

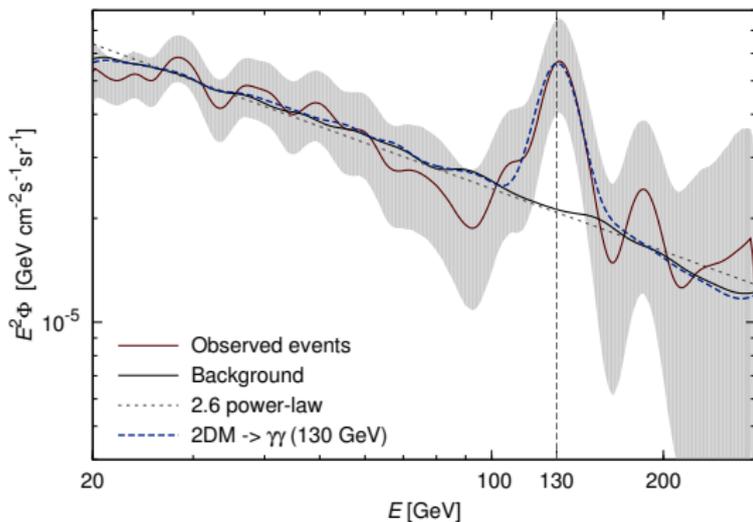
Evidence for 130 GeV gamma-ray line emission from the Fermi LAT data

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CERN, Geneva & NICPB, Tallinn

Dark Attack, Monte Verità
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Topic: “130 GeV line” in the Fermi LAT data

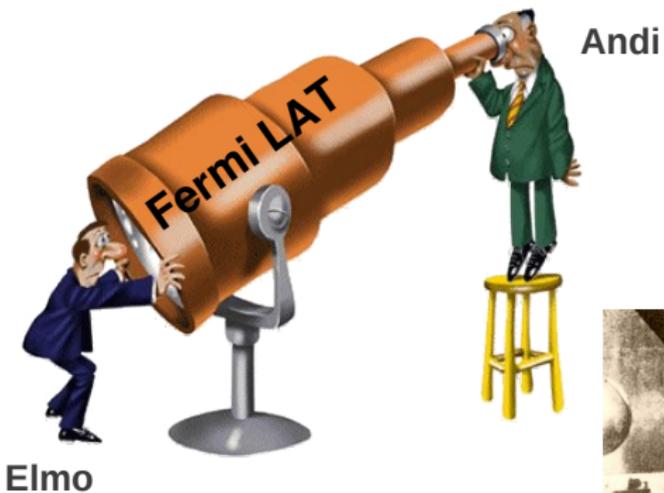


Based on: [1205.1045] and [1207.4466] ← **today!**

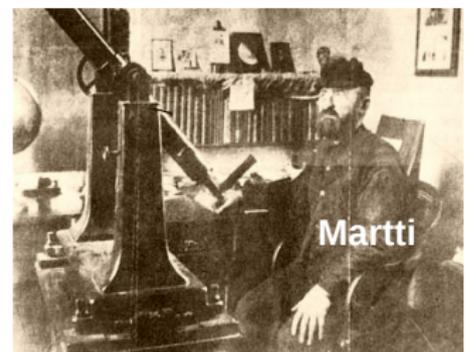
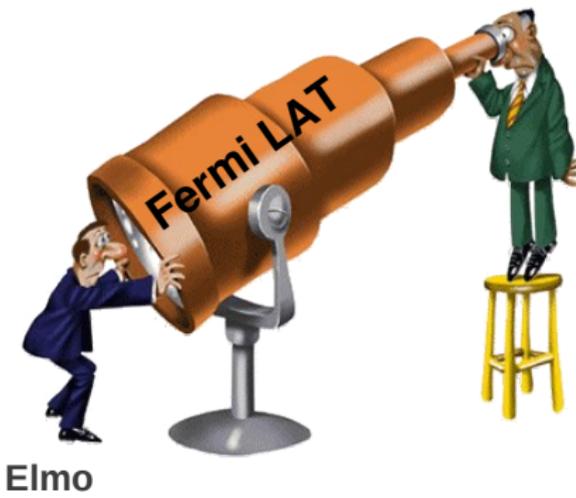
In same topic: Weniger et al [1203.1312], Weniger [1204.2797],

Su & Finkbeiner [1206.1616]

