Gamma-ray emission from AGN disk wind

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Newly Emerging Gamma-ray Population : Radio-Quiet Active Galactic Nuclei (RQ AGNs)

- Blazars have been dominant gamma-ray “detected” population (see e.g., Abdollahi+ ‘20)
  - But **Fermi started to see near RQ AGNs**.

  → Nearby Cosmic-Ray Accelerators?
- 90% of AGNs are RQ (Panessa+ ‘19)
  - Blazars are tip of the iceberg!

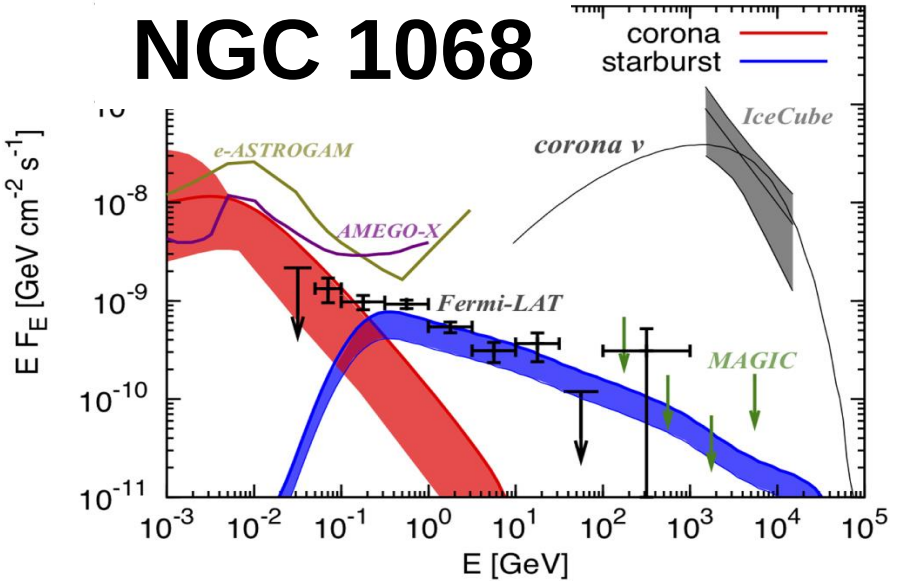
→ *Key to solve CR acceleration!?*

Circinus Galaxy © NASA

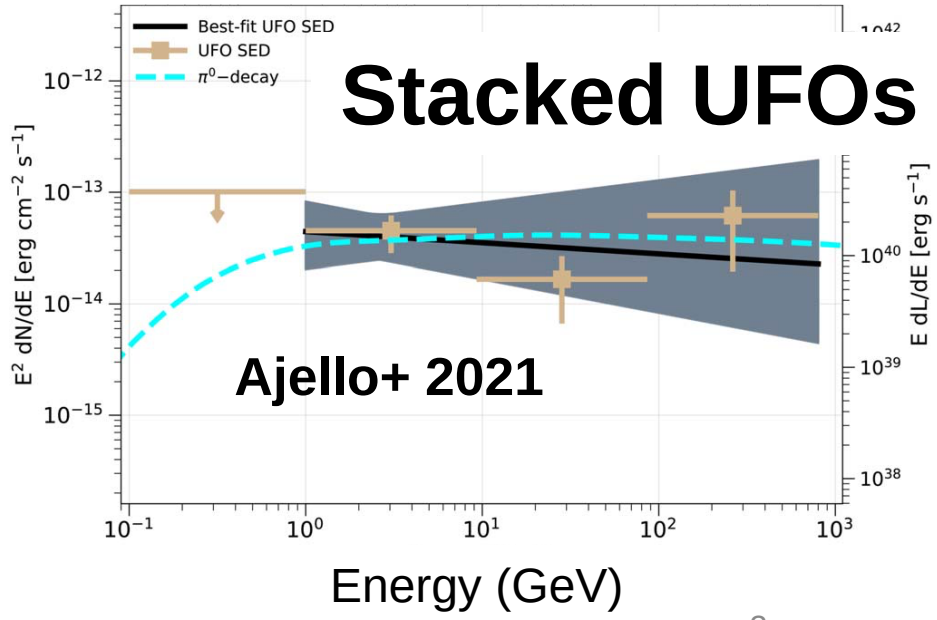
Gamma-ray Emission from RQ AGNs (observation)

- Fermi has detected several RQ AGNs (e.g., Abdollahi+ ’20; Ajello+ ’21)
  - Origins? (see e.g., Inoue+’08, ’19, ‘23)

    Starburst? Corona? Weak Jet? Fast outflow?
- Ajello+‘21 reported 5.1−σ detection of stacked ultrafast outflow (UFO) RQ AGNs.



Ajello+ 2023



Ajello+ 2021

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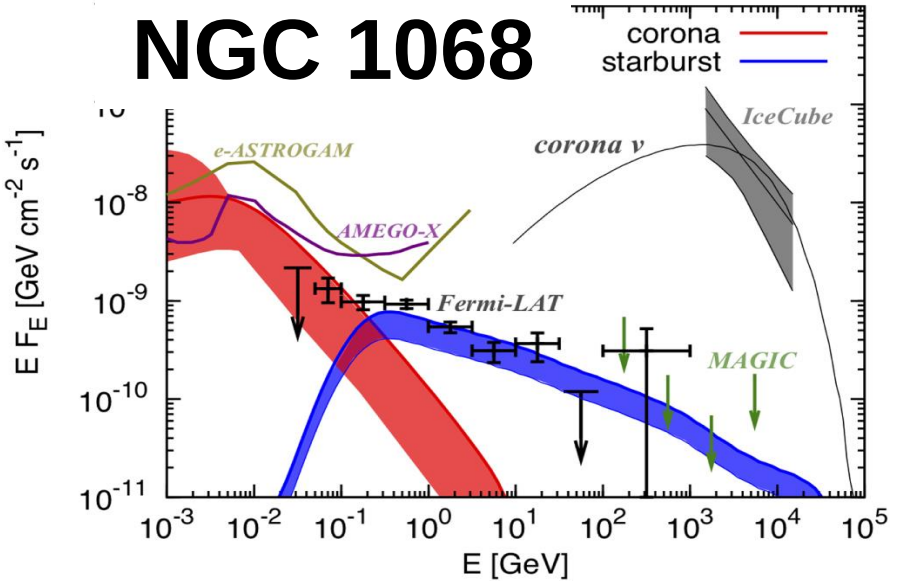
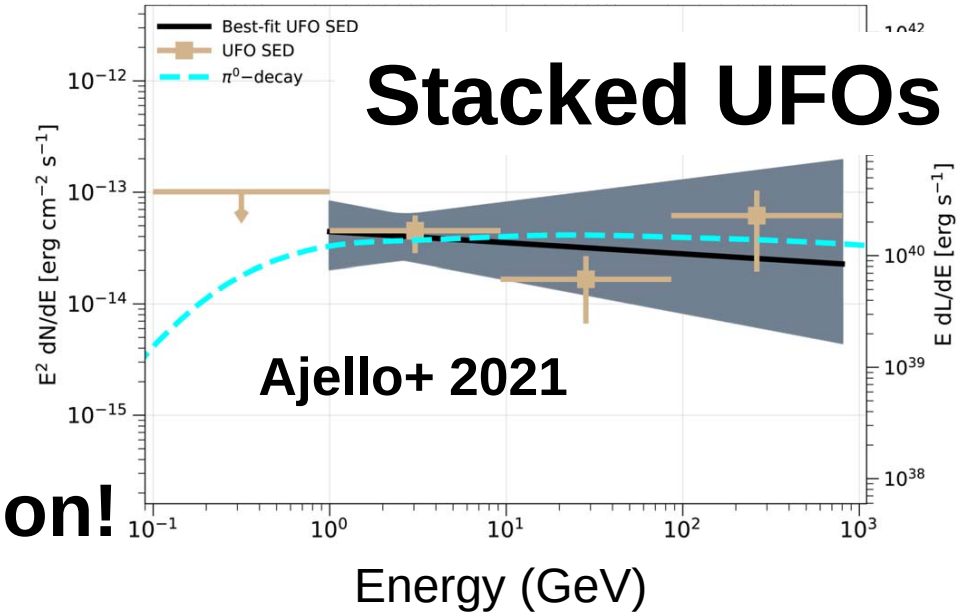
→UFO is a candidate of gamma-ray emission!



