

The radial distribution of supernovae in nuclear starbursts

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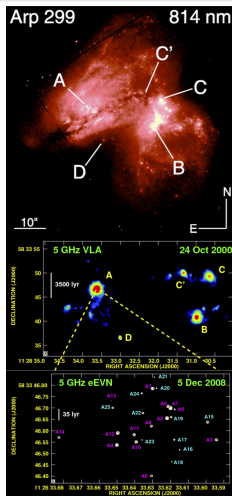
Introduction

LIRGs & ULIRGs



Introduction

LIRGs & ULIRGs



- (Ultra) Luminous Infrared Galaxies.
- IR luminosity:
 - LIRGs: $10^{11} L_{\odot} \leq L_{\text{IR}} < 10^{12} L_{\odot}$
 - ULIRGs: $L_{\text{IR}} \geq 10^{12} L_{\odot}$
- Dust emission.
- Mechanisms:
 - AGN.
 - Starburst \rightarrow **Supernovae.**
- Inflows: Loss of \vec{L} .
 - Reservoir? \rightarrow **Circumnuclear disks.**

(Neff et al., 2004, ApJ; Pérez-Torres et al., 2009, A&A)

Introduction

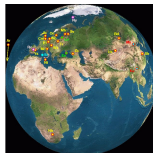
Aim

- Radial distribution of SNe in nuclear starbursts.
- Plenty of previous studies (optical range only!).
- Limitations:
 - Dust extinction.
 - Angular resolution.
 - Limited to galactic scales.

Introduction

Aim

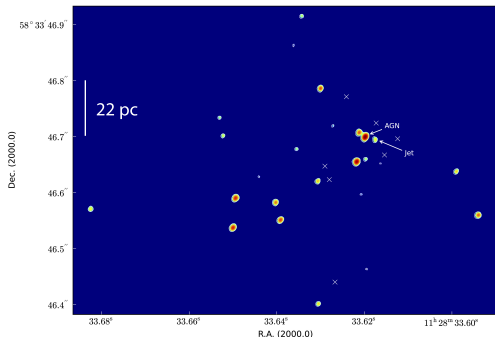
- Radial distribution of SNe in nuclear starbursts.
- Plenty of previous studies (optical range only!).
- Limitations:
 - Dust extinction.
 - Angular resolution.
 - Limited to galactic scales.
- Solution: **Radio-VLBI**.



Method

Samples

- Arp 299-A
 - LIRG at 44.8 Mpc.
 - 30 sources.
 - Confirmed AGN.
- Arp 220
 - ULIRG at 77 Mpc.
 - 48 sources.
 - Nuclei: emission peak.
- M82
 - Prototype starburst at 3.2 Mpc.
 - 39 sources.
 - Nucleus: Radio kinematical center.

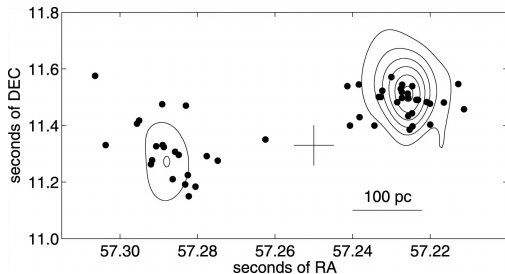


(Bondi, Pérez-Torres, Herrero-Illana,
Alberdi, 2012, A&A)

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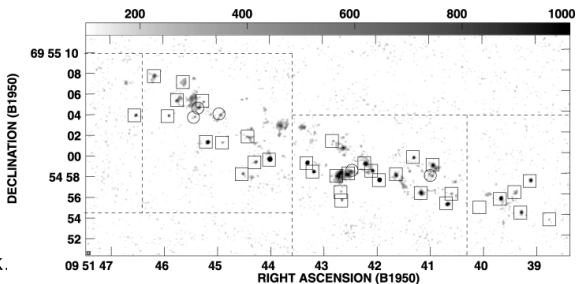


(Parra et al., 2007, ApJ)

