Nearby Galaxies and Stellar Populations

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Outline

• The key questions
• Multi-Great-Observatory science
• Other Legacy/Treasury/Large Project science
• Discussion
Questions and Boundary Conditions

• What are the 3 most important (and least understood) scientific issues within your subject area, and how can we best address them with the Great Observatories?
  - consider GALEX, FUSE, XMM, VLA/ACTA, 8-10m’s, SDSS too
• What important scientific issues would profit most from multi-band observations?
• What major future projects are likely to require substantial preparatory observations now?
  - consider leveraging of archival resources too
• What are the top 3 science priorities in your area?
Some Key Questions
(cf. European Strategic Surveys)

- What is the cycling of stars, gas, and dust in galaxies?
- What is the chemical history of the Universe?
- How did the Milky Way form?
- What is the role of black holes in galaxy formation?
- Is the initial mass function of stars universal?
The Big Questions: Independent Paths to Understanding Galaxy Formation/Evolution
CXO/HST/Spitzer Science

• Starbursts
  - star formation, winds, feedback
  - extreme starbursts as galaxy formation laboratories

• Centers of galaxies
  - the SF/AGN connection
  - dynamical connections to host galaxies and black holes

• Galaxy clusters: cycling of baryons, energy

• Populations of massive compact objects in galaxies
Starbursts

- triggering, regulation of SF, bursts
- feedback and galactic winds, superwinds, metal, dust ejection
- central starbursts: the AGN connection
- SF in extreme environments, IMF, abundances, etc
### The Starburst Bestiary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEHRs</td>
<td>nuclear starbursts</td>
</tr>
<tr>
<td>SSCs</td>
<td>circumnuclear starbursts</td>
</tr>
<tr>
<td>HII galaxies</td>
<td>clumpy irregular galaxies</td>
</tr>
<tr>
<td>ELGs</td>
<td>Ly-α galaxies</td>
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<tr>
<td>CNELGs</td>
<td>E+A galaxies</td>
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<tr>
<td>W-R galaxies</td>
<td>K+A galaxies</td>
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<tr>
<td>BCGs</td>
<td>LBGs</td>
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<tr>
<td>BCDs</td>
<td>DRGs</td>
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<tr>
<td>LIGs, LIRGs</td>
<td>EROs</td>
</tr>
<tr>
<td>ULIGs, ULIRGs</td>
<td>SCUBA galaxies</td>
</tr>
<tr>
<td>LUVGs, UVLGs</td>
<td>extreme starbursts</td>
</tr>
</tbody>
</table>
Contributions to the global star formation budget

IR-luminous: ~5-8%
circumnuclear: ~3-4%
BCGs, ELGs: ~5-8%

Total fraction ~10-20%
Starbursts: Key Observations

• Coupling of wind properties to SFR, SF concentration, host galaxy properties—scaling laws for feedback?

• Triggering and Fueling
  - gas flows, timescales
  - role of interactions
  - regulation of SFR in extreme environments

• Evolution
  - transformation from dust embedded to UV-luminous phases
  - coupling of central starburst vs AGN activities

• Clustering of star formation

• IMF in starbursts
Spitzer Legacy, Large Projects

- SINGS (UV → radio for 75 galaxies)
- SAGE (LMC) + SMC survey
- QUEST (quasars, ULIRGs)
- ULIRG spectra (Armus et al)
- SSGSS (Sloan, GALEX, Spitzer)

HST Legacy, Large Projects

- $H_0$ Key Project (distances, stellar/cluster pops)
- Nuker survey (centers, black holes)
- ACS Virgo cluster survey
- M31 halo surveys
- UV spectra of clusters, galaxies nuclear
- ACS Nearby Galaxy Survey Treasury (ANGST)
UV --> FIR SED Maps of Galaxies

[Diagram showing UV and FIR SED maps for different galaxies, with data on dust mass and oxygen abundance.]
ACS Nearby Galaxy Survey Treasury (ANGST)

- Recover SFH of Local Volume
- Provide Rich General Purpose Archive

- 295 Orbits
- 45 New Galaxies + 14 Archival
- Volume limited sample (|b|>20, D<3.5Mpc, cone out to M81 & Sculptor)
- Captures 99% of Past & Current SF
- 3 Filters for all galaxies with $M_B<-13.5$
ACS Nearby Galaxy Survey Treasury (ANGST)

1. Galaxies tiled in 3 filters
2. Volume limited sample of galaxies out to ~4Mpc
3. 1 deep field to reach below HB
4. 295 Orbits (cut from 552)
A tiny fraction of this short ACS snapshot!
>250,000 stars in a single ACS snapshot

NGC 55

Old
(~10^{10} yrs)

Intermediate
(~10^{9} yrs)

Young
(~10^{8} yrs)
The HI Nearby Galaxy Survey (THINGS)
F. Walter, E. Brinks, E. de Blok, F. Bigiel, M. Thornley, R. Kennicutt
The Circinus Galaxy
(Jones, Koribalski, Elmouttie & Haynes 1999)

D = 4.2 Mpc
HI extent > 70 kpc
$M_{\text{HI}} = 8 \times 10^9 \, M_\odot$
11 Mpc Hα/Ultraviolet Survey (11HUGS)
Distribution of Specific SFRs
M83 = NGC 5236 (Sc)

SINGG: Survey for Ionization in Neutral-Gas Galaxies
GALEX/Spitzer Synergies
Specific SFR vs Circular Velocity

J. Lee, PhD thesis
Parting Thoughts

- Local galaxies hold keys provide detailed fossil reconstructions of the assemblies of gas, spheroids, disks, heavy elements, and central black holes, and in revealing the physical processes driving these assemblies.

- The Great Observatories can make major strides toward understanding the “gastrophysical” processes that trigger and regulate star formation in galaxies (esp. starbursts), and characterizing the local inventory of galaxies and their constituent stellar/cluster populations.