



# Triggered Massive Star Formation in W49

# A Model for extragalactic Starbursts?!



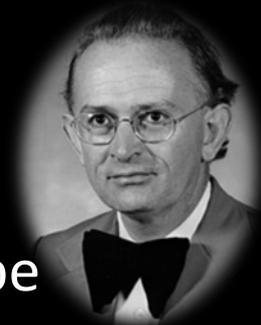
Bernhard Brandl  
Leiden Observatory

ESA-ESTEC,  
11 – 14 Nov 2014

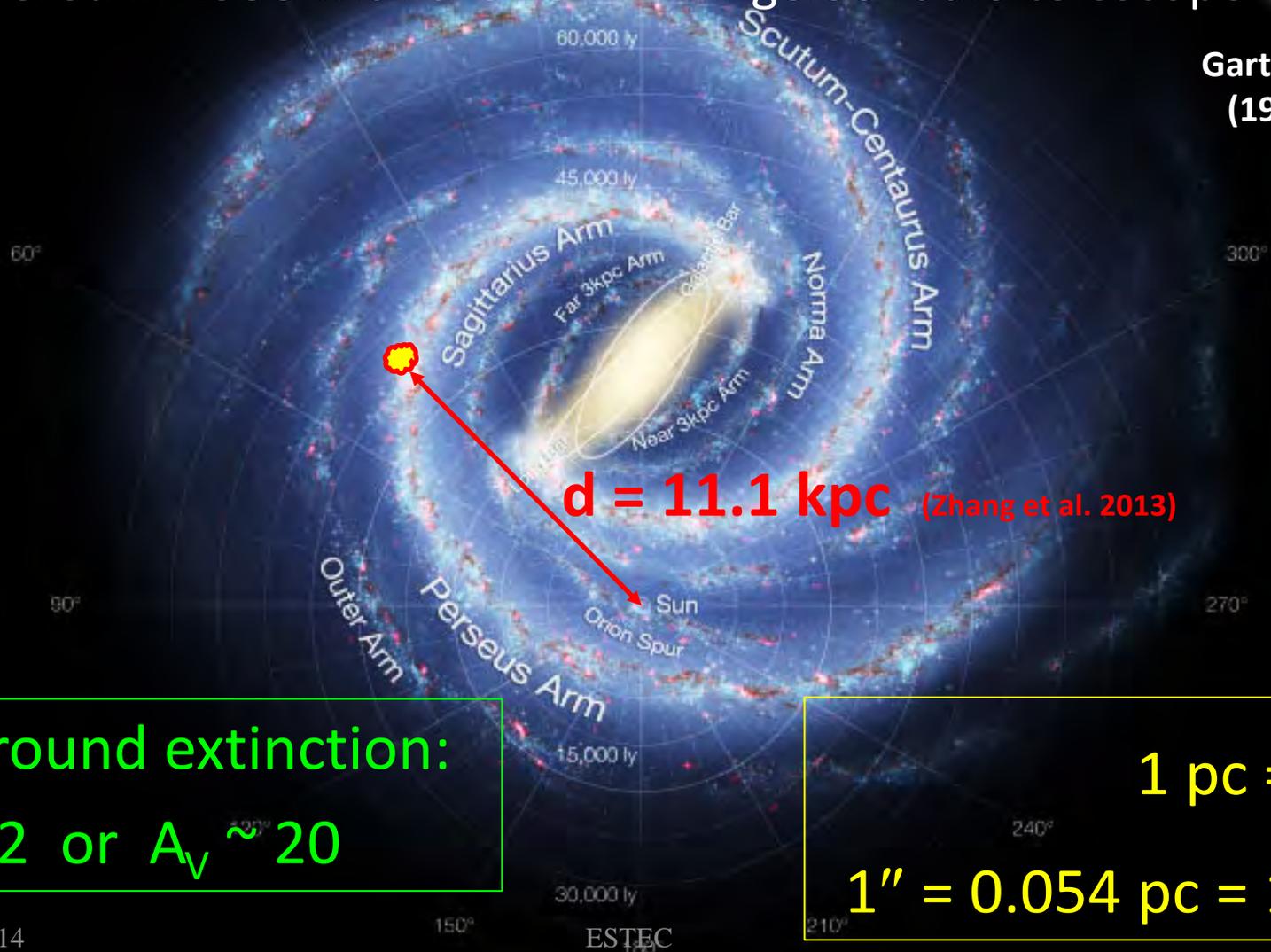
# What is W49 ?

