2” pixel scale
- Scans = 1’ per second, 1.3 second exposures taken per field with a secondary mirror tilted opposite the scan direction. Total integration time per field = 7.8 sec.

~ 1 billion point sources
~ 1.5 million extended sources
Northern & Southern Hemisphere Survey Telescopes

- Mt. Hopkins, Arizona (start date = June 1997)
- Cerro Tololo Inter-American Observatory, Chile (start date = March 1998)
The camera contained a beam splitter so that 1.25, 1.6, & 2.2µm data could be taken simultaneously.
Optical vs. Near-Infrared: (1) The Milky Way Galaxy

- Extinction by Dust is less of an issue at near-infrared wavelengths
Optical vs. Near-Infrared: (2) NGC 253

The Near-Infrared Local Universe

Courtesy: T. Jarrett
Optical: Patchy Spiral Disk

Near-infrared: Barred Spiral Arms

The barred spiral starburst galaxy NGC 253
Nearby Galaxies with 2MASS
Part 2: Disk Galaxy Mergers & the Evolution of Quasars

Disk Galaxy Mergers

Do these galaxies evolved into Quasars??
The Dust-Enshrouded Quasar Model

Progenitors

Merger phase
- Gas compression
- Star formation
- Black hole fueling/building

2MASS Quasars??

Quasar phase

Elliptical

100 million years

Time

1 billion years
2MASS Quasars: Questions to Address

- Are there a significant population of red, 2MASS Quasars?
- Are the host galaxies of these 2MASS quasars consistent with them being created by mergers?

(Marble et al. 2003)
Two technical issues...

(1) Subtraction of bright quasar nucleus

(2) Fits to brightness profile of the host galaxy (i.e., spiral galaxy vs. elliptical galaxy)
Hubble Space Telescope Images of 2MASS Quasars

- Many appear to be mergers…
Hubble Space Telescope Images of 2MASS Quasars

- But many appear to be spiral and elliptical galaxies as well.
- I.e., like Optically-selected Quasars, the morphologies appear to be diverse.
What we’ve learned thus far from 2MASS Quasar studies

- A lot of Quasars have been missed by optical surveys
- The success of finding 2MASS Quasars likely means that many more reddened quasars will be found with the Spitzer (Infrared) Telescope
- The morphologies are as diverse as optical QSO host galaxies. I.e., some, but not all, 2MASS quasars result from mergers
Thanks to…

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