



# The First GeV Detection From ULIRG Arp 220

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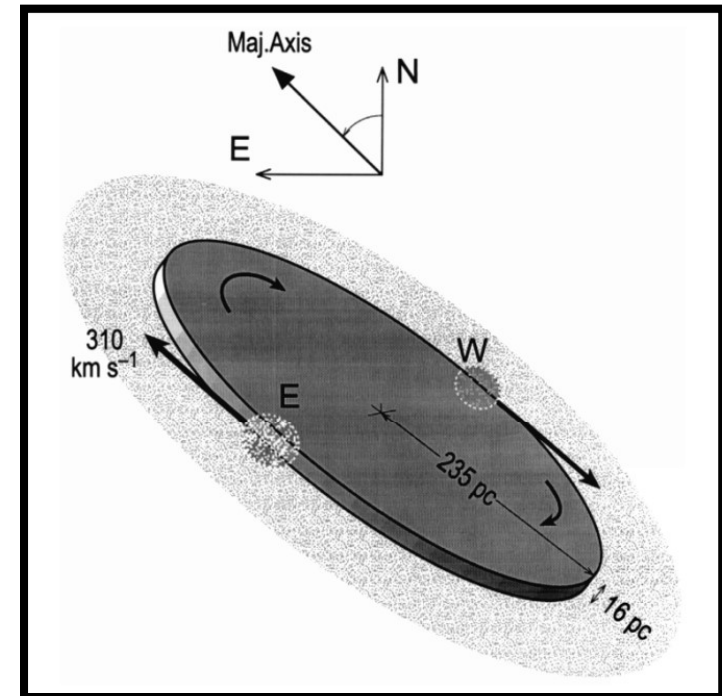
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# Why do we focus on Arp 220



- ◆  $d = 78$  Mpc
- ◆ IR luminosity  $(1-2)10^{12} L_{\text{sun}}$
- ◆ SN rate: 4/yr
- ◆ Star-forming rate:  $240 M_{\text{sun}}/\text{yr}$



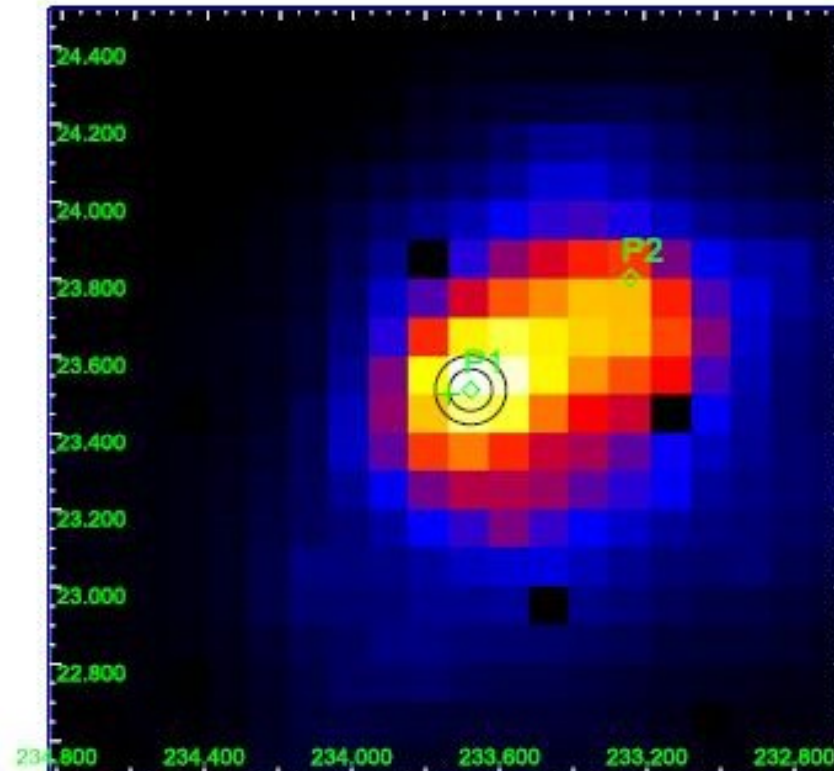
Yoast-Hull et al 2015; Konig et al. 2015

High expectation of GeV emission from  $pp$  collision,  
i.e., CR proton  $p$  will collide with environment gas  $p$ .