In collaboration with Martti Raidal and Elmo Tempel



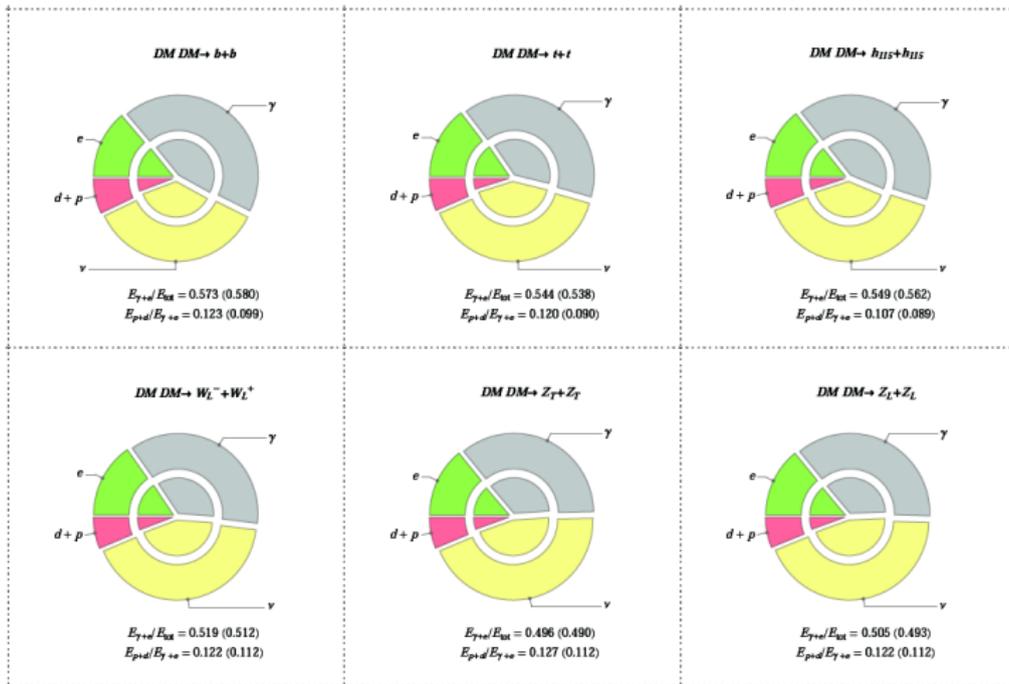
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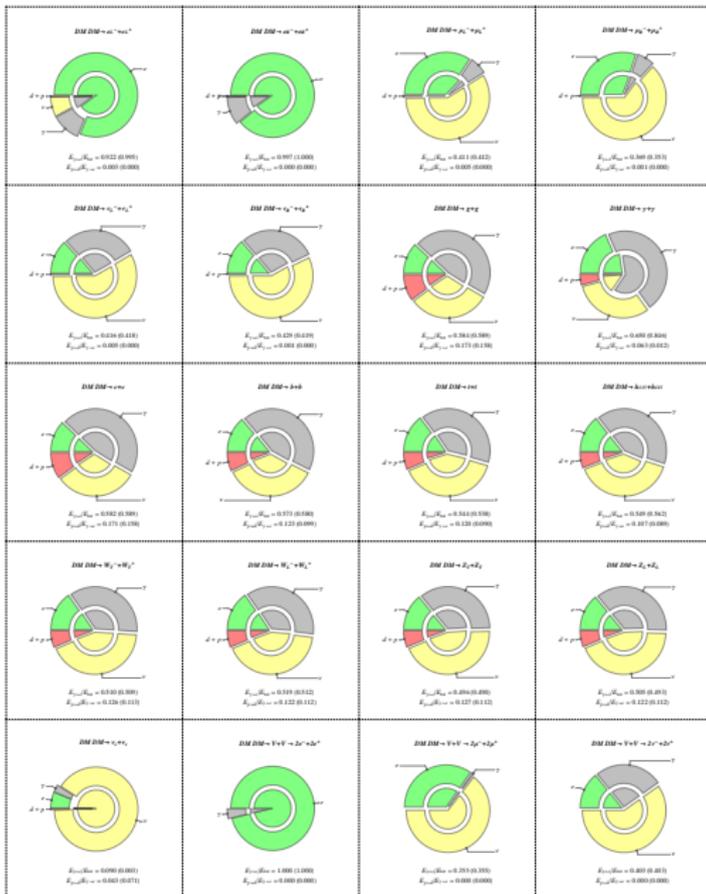


Welcome to the world of amateur (γ -ray) astronomy!