Ajello+ 2023



Ajello+ 2021

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UltraFast Outflows (UFOs)

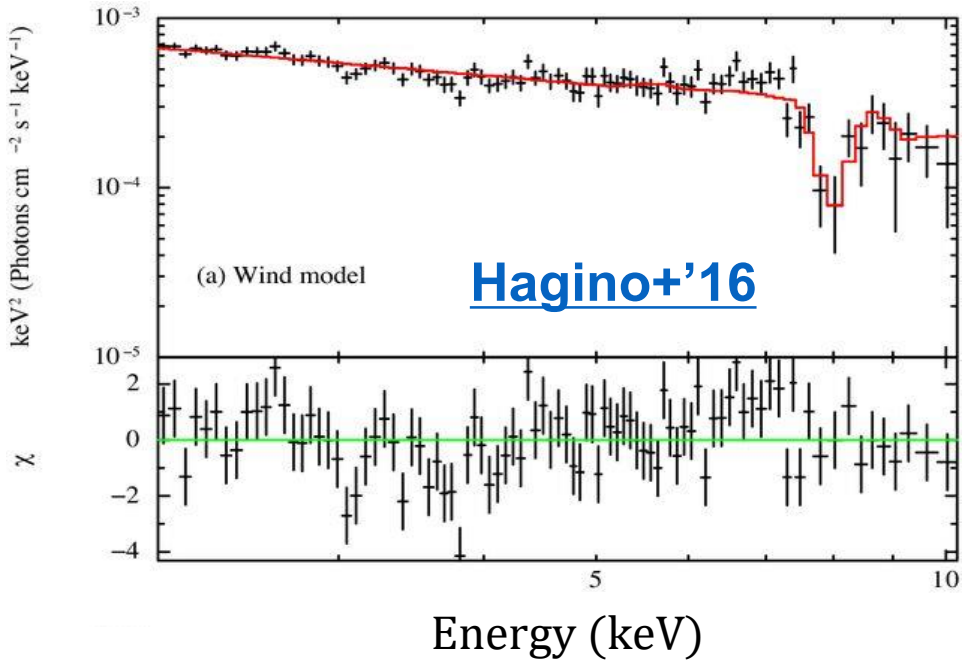
- Fast and wide-angle disk wind
  - Wind velocity $\sim 0.1\ c$

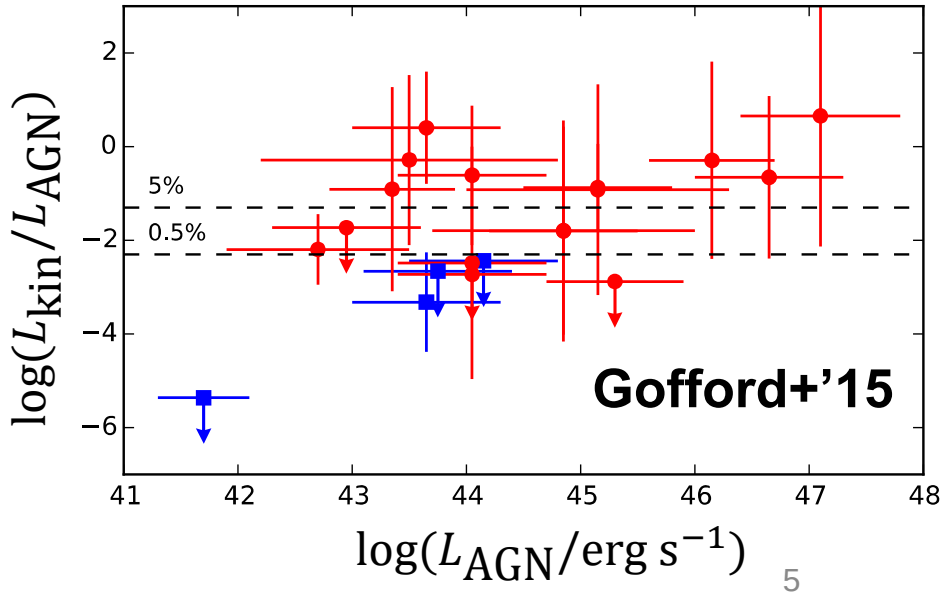
    (Tombesi+ ’10; Hagino+ ’16; Mizumoto+ ‘19)
- **~40% RQ AGNs have UFOs**

  (Tombesi+ ’10)
- Kinetic Power : $L_{\rm kin} \sim 0.01 - 1\ L_{\rm AGN}$

  (Gofford+ ’15; Mizumoto+ ’19)