Most luminous star forming region in the Milky Way

Discovered in 1958 with the 25m Dwingeloo radio telescope



Gert Westerhout  
(1927 – 2012)



Foreground extinction:

$A_K \sim 2.2$  or  $A_V \sim 20$

1 pc = 18.6"

1" = 0.054 pc = 11 kAU

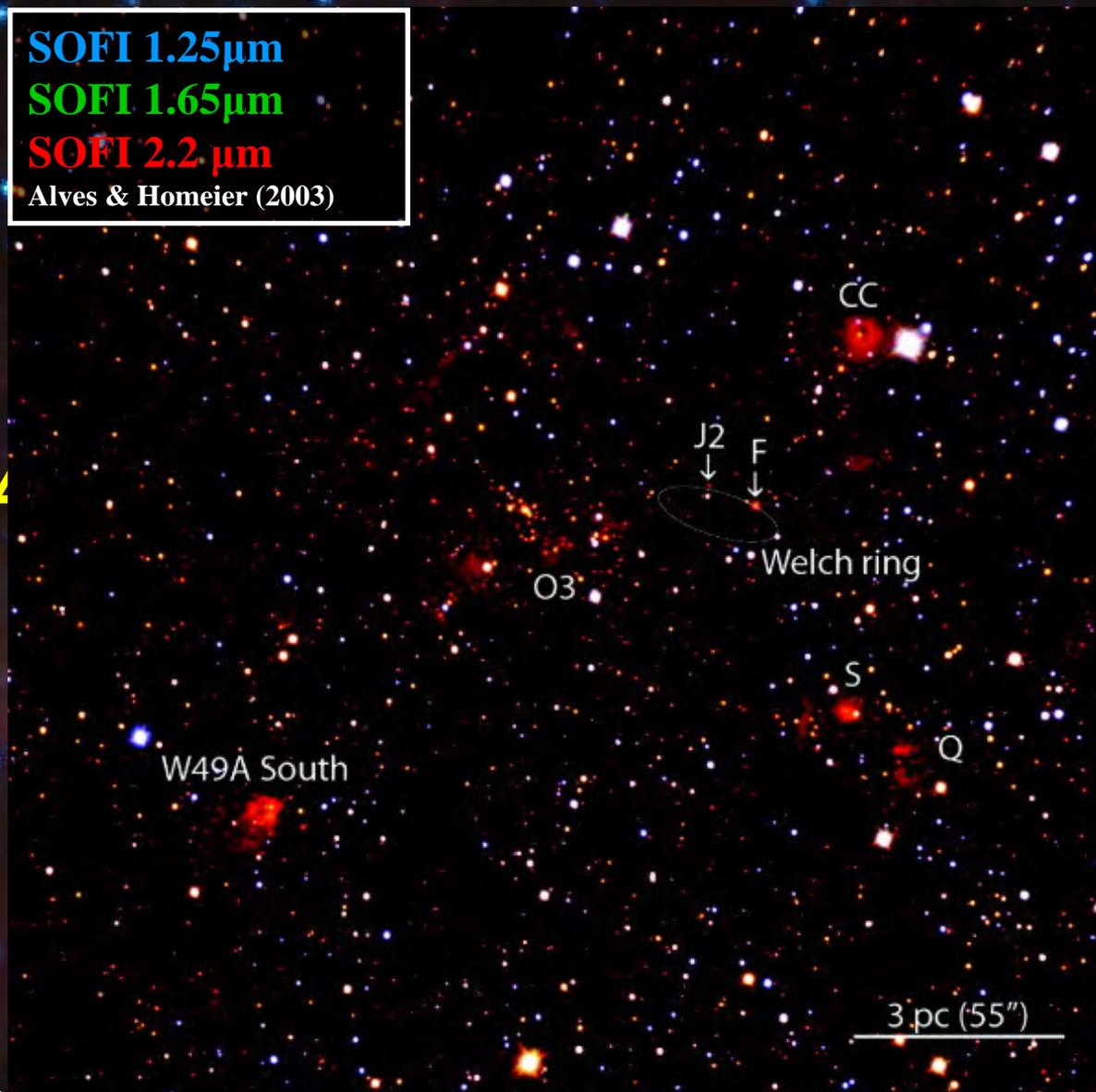


