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Bridging the Gap: From UV/IR to Radio via SED Modeling of Infrared Bright Galaxies
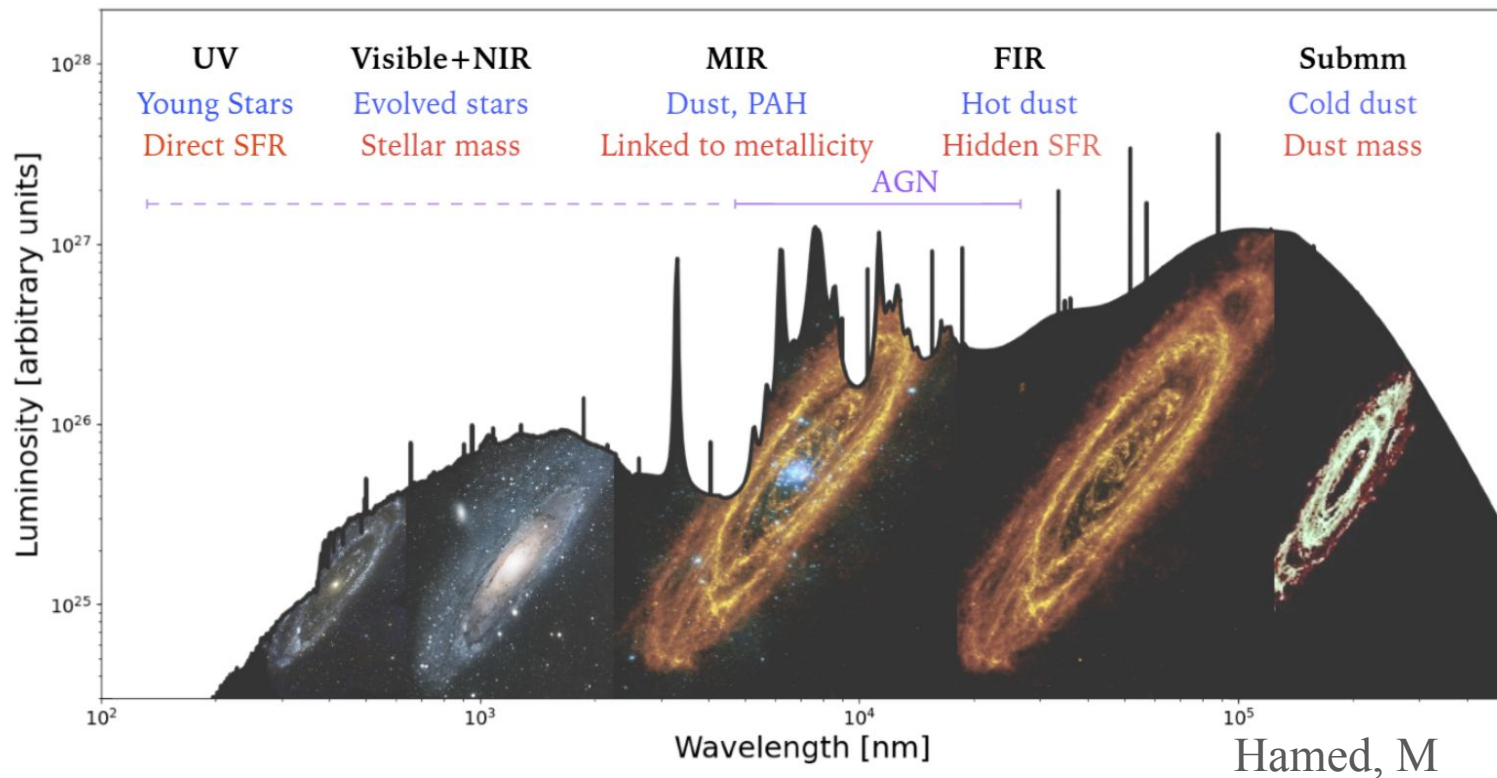
Subhrata Dey[1] , Arti Goyal[1], Katarzyna Małek[2], Tanio Diaz Santos[3]