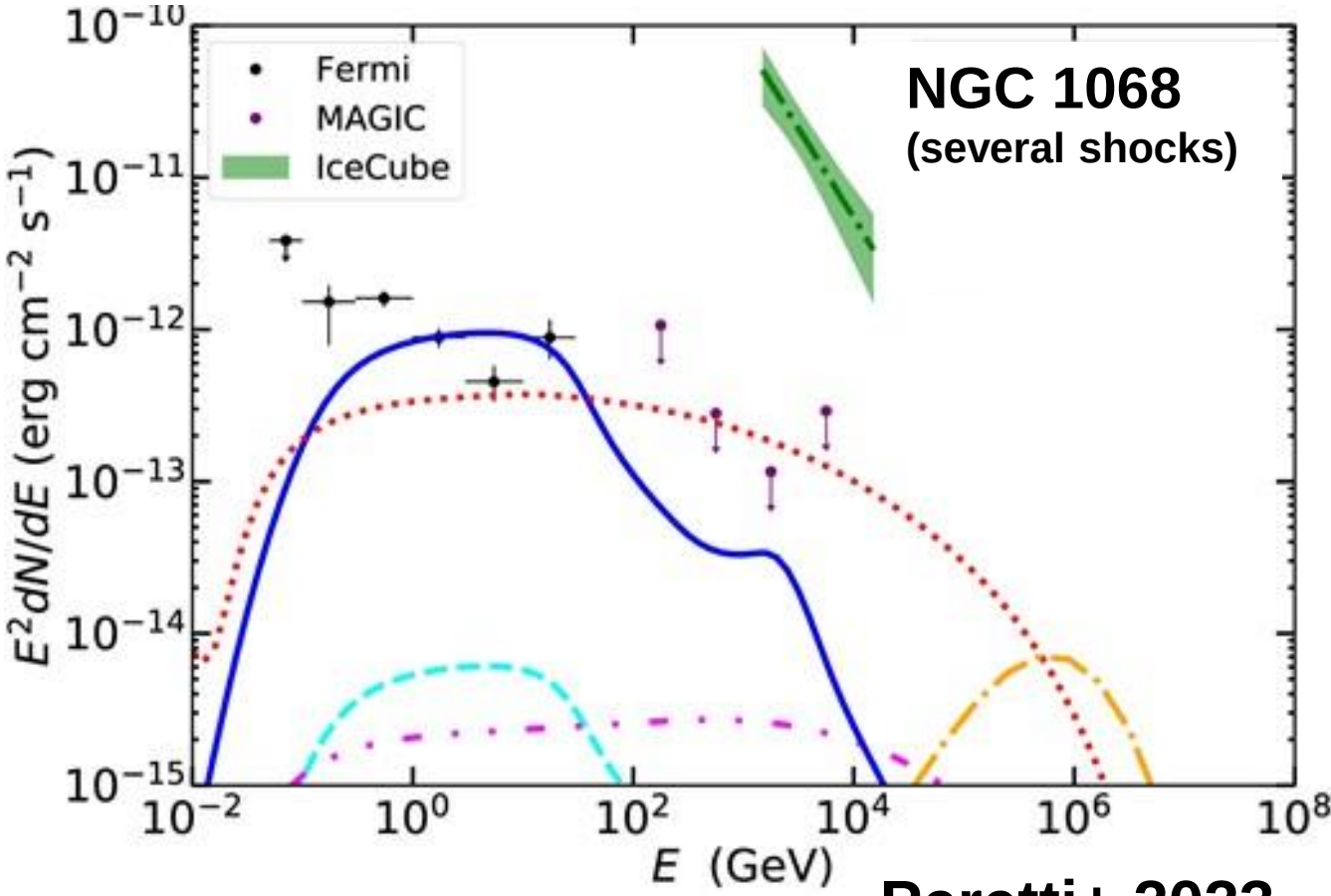
UFO in 1H 0707-495





Gamma-ray Emission from UFOs (model)

- Interactions with ISM gas
  (e.g., Wang & Loeb ‘16; Lamastra+’16; Liu+’18; S. Inoue+’22; Peretti+’23)
  - ➢Formation of Shocks
  - ➢Diffusive Shock Acceleration (DSA)
  - ➢Gamma-ray Emission
- Applied to
  - Cosmic Background Radiation, NGC 1068, NGC 4151



Peretti+ 2023

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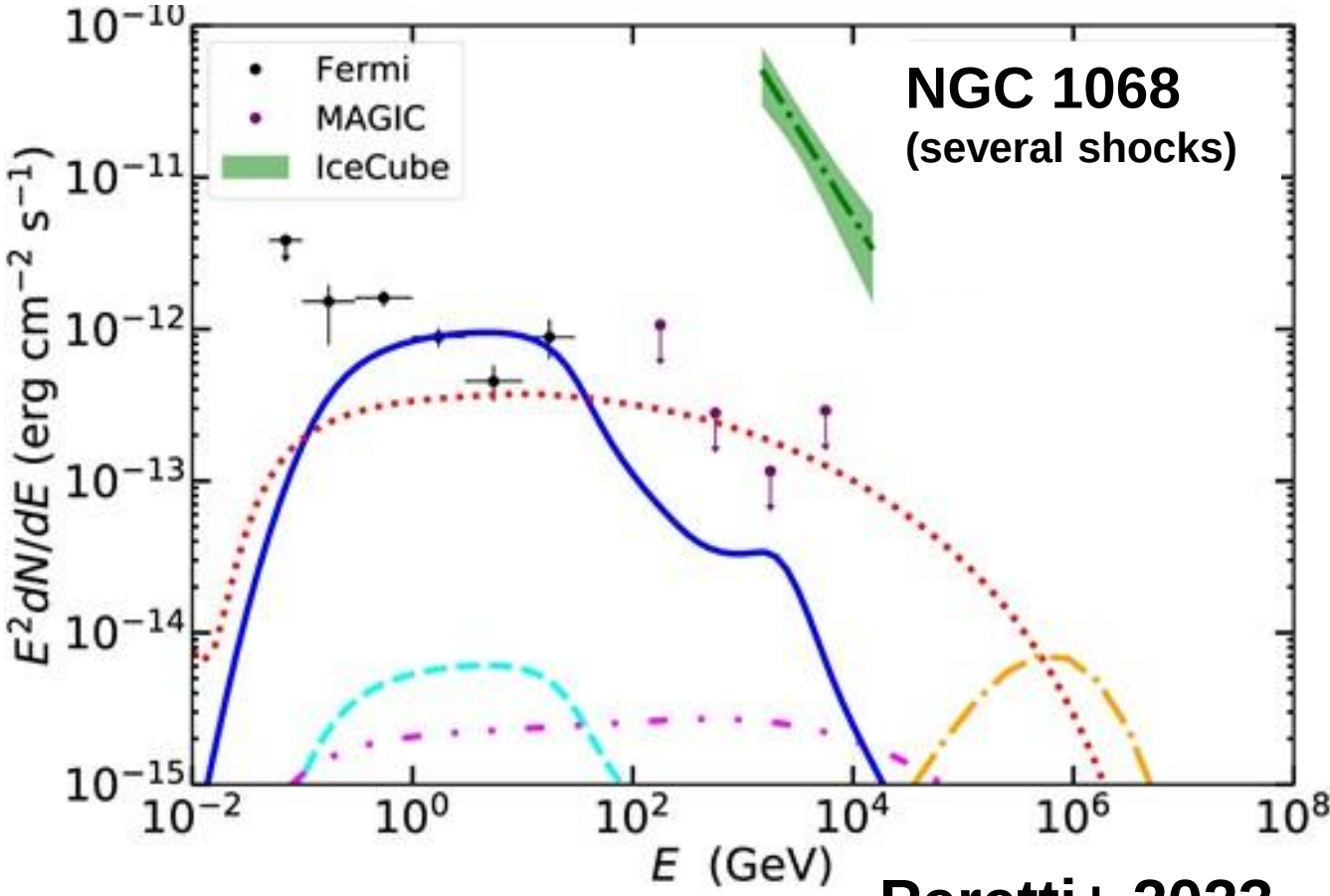
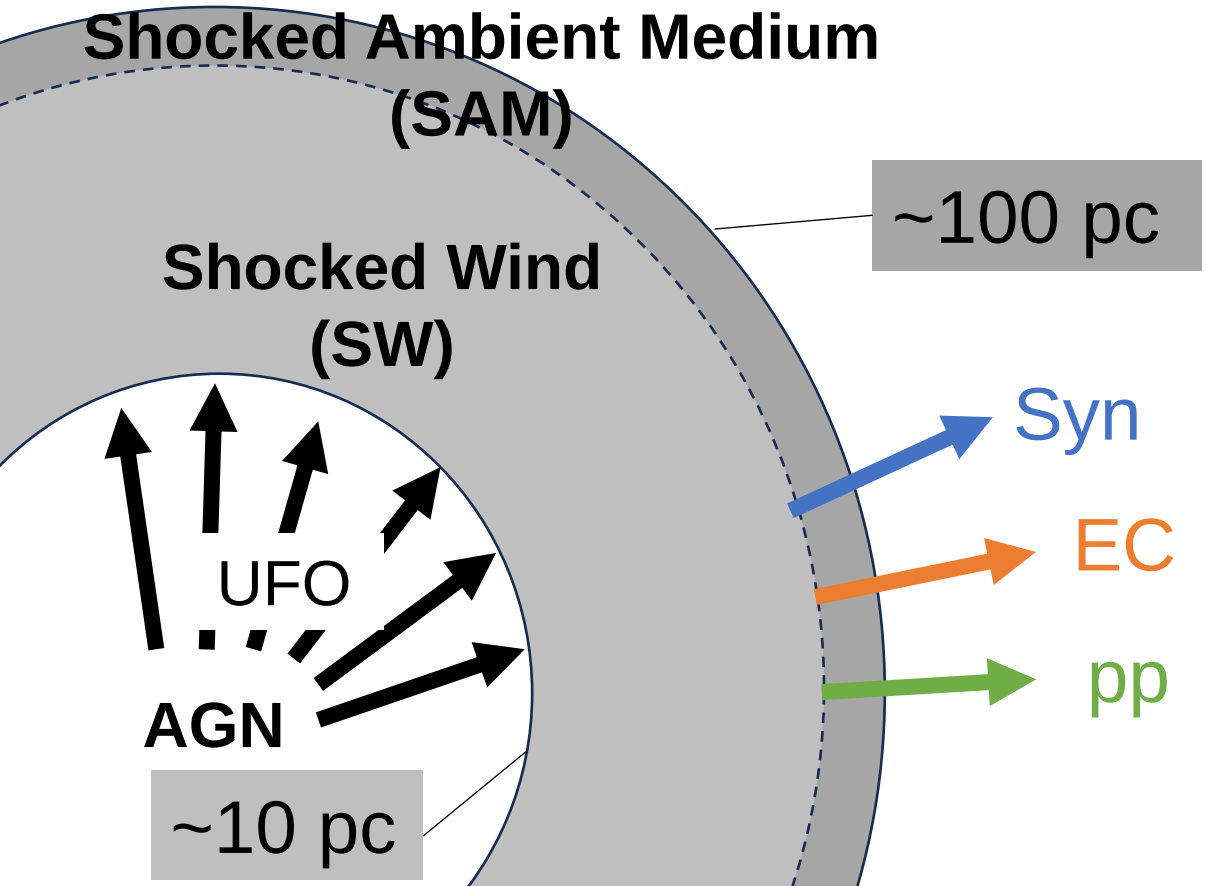