# W49 A

**SOFI 1.25  $\mu\text{m}$**   
**SOFI 1.65  $\mu\text{m}$**   
**SOFI 2.2  $\mu\text{m}$**   
Alves & Homeier (2003)

← W49

1'  $\updownarrow$   
3.3 pc

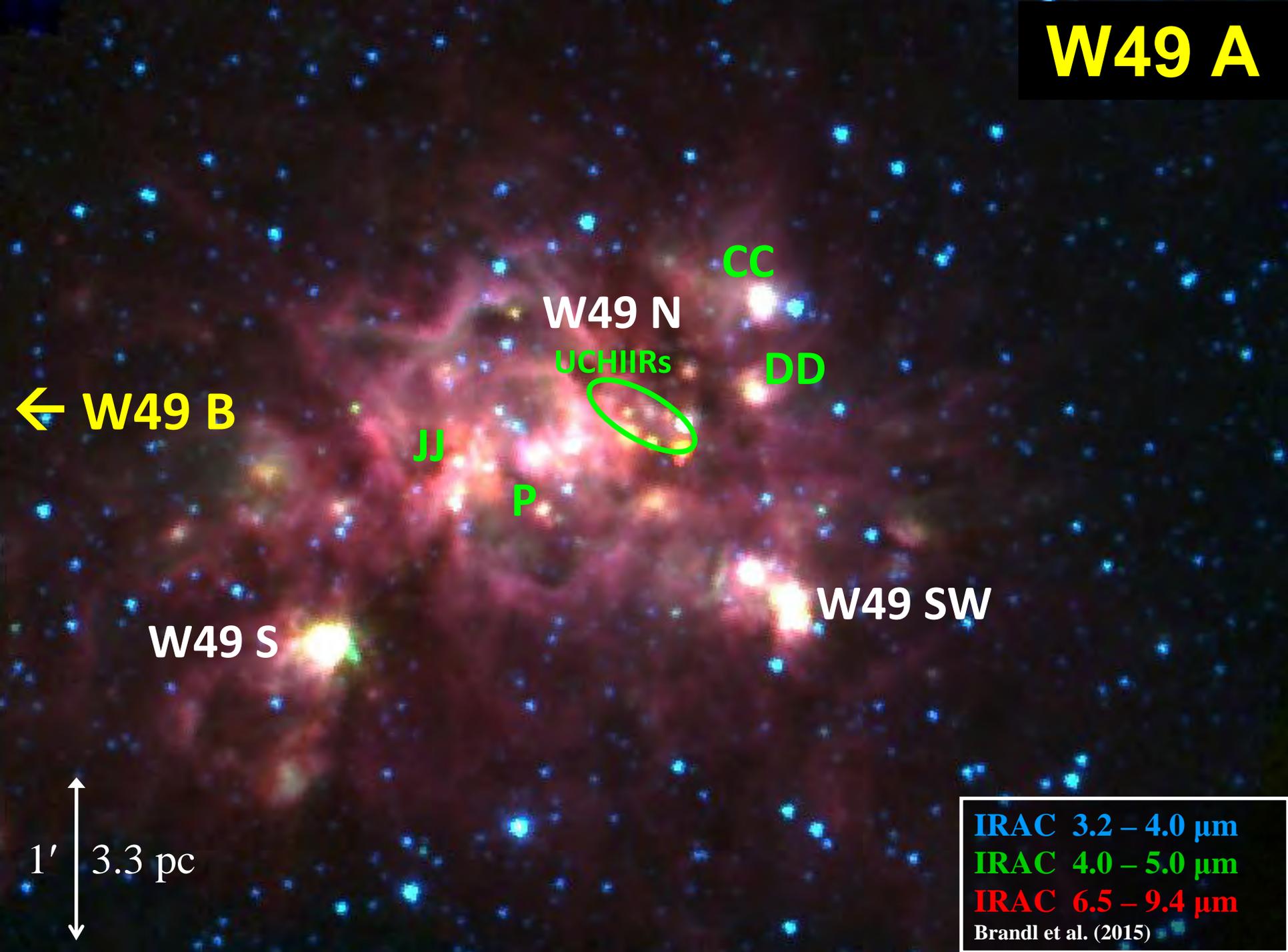


3 pc (55")

**IRAC 3.2 – 4.0  $\mu\text{m}$**   
**IRAC 4.0 – 5.0  $\mu\text{m}$**   
**IRAC 6.5 – 9.4  $\mu\text{m}$**   
Brandl et al. (2015)

SW

