Local Benchmarks of IR Galaxy Evolution
The SWIRE-SDSS Far-Infrared Local Luminosity Function & VO Tools

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About 50% of 0.1-1000 µm Extragalactic Background Light is emitted in the infrared & sub-millimeter by discrete sources at cosmological distances. A full understanding of galaxy formation and evolution processes requires resolving the CIRB into its constituent sources at different wavelengths.

ISO ('95-'98)  Spitzer ('03-'09)  ...  Herschel ('09-'13)

The Era of Infrared Space Observatories

ISO : \( z \approx 1 \)

Spitzer: \( z \approx 3 \)

Lagache+ 05
Stellar Mass Build-Up & (Dust-Enshrouded) Star Formation History Studies at high-z

**IRAC** (Infrared Array Camera)
3.6 / 4.5 / 5.8 / 8.0 µm
Stellar Mass up to z~4/6

**MIPS** (Multiband Imaging Photometer for Spitzer)
24 / 70 / 160 µm
Star Formation Processes affected by strong dust extinction up to z~2/3
The IR Luminosity (SFR) Density

IRAS

ISO

Spitzer

Pérez-Gonzáles et al. (2005)

Caputi et al. (2007)

Pre- and non-Spitzer data

Total: Reddy et al. (2008)

Total: Le Floc’h et al. (2005)

LIRG: Le Floc’h et al. (2005)

ULIRG: Le Floc’h et al. (2005)

LIRG: Reddy et al. (2008)

Soifer+ 2008

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SWIRE-SDSS MIPS LLFs
IR Surveys: Shallow to Deep

Spitzer GOODS-N 24 micron Survey (~0.04 deg²)

2MASS 2.2 micron All-Sky Survey (~40000 deg²)
Large Area Surveys

SDSS (DR6) ( ~10000 deg² )

LOCKMAN

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The Panchromatic Lockman Hole

- **Red**: SWIRE FIR (MIPS)
- **Orange**: SWIRE MIR (IRAC)
- **Cyan**: UV (GALEX)

SDSS & SWIRE Miscellaneous
Optical Phot & Spec

2MASS & UKIDSS

SCUBA

...
1. \( \text{IRAC1234+MIPS1+MIPS2+MIPS3} = \text{IRAC1234&MIPS123} \)

2. \( \text{IRAC1234&MIPS123} + \) Additional Optical/NIR Surveys

SNR criteria embedded in single-band catalogs

Flux Selection

\[
S_{24} > 500 \, \mu\text{Jy} \\
\text{or} \\
S_{24} > 300 \, \mu\text{Jy} \quad \& \quad (S_{70} > 15 \, \text{mJy} \quad \text{or} \quad S_{160} > 75 \, \text{mJy})
\]

Positionally Associated With

SDSS DR6 (PhotoObj + SpecObj + Photoz + Photoz2)

MIPS1-LLF     MIPS2-LLF     MIPS3-LLF
Star-Galaxy Separation

Rowan-Robinson+ 05

All IRAC1 sources

S24 > 1 mJy

Source diagnostic power of multi-band info

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SWIRE-SDSS MIPS LLFs
Data Quality Control
Redshift Distribution

Before

After

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SWIRE-SDSS MIPS LLFs
Low-luminosity bump

$S_{24} > 1 \text{ mJy}$

Good agreement with AF08 model

Better sampling with respect to Marleau+ 07

- Shupe+ 98
- Marleau+ 07
- Rodighiero+ (in prep)
$S_{70} > 15/25 \text{ mJy}$

Low-Luminosity Bump

Underestimate

- Saunders+ '90
- Takeuchi+ 03
Completeness of SWIRE catalogue

$S_{160} > 75/125$ mJy

Low-Luminosity Bump

Good agreement with AF08 model

$\Delta$ Takeuchi+ 06
The homogeneity, quality, well-characterized limits as well as the sheer size of the SWIRE-SDSS database allow a relatively straightforward estimate of the FIR Local Luminosity Function down to flux levels order(s) of magnitude fainter than IRAS (albeit over a smaller area).

Ample opportunity to extend such a study:
- SWIRE EN1 & EN2 fields
- Higher redshift (0.25 < z < 0.5)
- New spectroscopic observations of complete samples
- Herschel observations of same fields at 100-500 µm
3 nights of AF2+WYFFOS@WHT
PI : Dave Clements (ICL)
Observed Nov 2008
~600 70 micron sources
2 nights of AF2+WYFFOS@WHT
PI : Antonio Cava (IAC)
Approved Nov 2008
~600 160 micron sources
Mattia's Herschel Survey of Surveys
http://www.mattiavaccari.net/sos/herschel
SWIRE-SDSS Workflow

- Download Input Catalogs: SDSS (Pub), IRSA (Pub), IRSA (SWIRE), SSC (Pub), WSA (ESO)
- Source Identification: based on position and flux matching, e.g. Nearest-Neighbor or Likelihood Ratio
- Quality Control: based on several SWIRE & SDSS flags
- Source Characterization: Star/Galaxy
- Phot-z calculation following an optimized procedure (TBD skipped so far in favor of SDSS phot-z)
- Completeness & Reliability Analysis of all previous steps
- Finally: Ad Hoc Science Analysis (e.g. $1/V_{\text{max}}$)
Challenges for the VO

- Seamless access to public as well as proprietary databases
- User-friendly GUIs and recipes to get newbies started
- Straightforward CLI using a flexible scripting language allowing personalization for advanced users
- Easy integration of algorithms coded in “any” language
- Documentation, Integration and Organization of Resources
- PR effort within the community (and particularly students)
An extremely versatile set of VO tools has been made available to astronomers over the last few years. Some consolidation is probably still in order to reach out to the widest audience.

**Unified Access Point?**

**Resource Directory?**

**Good Documentation?**

**Well-Heeled Helpdesk?**

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Thanks!

“Don't clap too loudly - it's a very old world”
Tom Stoppard, Rosencrantz and Guildenstern are dead

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