Peretti+ 2023

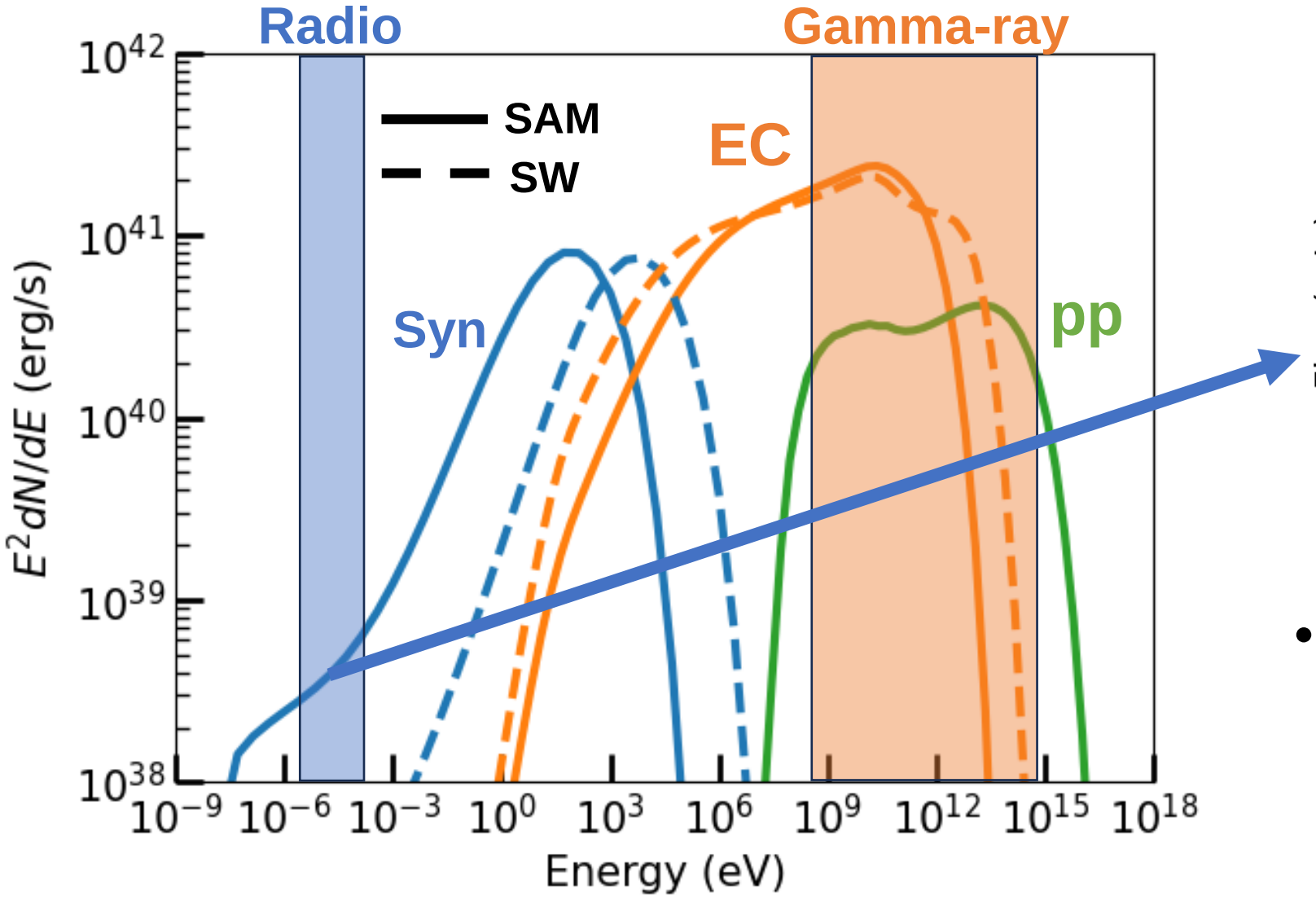
Any Potential UFO Targets for CTA south?