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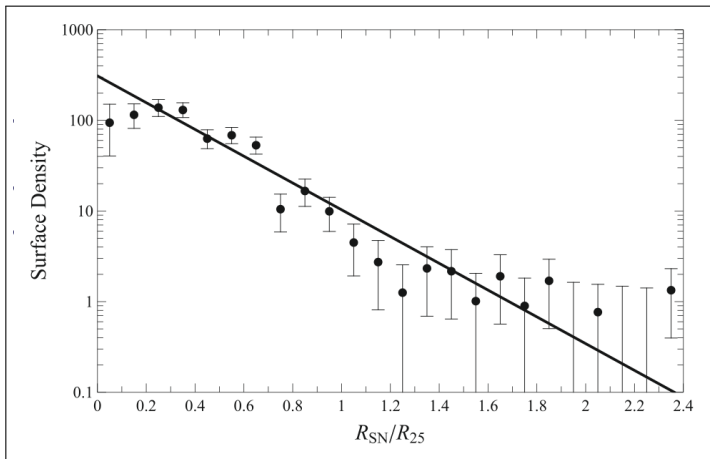
(McDonald et al., 2002, MNRAS)

Method

Fits

- Surface density in concentric rings $\left[\frac{n_{\text{SN}}}{\pi(r_{i+1}^2 - r_i^2)} \right]$.
- Few sources \rightarrow Poisson statistics.
- Non-linear fits:

$$\text{Freeman} \rightarrow \Sigma^{\text{SN}} = \Sigma_0^{\text{SN}} \exp(-r/h_{\text{SN}})$$

Method
Fits

Hakobyan et al., 2009, A&A

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Method

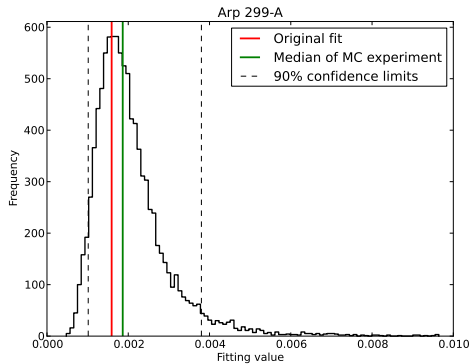
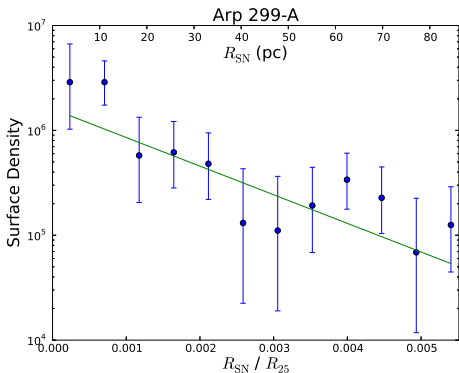
Fits

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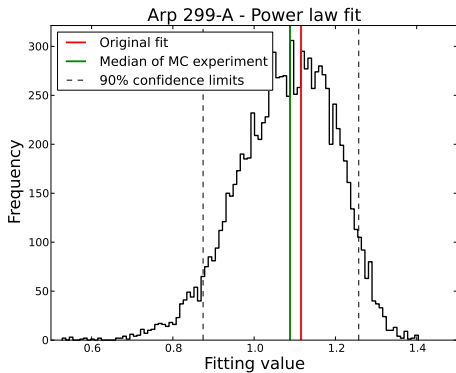
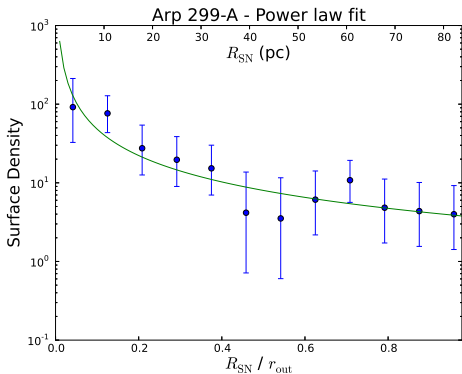
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Results



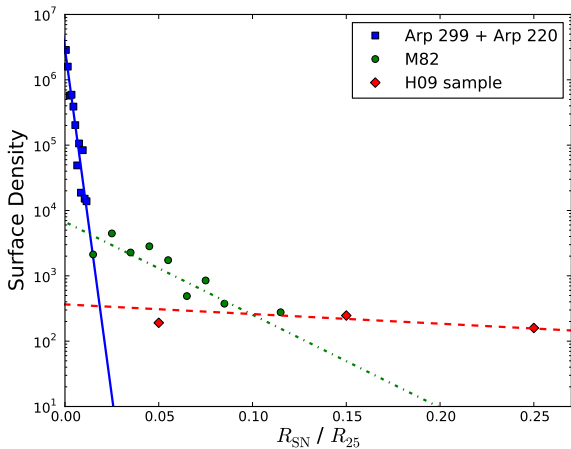
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Conclusions



(Herrero-Illana, Pérez-Torres, Alberdi, 2012, A&A)

Conclusions

Table: Fitting values.