$$\pi^0 \rightarrow \gamma\gamma \quad 2$$



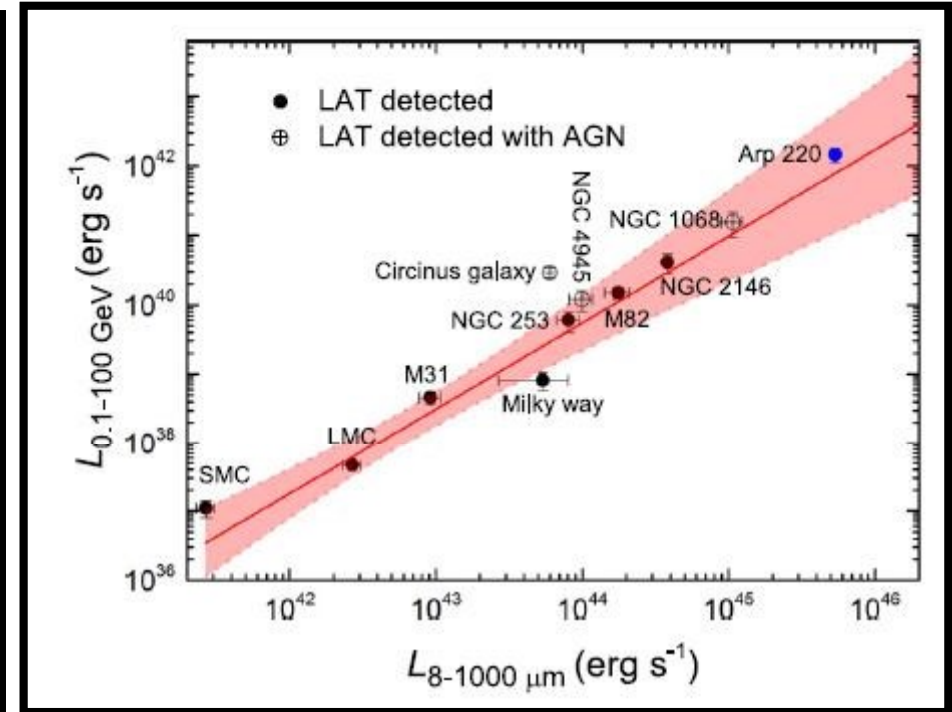
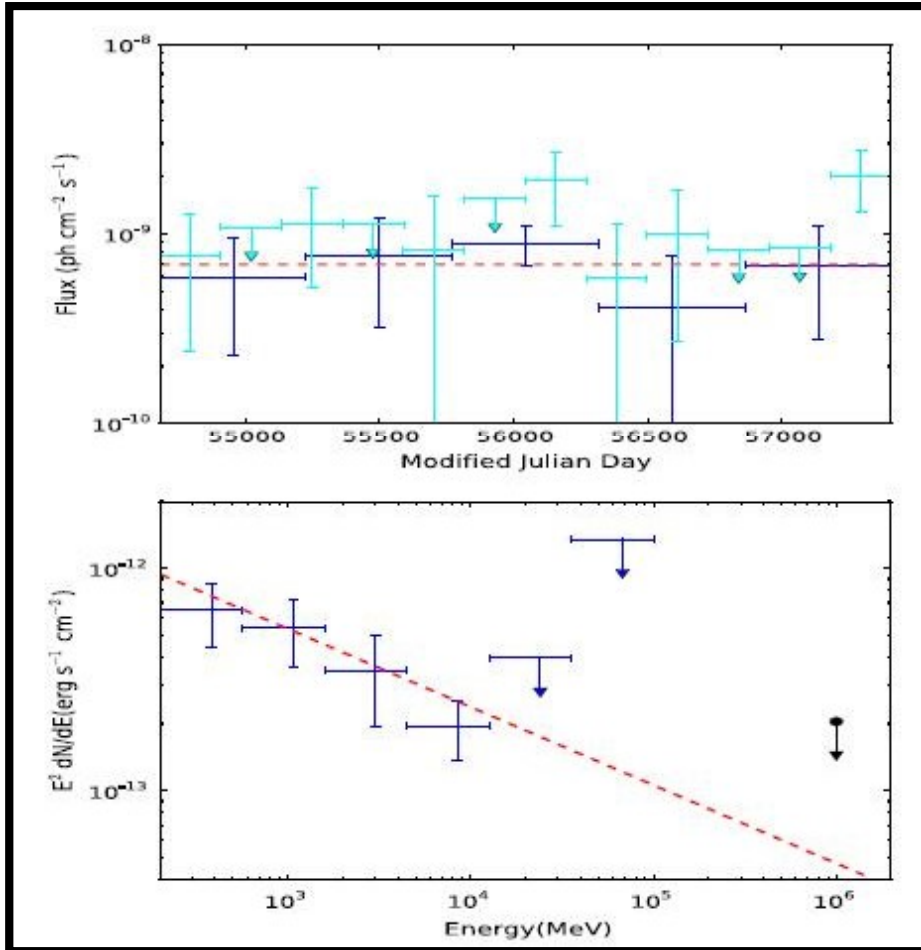
# Fermi observation—P8



Point	Position (degree)	$r_{95}$ (degree)	Separation (degree)	Photon Flux ( $10^{-9} \text{ ph cm}^{-2} \text{ s}^{-1}$ )	Energy Flux ( $10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$ )	$\Gamma$	TS	Association
P1	(233.677, 23.5163)	0.090	0.058	$1.76 \pm 0.52$	$1.92 \pm 0.43$	$2.35 \pm 0.16$	40	Arp 220
P2	(233.239, 23.8049)	0.279	0.547	$1.45 \pm 0.52$	$1.39 \pm 0.40$	$2.45 \pm 0.19$	22	...



# LC and SED of Arp 220



Cosmic Rays origin



# Efficiency of powering CRs



## Cosmic Rays injection power

$$L_{\text{CR}}(>1 \text{ GeV}) = 1.3 \times 10^{44} \text{ erg s}^{-1} E_{51} \eta \left( \frac{\Gamma_{\text{SN}}}{4 \text{ yr}^{-1}} \right)$$

## GeV emission luminosity from CRs

$$L_{\text{CR}}(>1 \text{ GeV}) = 3L_{\gamma}(>1 \text{ GeV})(\Gamma - 1)\beta_{\pi}^{-1}$$

## Efficiency of powering CRs protons of SRNs

$$\eta \simeq (4.2 \pm 2.6) \% E_{51}^{-1} \left( \frac{\beta_{\pi}}{0.6} \right)^{-1} \left( \frac{\Gamma_{\text{SN}}}{4 \text{ yr}^{-1}} \right)^{-1}$$

**Thank you!**