UFO Emission Model

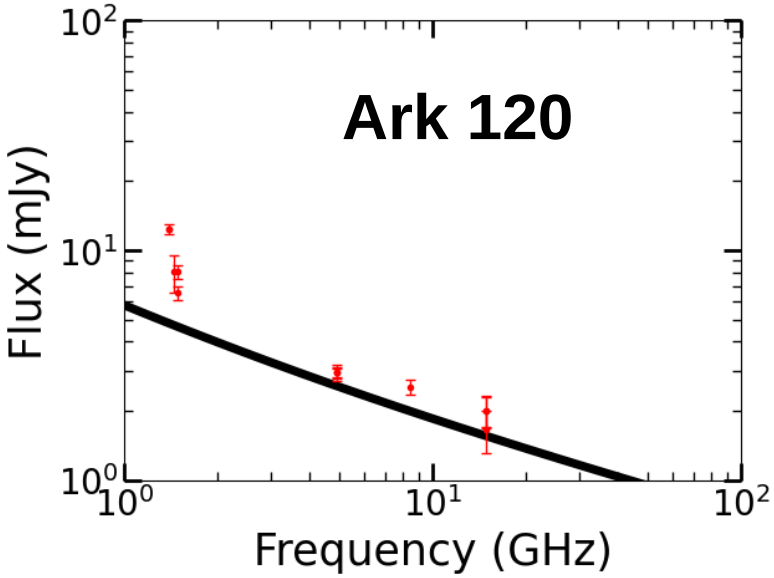


- Develop AGN Disk Wind Emission Model (Yamada, **NS**+ submitted; NS+ in prep.)
- Typical value of main parameters
  - $L_{\rm AGN} \sim 10^{46}$ erg/s
  - $v_{\rm UFO} \sim 0.1c$
  - $B_{\rm SAM} \sim 0.1$ mG
  - $n_{\rm ISM} \sim 10$ cm^{-3}
- Emission mechanism
  - Synchrotron (Syn)
  - External Compton (EC)
  - pp interaction (pp)

Multiwavelength spectrum of UFO emission model

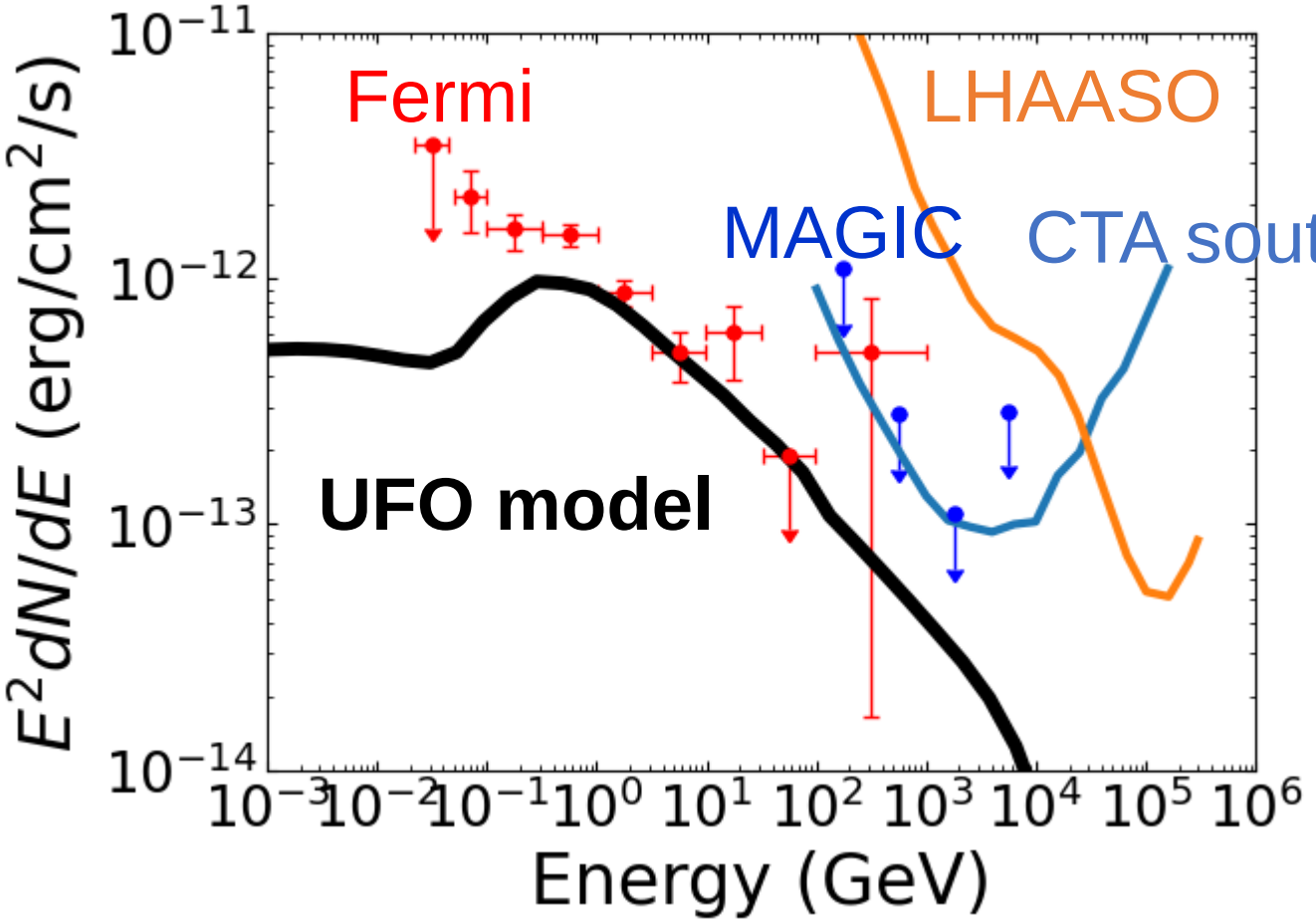


- Yamada+ reproduced radio data of UFO AGNs, considering DSA @ SAM.

