

A dark matter spike in M87?

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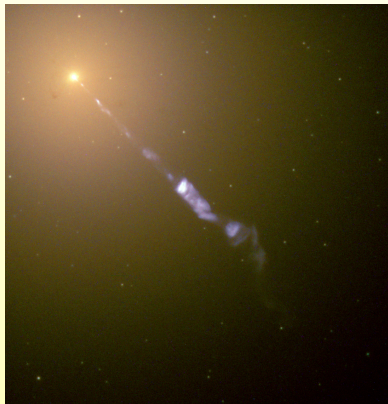


Introduction

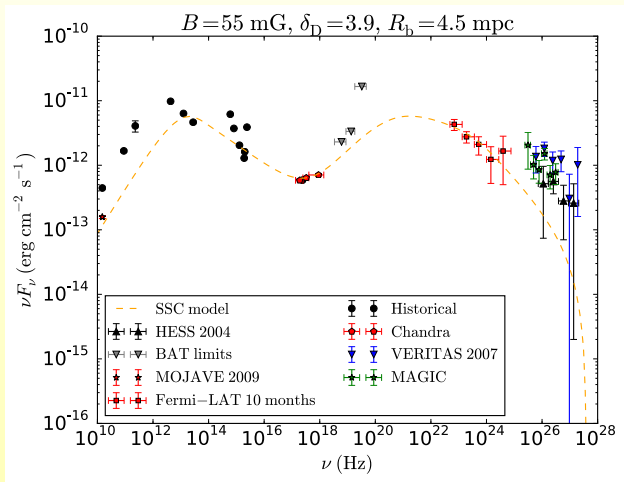
- Slow growth of supermassive black hole (BH) at the center of a galaxy \Rightarrow dense DM spike $\rho(r) \propto r^{-7/3}$ (Gondolo & Silk 1999)
- Can be destroyed by mergers, weaker cusp if BH growth not exactly at the center (Gnedin & Primack 2004)
- Most important: scattering of DM particles off stars (Gnedin & Primack 2004, Vasiliev & Zelnikov 2008)
 \Rightarrow smoother profile $\rho(r) \propto r^{-3/2}$

- Dynamical relaxation time in M87: 10^5 Gyr vs several Gyr for the Milky Way
 - ⇒ spike more likely to have survived in M87
 - ⇒ huge potential for indirect detection signals
- $M_{\text{BH}} = 6.4 \times 10^9 M_{\odot}$ and $d = 16$ Mpc
 - ⇒ same angular Schwarzschild radius as Sgr A* ($\sim 10 \mu\text{as}$)
 - ⇒ excellent target for the Event Horizon Telescope (EHT) with planned angular resolution of $23 \mu\text{as}$ at 230 GHz
 - ⇒ Possibility to probe the central part of the spike

- Powerful jet in M87
- Look for emission brighter than the jet
- But jet emission not yet perfectly constrained

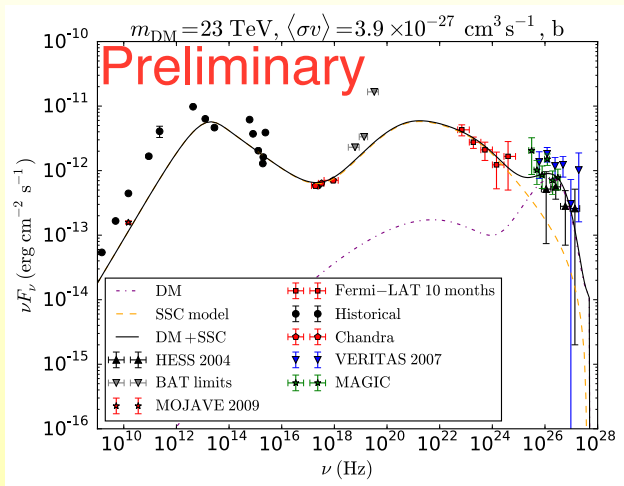


SSC model from [Finke et al. 2008](#), parameters from [Abdo et al. 2009](#)