Nucleus	$\tilde{h}_{\text{SN}}/10^{-3}$	h_{SN} (pc)	γ
Arp 299-A	$1.9^{+1.9}_{-0.8}$	$29.3^{+29.6}_{-13.7}$	$1.1^{+0.2}_{-0.2}$
Arp 220 East	$3.1^{+2.0}_{-0.9}$	$22.2^{+14.4}_{-6.2}$	$1.0^{+0.2}_{-0.3}$
Arp 220 West	$3.4^{+1.6}_{-1.5}$	$24.4^{+11.2}_{-10.8}$	$0.8^{+0.3}_{-0.2}$
Arp 220 E+W	$3.3^{+0.7}_{-0.9}$	$23.4^{+4.7}_{-6.6}$	$0.8^{+0.1}_{-0.2}$
Arp 299 + Arp 220	$2.0^{+0.3}_{-0.4}$	$20.9^{+2.6}_{-2.3}$	$0.9^{+0.1}_{-0.1}$
M82	$(2.8^{+0.9}_{-0.7}) \times 10^1$	$144.4^{+21.5}_{-17.5}$	-
H09 sample	$(2.9^{+0.2}_{-0.1}) \times 10^2$	-	-

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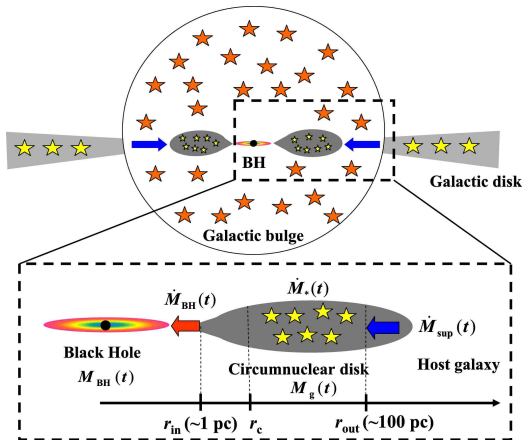
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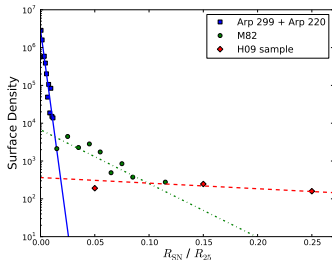
Introduction

LIRGs & ULIRGs



(Kawakatu & Wada 2008, A&A)

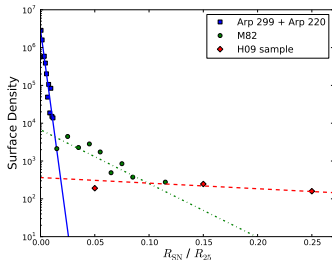
Conclusions



(Herrero-Illana, Pérez-Torres,
Alberdi, 2012, A&A)

- Global VS nuclear distribution.
- Circumnuclear disks:
 - Arp 299-A & Arp 220: 20 - 30 pc.
 - M82: \sim 140 pc.
- Power-law fit:
 - Supports theoretical models ($\gamma = 1$).
- EVN obs. \rightarrow 30 (U)LIRGs.
 - EVN - LIRGI.

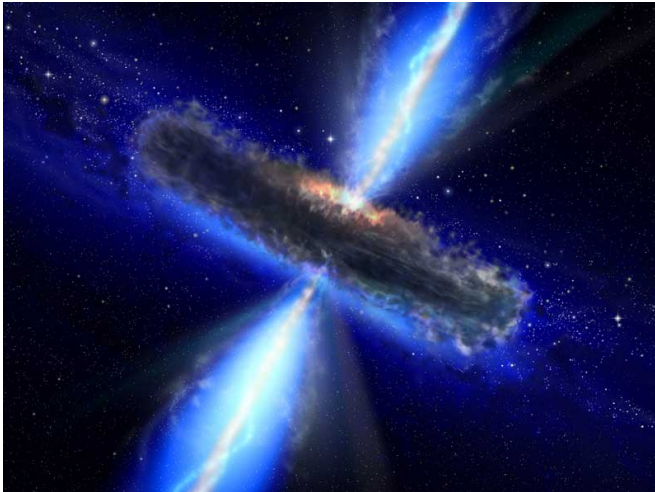
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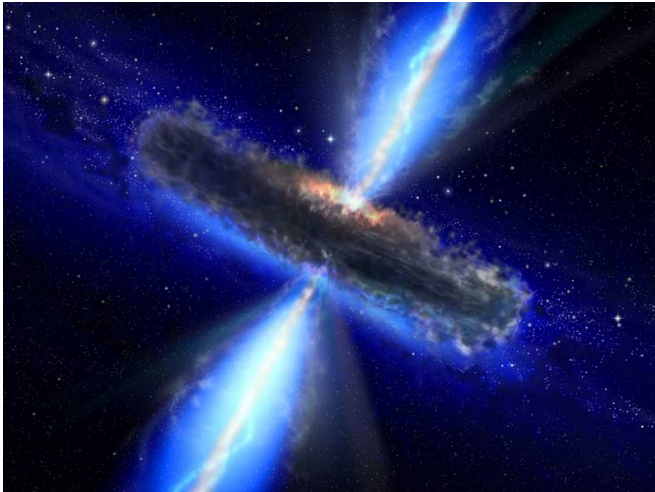