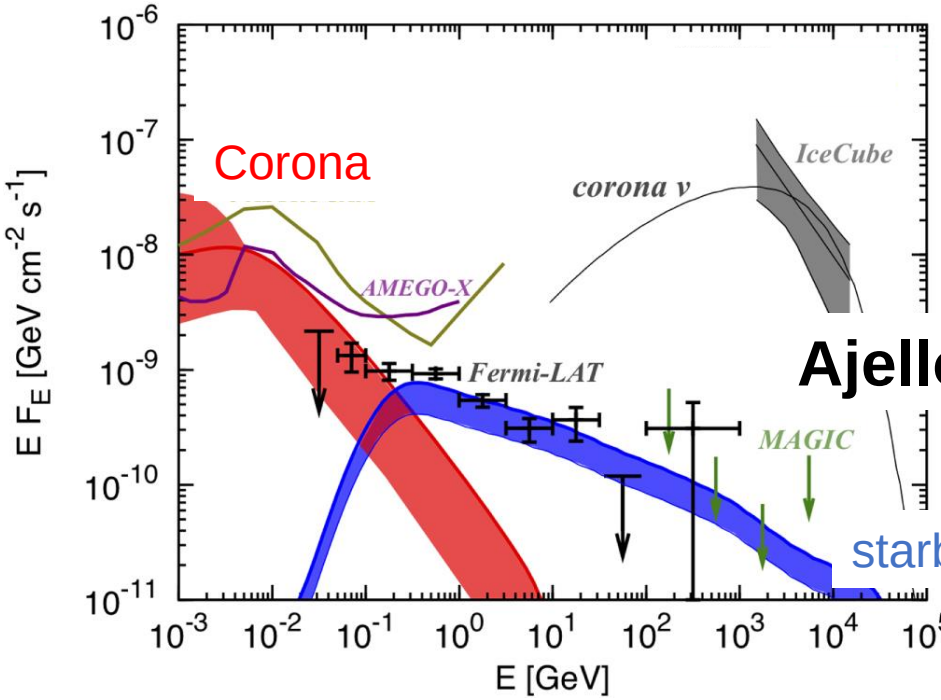


- Build **lepto-hadronic** model both for **SAM** & **SW**.

Gamma-ray SED of NGC 1068

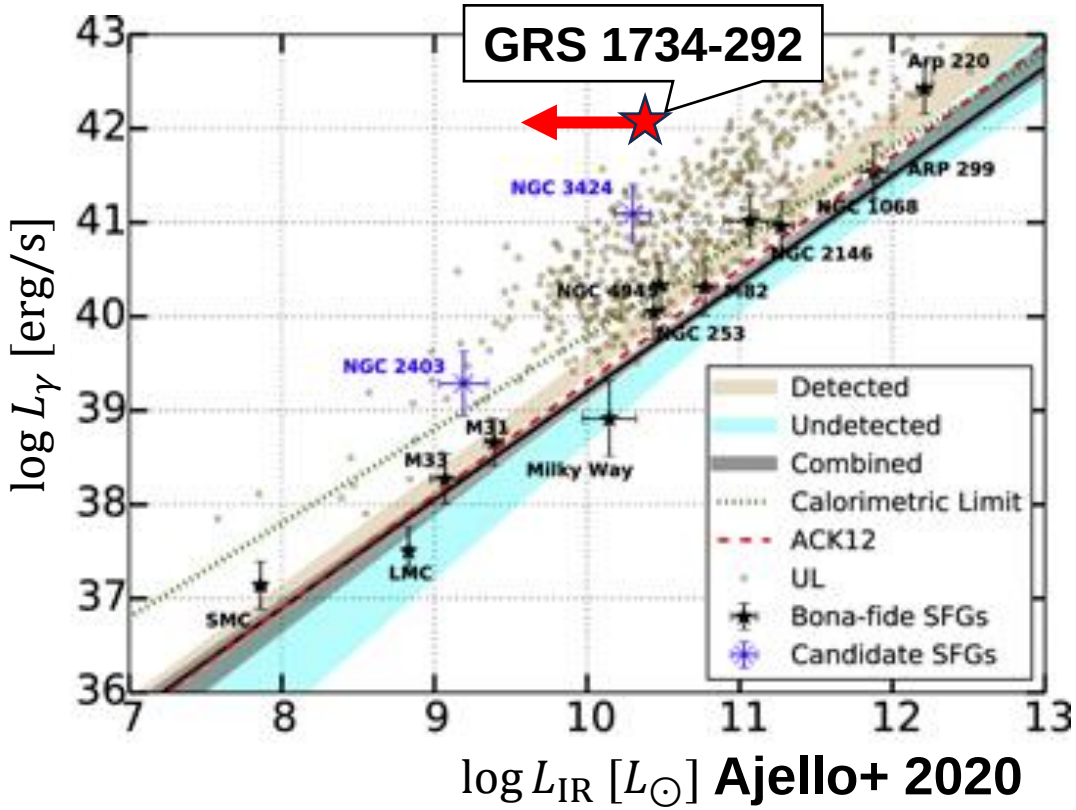


- Wind model can explain the data
  - But, SF should also contribute
- Low-energy band would be explained by corona (Inoue+'20; Murase+'20; Ajello+'23)

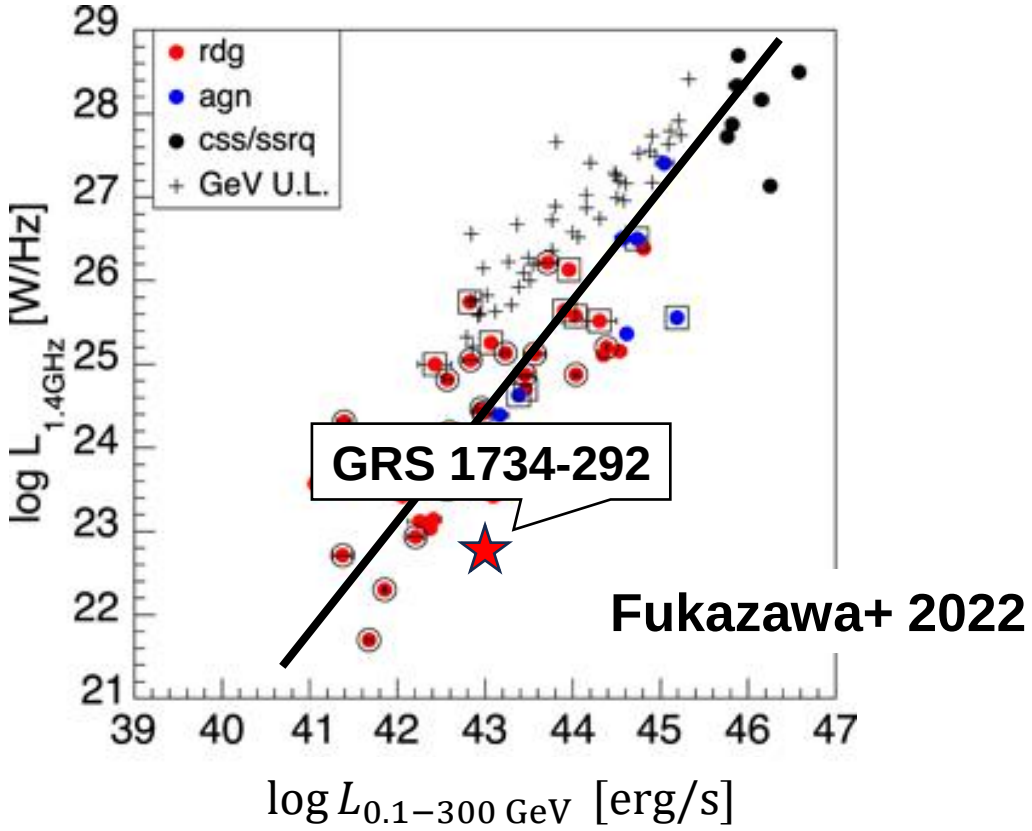


Ajello+ 2023

GRS 1734-292 (South target, studied in Michiyama+ submitted)
Fermi detected but no SF and jet activities