Astronomical Observatory of the Jagiellonian University, Krakow, Poland; [2]National Centre for Nuclear Research, Warsaw, Poland; [3]Institute of Astrophysics, Foundation for Research and Technology-Hellas, GR-71110, Heraklion, Greece
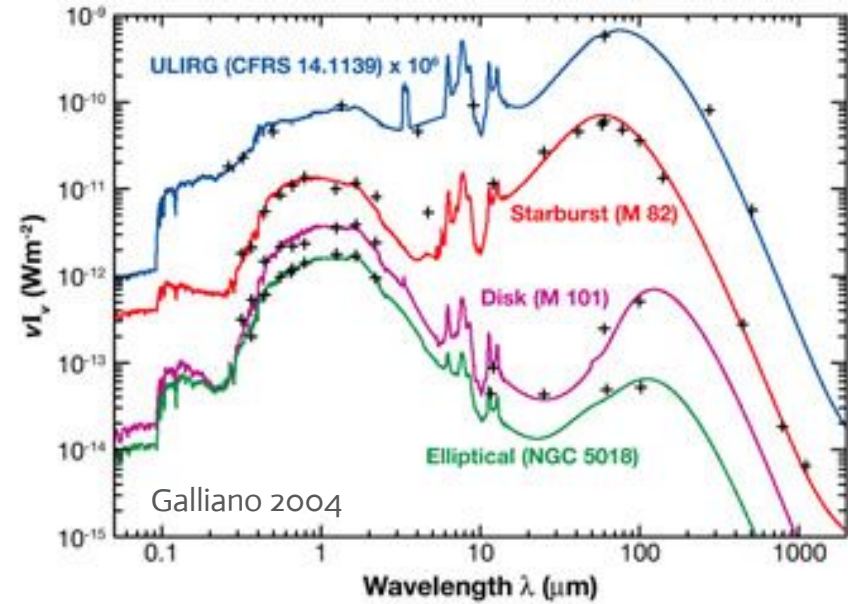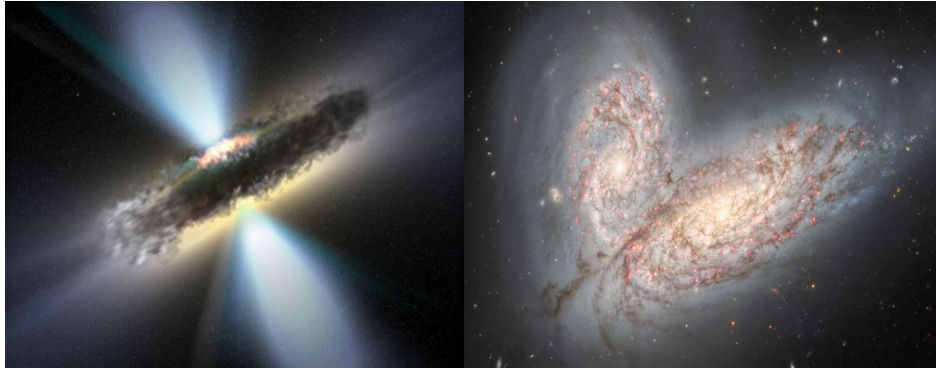
LOFAR

Lofar Family Meeting, 5th June, 2024

Hamed, M

Luminous Infrared Galaxies(**LIRGs**): $L_{IR[8-1000\mu m]}$ = 10^{11}-$10^{12}L_{\odot}$

Ultraluminous Infrared Galaxies (**ULIRGs**): $L_{IR[8-1000\mu m]}$ ≥ $10^{12}L_{\odot}$