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- Global VS nuclear distribution.
- Circumnuclear disks:
 - Arp 299-A & Arp 220: 20 - 30 pc.
 - M82: ~ 140 pc.
- Power-law fit:
 - Supports theoretical models ($\gamma = 1$).
- EVN obs. \rightarrow 30 (U)LIRGs.
 - EVN - LIRGI.

General rule?





Thanks!

Extra material

▶ Arp 220

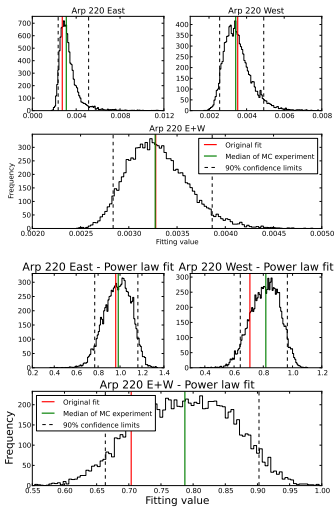
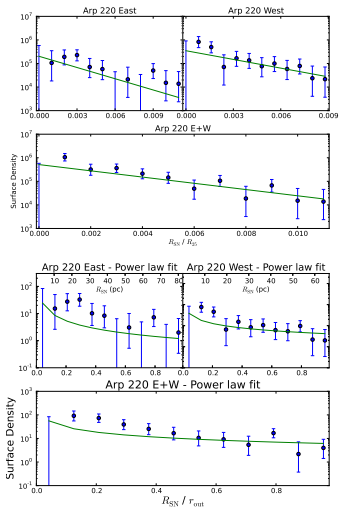
▶ Arp 299 + Arp 220

▶ M82

▶ Kawakatu model

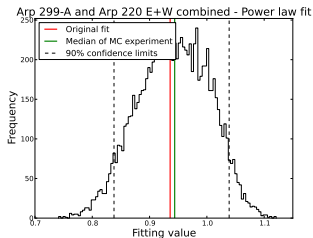
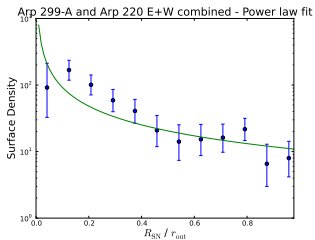
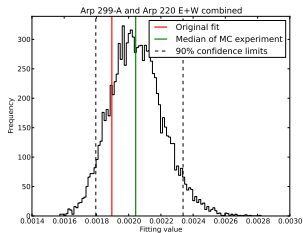
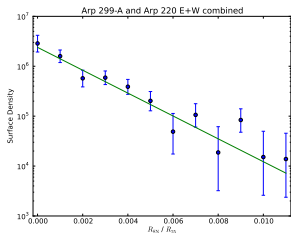
Results

Arp 220



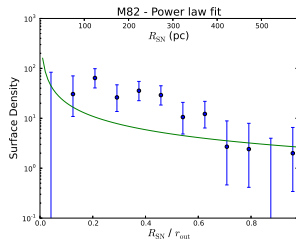
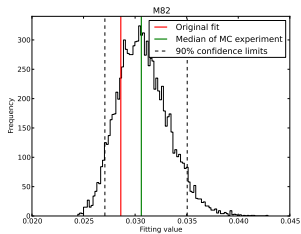
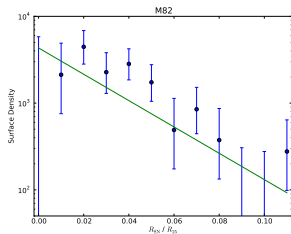
Results

Arp 299-A & Arp 220 combination



Results

M82



Extra material

Kawakatu model