Ajello+ 2020



Fukazawa+ 2022

- Star formation

→**insufficient** for gamma-ray

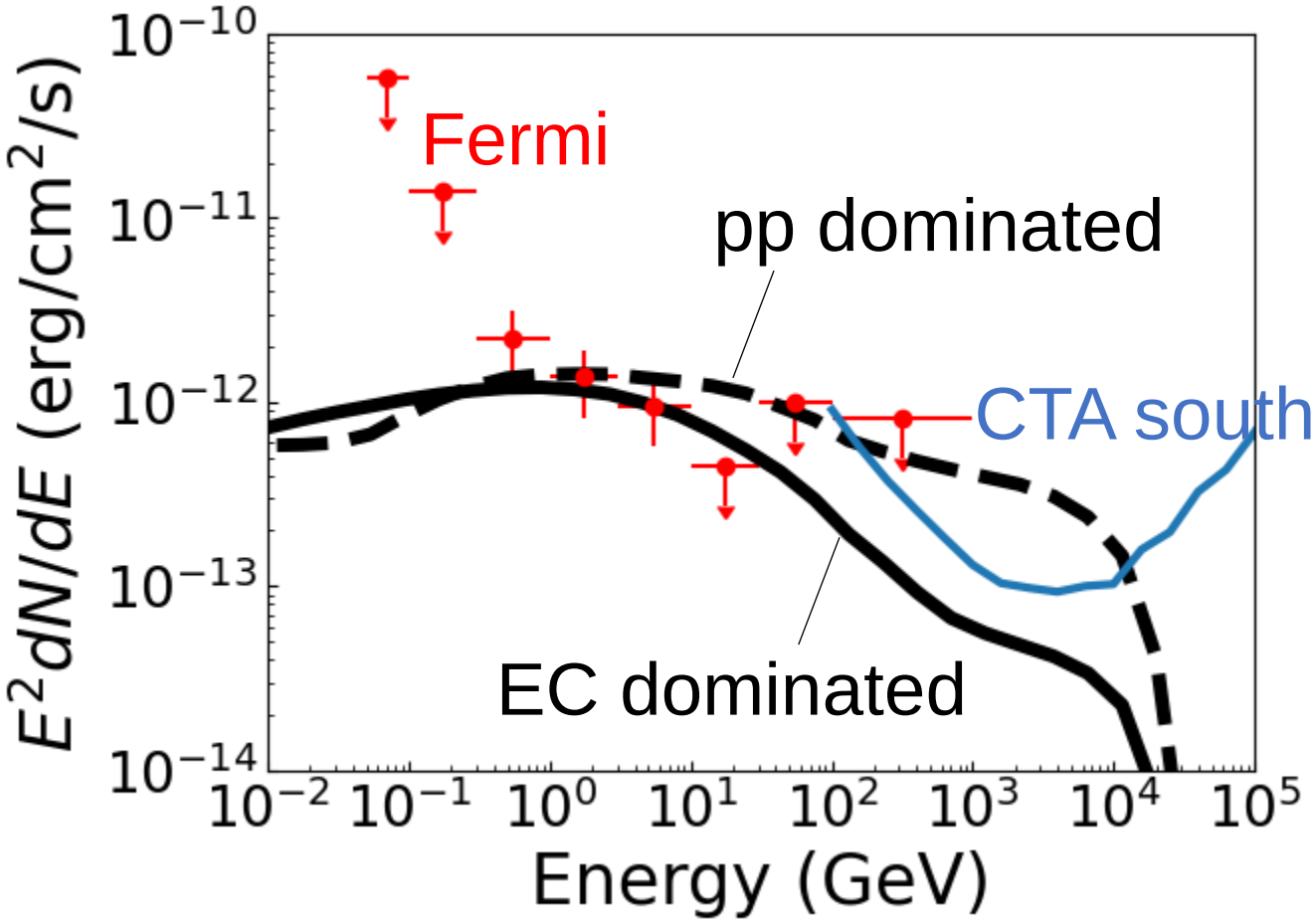
- Jet power

→ **insufficient**

GRS 1734-292 (South target)
Fermi detected but no SF and jet activities

- UFO (pp dominated scenario)
  - $n_{\mathrm{ISM}} = 200\ \mathrm{cm}^{-3}$ @ 100 pc
  - **Could be detected!**
- UFO (EC dominated scenario)
  - $n_{\mathrm{ISM}} = 10\ \mathrm{cm}^{-3}$ @ 100 pc
  - Could not be detected