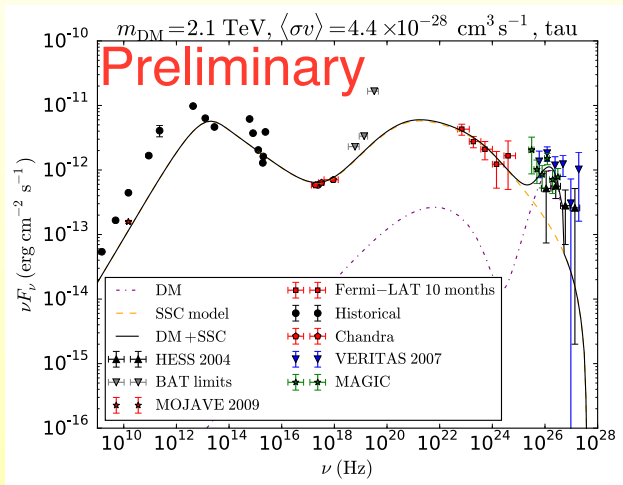
Underestimates TeV emission

Unless we include TeV DM! Suggested by [Saxena et al. 2011](#) for NFW

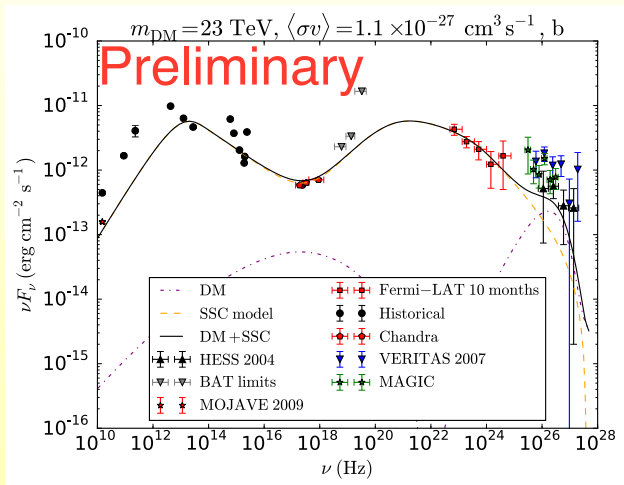


But with spike much smaller cross section needed

Good fit for channels with spectra softer than electrons and muons

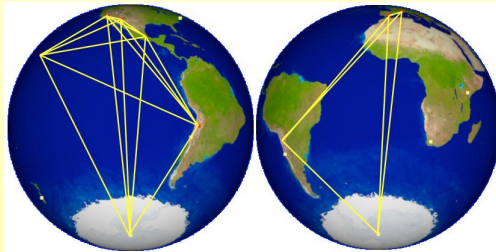


Smaller B in the accretion region \rightarrow start messing with X-ray data

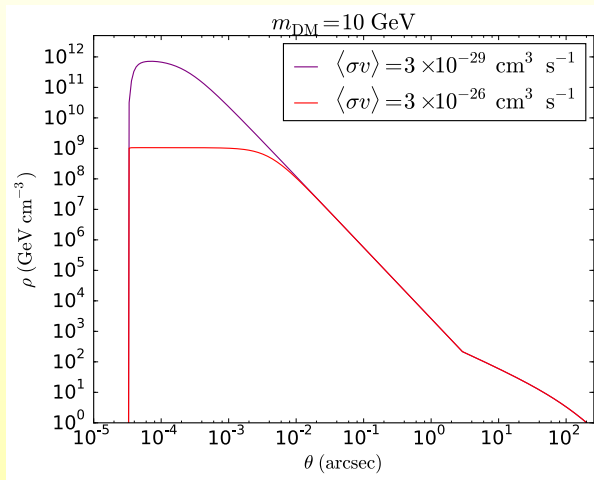


But freedom on SSC model

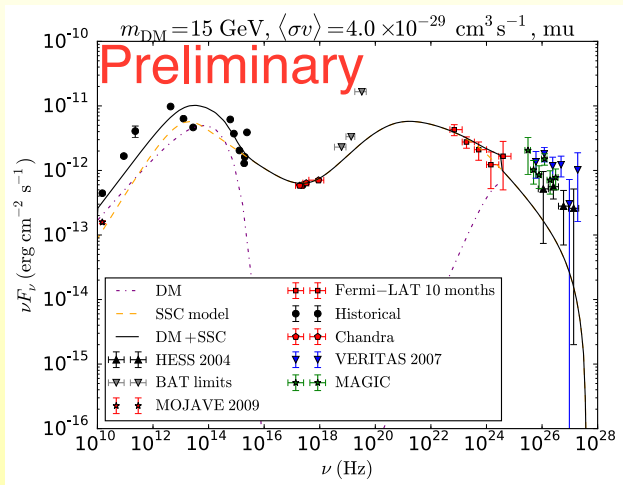
- Network of millimeter/submillimeter telescopes
- Very Long Baseline Interferometry
- Effective size of the order of the size of the Earth
- Currently baselines between Hawaii, California and Arizona → $60 \mu\text{as}$ resolution
- Inclusion of ALMA in progress → will double the resolution