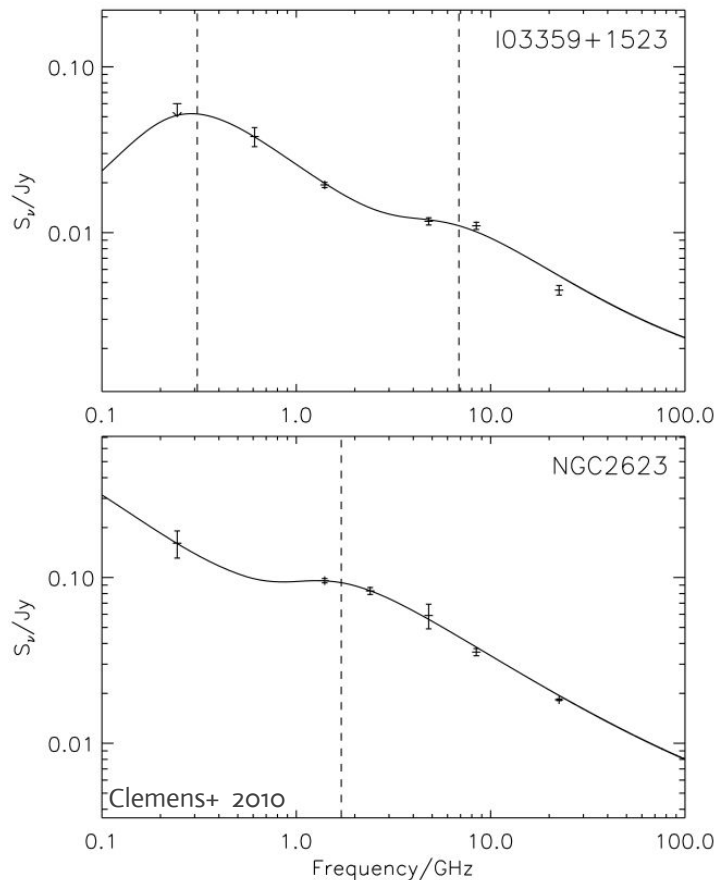What is Powering them???

Galliano 2004

- Synchrotron emission

$$S_\nu = A\left(\frac{\nu}{\nu_0}\right)^{\alpha}$$

- Synchrotron and Free-Free Emission

$$S_\nu = A\left(\frac{\nu}{\nu_0}\right)^{\alpha} + B\left(\frac{\nu}{\nu_0}\right)^{-0.1}$$

- Synchrotron and Free-Free Emission with Free-Free Absorption

$$S_\nu = (1 - e^{-\tau})\left[B + A\left(\frac{\nu}{\nu_{t,1}}\right)^{0.1+\alpha}\right]\left(\frac{\nu}{\nu_{t,1}}\right)^2$$

Radio SED modeling

- Synchrotron emission

$$S_\nu = A\left(\frac{\nu}{\nu_0}\right)^\alpha$$

- Synchrotron and Free-Free Emission

$$S_\nu = A\left(\frac{\nu}{\nu_0}\right)^\alpha + B\left(\frac{\nu}{\nu_0}\right)^{-0.1}$$
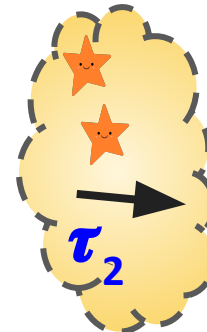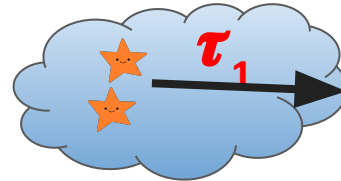
- Synchrotron and Free-Free Emission with Free-Free Absorption

$$S_\nu = (1 - e^{-\tau})\left[B + A\left(\frac{\nu}{\nu_{t,1}}\right)^{0.1+\alpha}\right]\left(\frac{\nu}{\nu_{t,1}}\right)^2$$

Multiple Component Models

- Different Orientation (optical depth) or Different e⁻ populations (spectral indices α)

$$S_\nu = (1 - e^{-\tau_1})\left[B + A\left(\frac{\nu}{\nu_{t,1}}\right)^{0.1+\alpha_1}\right]\left(\frac{\nu}{\nu_{t,1}}\right)^2 +$$