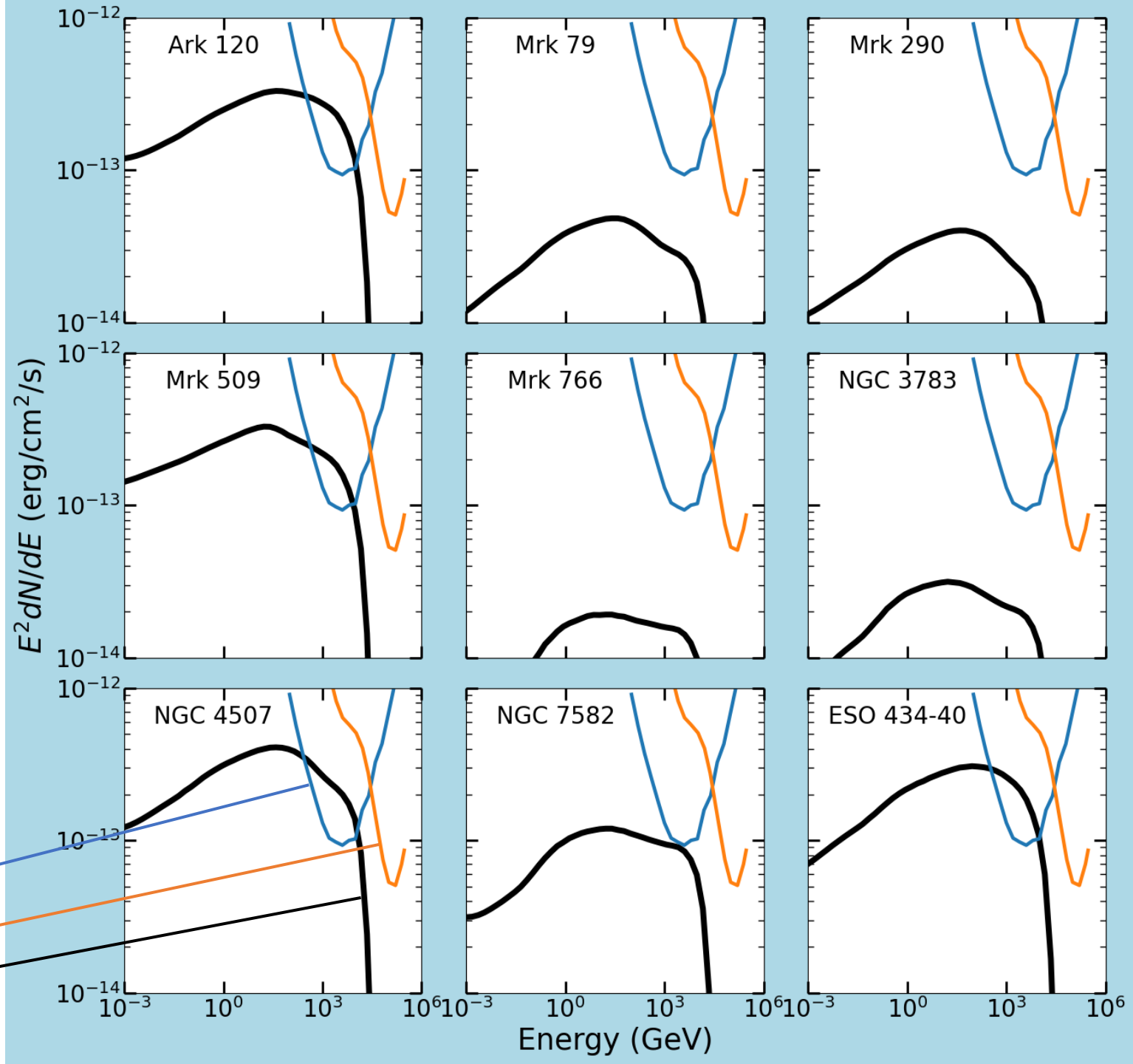
→CTA south may be able to detect GRS!



9 RQ AGNs

(studied in Yamada+)

- Consistent with radio data
- Same parameters as Yamada+



CTA south sensitivity curve

LHAASO sensitivity curve

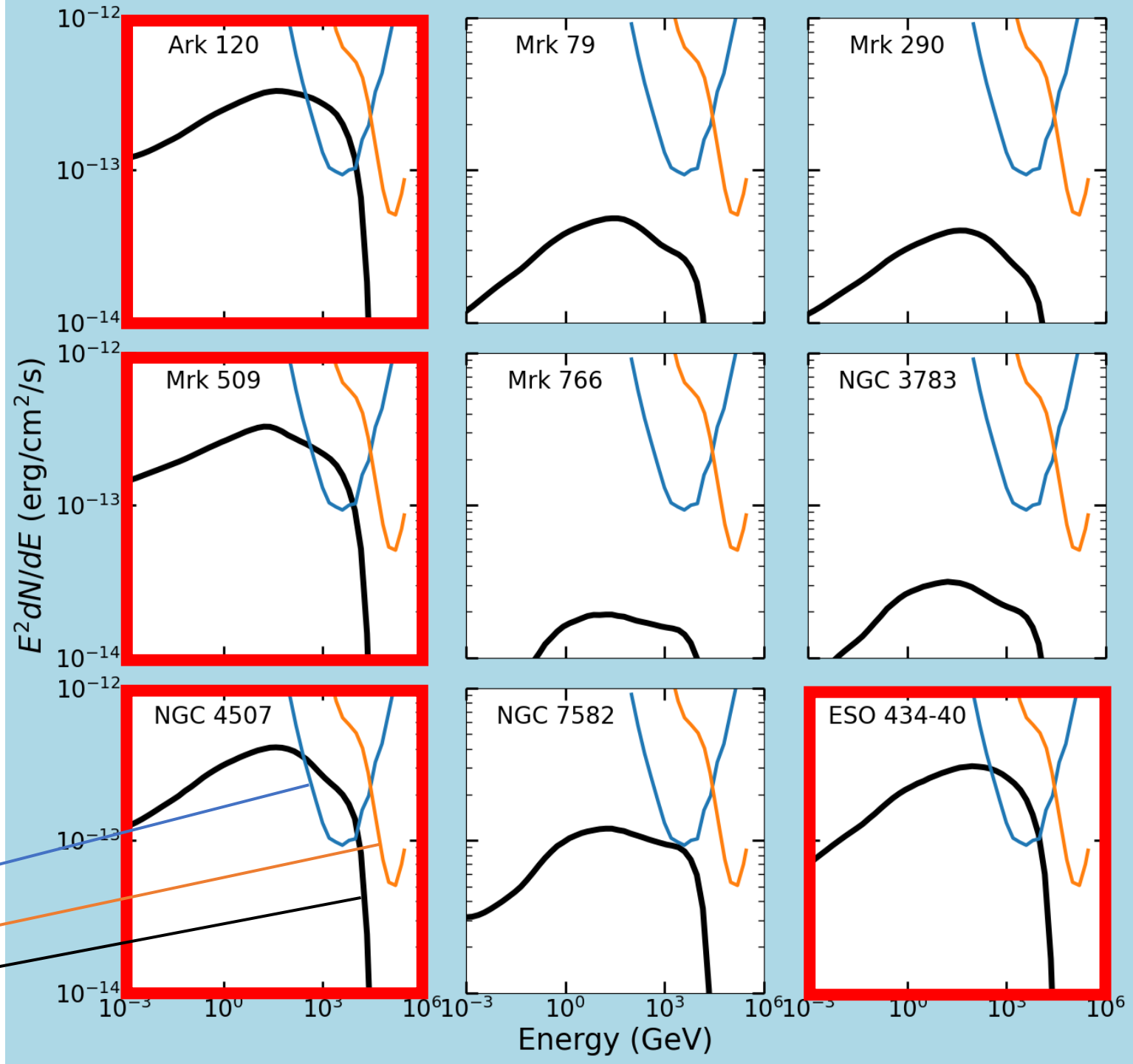
UFO emission model

9 RQ AGNs

(studied in Yamada+)

- Consistent with radio data
- Same parameters as Yamada+
- **4 AGNs could be detected by CTA south!**

→ CTA south is a key to solve radio and gamma-ray emission from RQ AGN!



Summary

- RQ AGNs are **new** and **major** population for gamma-ray observation.
- AGN disk wind (UFO) model for both **SAM** & **SW**
- **Lepto-hadronic** emission model
- **Following 5 RQ AGNs could be detectable with CTA south:**
  - GRS 1734-292
  - Ark 120
  - Mrk 509
  - NGC 4507
  - ESO 434-40

→ **CTA south is a key to reveal non-thermal emission from RQ AGN!**