The Point Source
Properties of Nearby
Spiral Galaxies

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SPIRALS SURVEY

- 11 spiral galaxies
  - nearby ( < 15 Mpc)
  - spanning Hubble sequence (S0 through Sd), hence a wide range of SFR
  - low inclination (i < 30°)
  - low nH (< 10^{21} cm^-2)
  - at least 2 observations per galaxy to study variability
  - completeness limit of ~ 10^{36} erg/s

<table>
<thead>
<tr>
<th>Galaxy</th>
<th>Type</th>
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<tbody>
<tr>
<td>NGC 278</td>
<td>Sb</td>
</tr>
<tr>
<td>M74 (NGC 628)</td>
<td>Sc</td>
</tr>
<tr>
<td>NGC 1291</td>
<td>S0/a</td>
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<tr>
<td>NGC 2681</td>
<td>S0/a</td>
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<tr>
<td>NGC 3184</td>
<td>Scd</td>
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<tr>
<td>NGC 4314</td>
<td>SaB</td>
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<tr>
<td>M94 (NGC 4736)</td>
<td>Sab</td>
</tr>
<tr>
<td>M51 (NGC 5194/95)</td>
<td>Sbc/interacting</td>
</tr>
<tr>
<td>M83 (NGC 5236)</td>
<td>Sc(B)</td>
</tr>
<tr>
<td>M101 (NGC 5457)</td>
<td>Scd</td>
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<tr>
<td>IC 5332</td>
<td>Sd</td>
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</table>
Science Topics

- Discrete Source Luminosity Functions
- Source spectra, colors, and variability
- Source environments
- Multi-wavelength counterparts

Star Formation
Survey Statistics

- 869.6 ksec of Chandra data (good-time)
- 919 point sources within D_{25} ellipses (plus hundreds of serendipitous sources)
  - counts (soft, med, hard, total)
  - hardness ratios
  - fluxes and luminosities
  - variability info
  - spectral fits (if enough counts)
  - identified optical/radio counterparts
  - initial source classifications
- \sim 19 ultra-luminous X-ray sources (L_X > 10^{39} \text{ erg/s})
- other unique sources
M101
IC 5332
Discrete source luminosity functions

(see Kilgard et al., 2002 ApJ, 573, 138)

LF slopes of starburst galaxies are flatter than those of normal spirals
Model cumulative luminosity functions

- Young stellar populations have flatter LFs above $2 \times 10^{37}$ erg/s
- High energy cutoff $>10^{39}$ erg/s

Simulating star formation

See Poster 12-18, K. Wu et al.
Survey Luminosity Functions

galaxies with high SFR have slightly flatter LF slopes than do both disk- and bulge-dominated galaxies
Colors


Graph showing the relationship between soft color and hard color, with various sources and their characteristics labeled. Absorbed sources show power law + increasing absorption with increasing hardness. Blue curves rising vertically show power law. XRBs, photon index 0.7. Thermal SNR, photon index 3.0. Super-soft sources at hνc = 0. Background sources, increasing hardness.
Luminosity functions by color

Source Type LFs

Luminosity [erg/s]

N(>L)

old population

young population
short-term variability

NGC 1291: ../n1291/6S3.4.6.dat (500 sec. bins)

CXOU J031736.8-410901
lightcurves of the ULX M74 X-1

M. Krauss et al.
optical counterparts
optical counterparts
Environments
Conclusions

- X-ray LFs of individual galaxies are correlated with SFR of those galaxies

- Point source classification from colors and variability:
  - may allow insights into SF history of the local universe
  - uncovers unique sources that allow us to perform "Galactic" astronomy beyond the Local Group

- Work is continuing...