$$(1 - e^{-\tau_2})\left[D + C\left(\frac{\nu}{\nu_{t,2}}\right)^{0.1+\alpha_2}\right]\left(\frac{\nu}{\nu_{t,2}}\right)^2$$
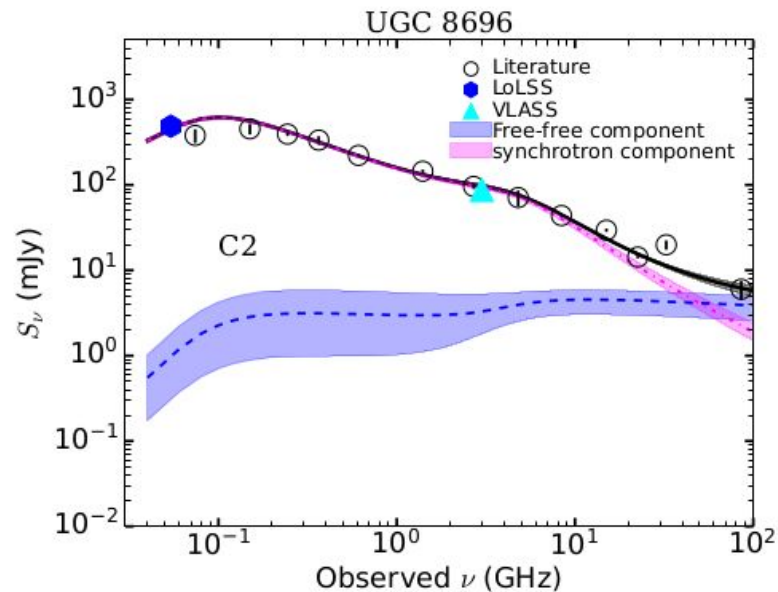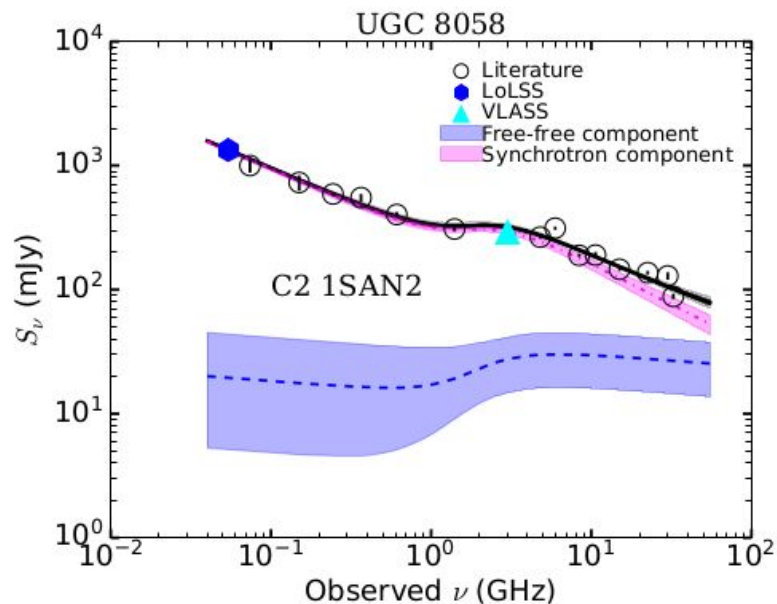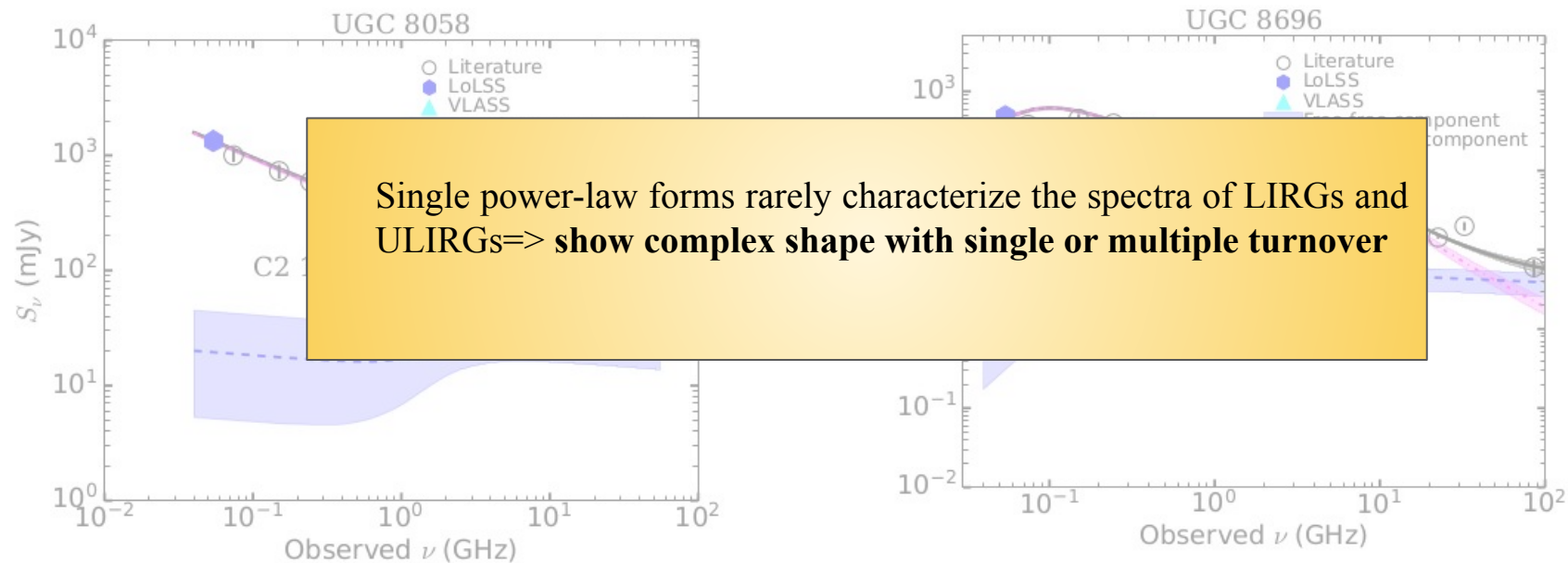
Multifrequency radio data (54 MHz to 33 GHz):
LOFAR, GLEAM, GMRT, WENSS, WISH, TEXAS sky survey,
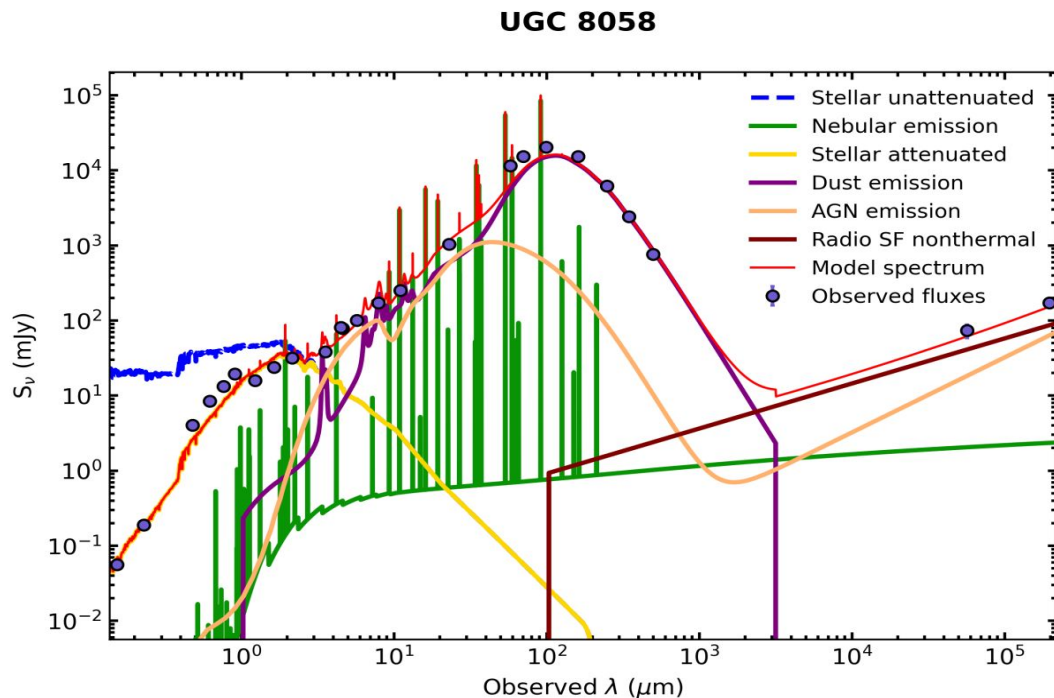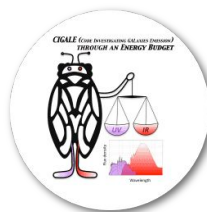Molonglo Reference Catalog, SUMSS, RACS, VLA

Ultranest Bayesian modeling

UGC 8058

UGC 8696

○ Literature
● LoLSS
▲ VLASS

S_ν (mJy)

C2

Observed ν (GHz)

Single power-law forms rarely characterize the spectra of LIRGs and ULIRGs=> **show complex shape with single or multiple turnover**

UV-IR SED modeling with radio extension

UGC 8058

Inclusion of radio data to UV-IR SED -> L_{dust} and SFR are estimated with **one-order magnitude better accuracies**

SFR calibration

Note: p ≤ 0.01, correlation significant

SFR$_{IR}$ vs SFR$_{1.4GHz}$

SFR$_{IR}$ vs SFR$_{4.8GHz}$