**W49 A**



**← W49 B**

**W49 N**

**CC**

**UCHIIRs**

**DD**

**JJ**

**P**

**W49 S**

**W49 SW**

1' 3.3 pc

**IRAC 3.2 – 4.0  $\mu\text{m}$**   
**IRAC 4.0 – 5.0  $\mu\text{m}$**   
**IRAC 6.5 – 9.4  $\mu\text{m}$**   
Brandl et al. (2015)



























# Dynamical Evolution

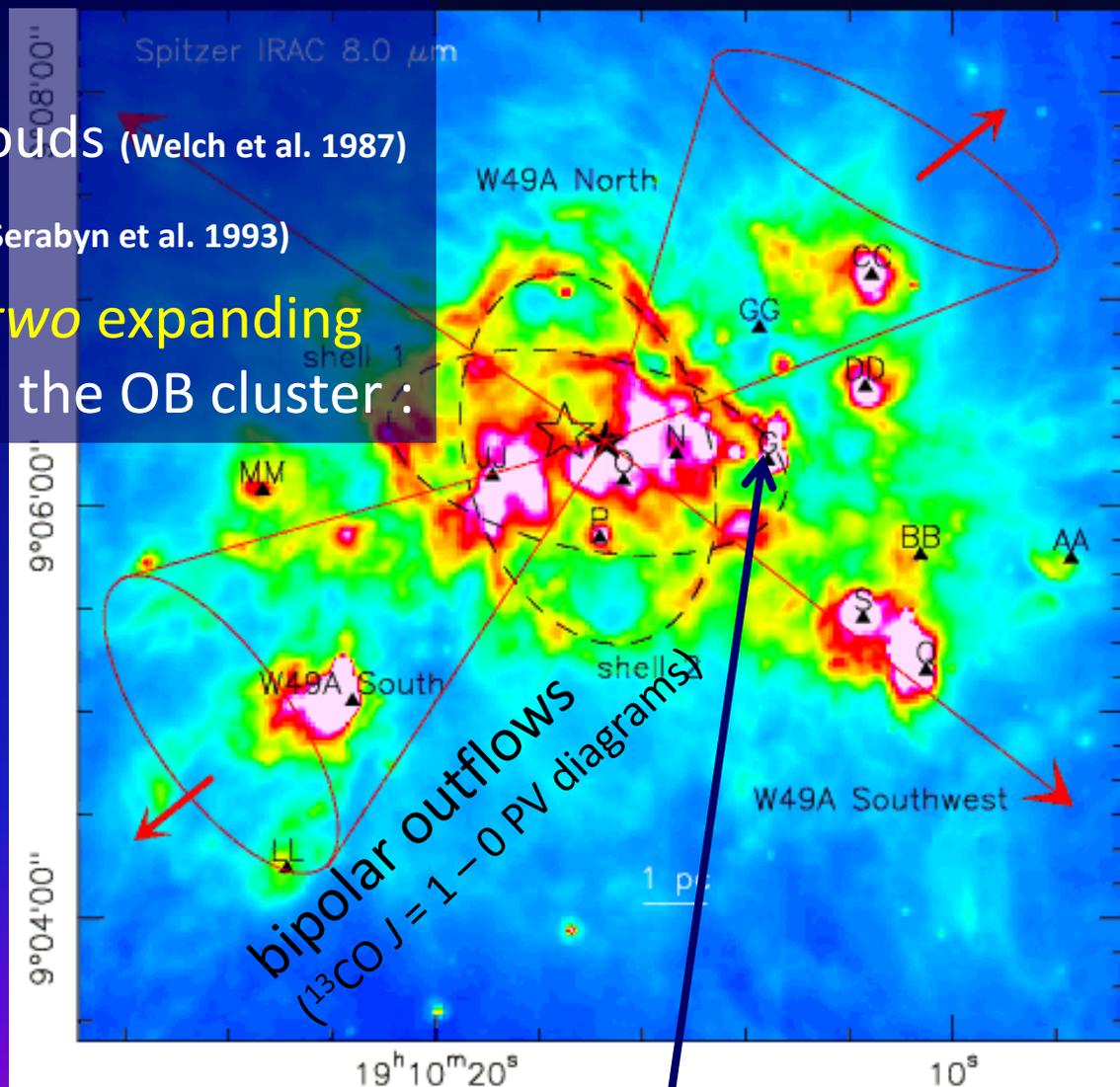
Historically:

Large scale collapse of clouds (Welch et al. 1987)

Cloud-cloud collision (e.g., Serabyn et al. 1993)

Peng et al. (2010) found **two expanding shells** found, centered on the OB cluster:

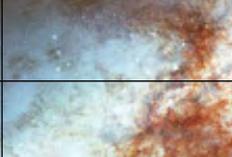
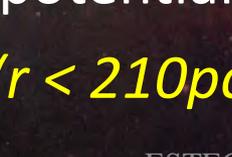
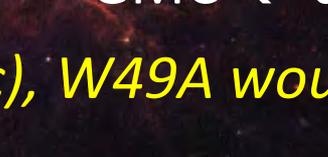
- Radius  $r_i \sim 2 - 3$  pc
- Thickness  $d \sim 0.4$  pc
- $M_{\text{shell}} \sim 1.9 \times 10^4 M_{\odot}$
- $E_{\text{kin}} \sim 10^{49}$  erg
- $v_{\text{expansion}} \sim 5$  km/s
- $\text{age}_{\text{kin}} \sim (3 - 7) \times 10^5$  yr



# Starbursts: W49 $\leftrightarrow$ M82

W49A:  $L_{\text{IR}} \sim 1.7 \times 10^7 L_{\odot}$  (Sievers et al. 1991, rescaled)

M82 center:  $L_{\text{IR}} \sim 3.8 \times 10^{10} L_{\odot}$  (Colbert et al. 1999)

Region	W49	M82	W49 scaled	
Starburst $\varnothing$ [pc]	20	420	9261	scale factor
L(IR) [ $L_{\odot}$ ]	1.7E+07	3.8E+10	1.6E+11	
M(gas) [ $M_{\odot}$ ]	2.2E+05			
M(stars) [ $M_{\odot}$ ]	6.0E+04		1.1E+09	
SFR [ $M_{\odot}/\text{yr}$ ]	2.9E-03	6.6	27.2	
SFE [ $M^*/M_{\text{gas}}$ ]	0.27			
sSFR [SFR/ $M^*$ ]	2.5E-08			

Not similar: gravitational potential  $\leftrightarrow$  GMC  $\leftarrow$  disruption by SNe

*Scaled to the size of M82 ( $r < 210\text{pc}$ ), W49A would be an even more luminous starburst.*