- Aims to achieve resolution of $23 \mu\text{as}$ at 230 GHz and $15 \mu\text{as}$ at 345 GHz.



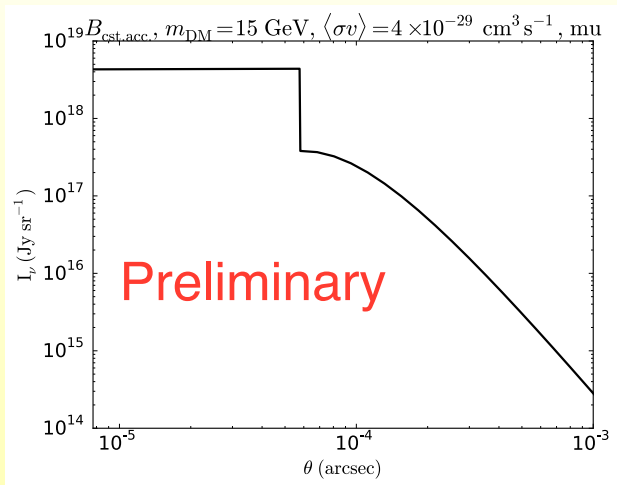
Intriguingly spike falls right into scales relevant for the EHT



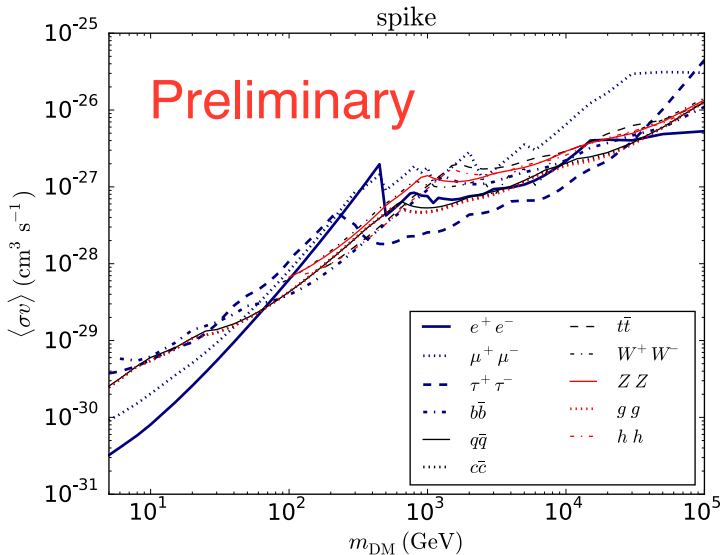
For low mass DM and e^+e^- or $\mu^+\mu^-$ channels:
 synchrotron from DM spike \sim synchrotron from jet



The EHT has the potential to see the jet + glow of DM spike around



$\nu = 230 \text{ GHz}$



Conclusion

- Strong case for a DM spike in M87
- TeV DM can account for the TeV γ -ray emission (or at least contribute) for annihilation cross sections $\sim 10^{-27} \text{ cm}^3 \text{ s}^{-1}$
- Low mass DM (typically $\sim 10 - 20 \text{ GeV}$) can give very sharply peaked synchrotron emission in the reach of the EHT
- If spike: M87 data probe small cross sections

Thank you for your attention!