Motivation

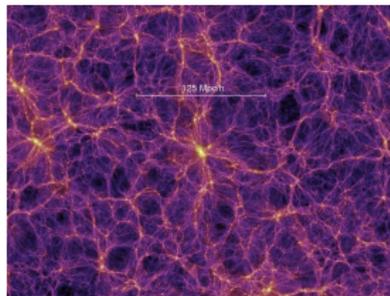
Energy distribution between the final state particles





DM annihilation & γ -rays

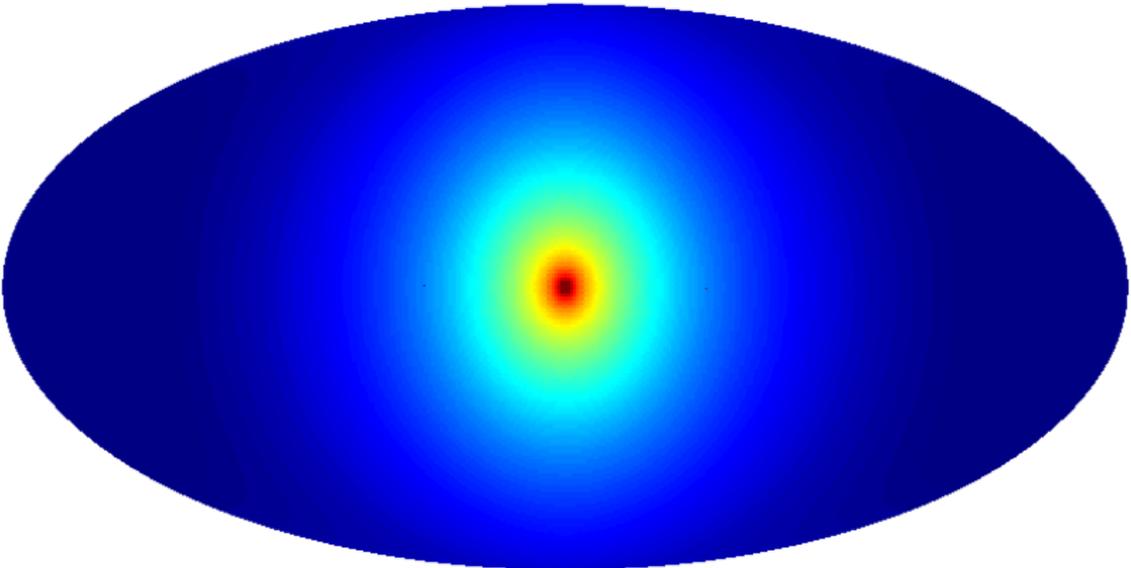
Annihilation of DM



- **Nonlinear development of DM distribution: DM forms clumps**
 - **Nearest big clump is the Centre of the Galaxy**
 - **One can see only the gamma rays (and probably neutrinos) directly from the GC**
 - **Intense background/foreground**
-
- **Smaller yet “cleaner” clumps: subhalos, galaxy clusters, dwarf galaxies, extragalactic isotropic**

γ -rays: main Galactic halo

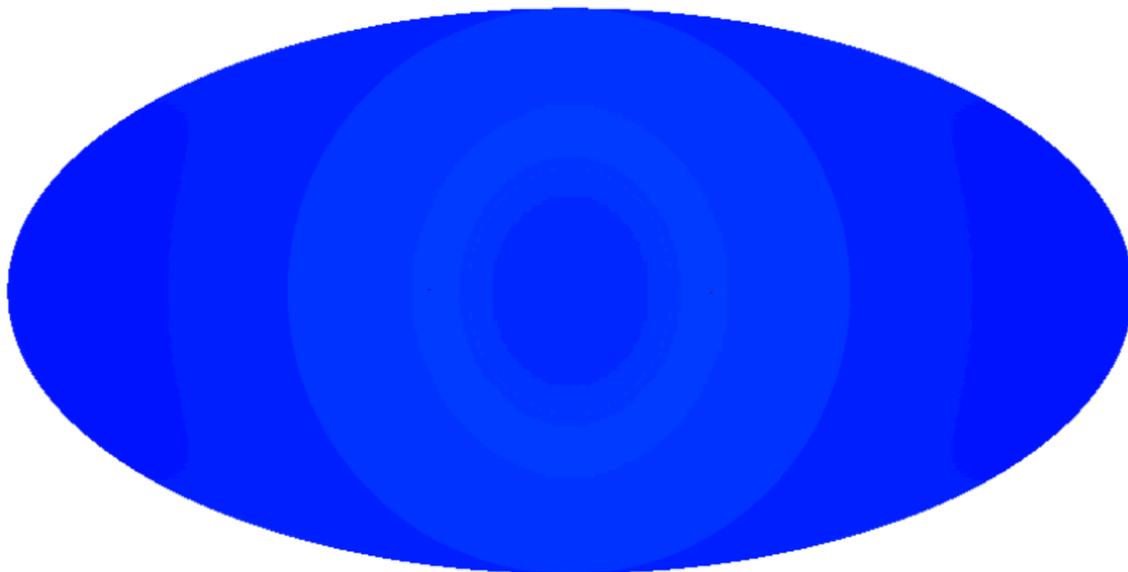
main



By Yuan et al [arXiv:1203.5636]

γ -rays: Galactic subhalos, unresolved

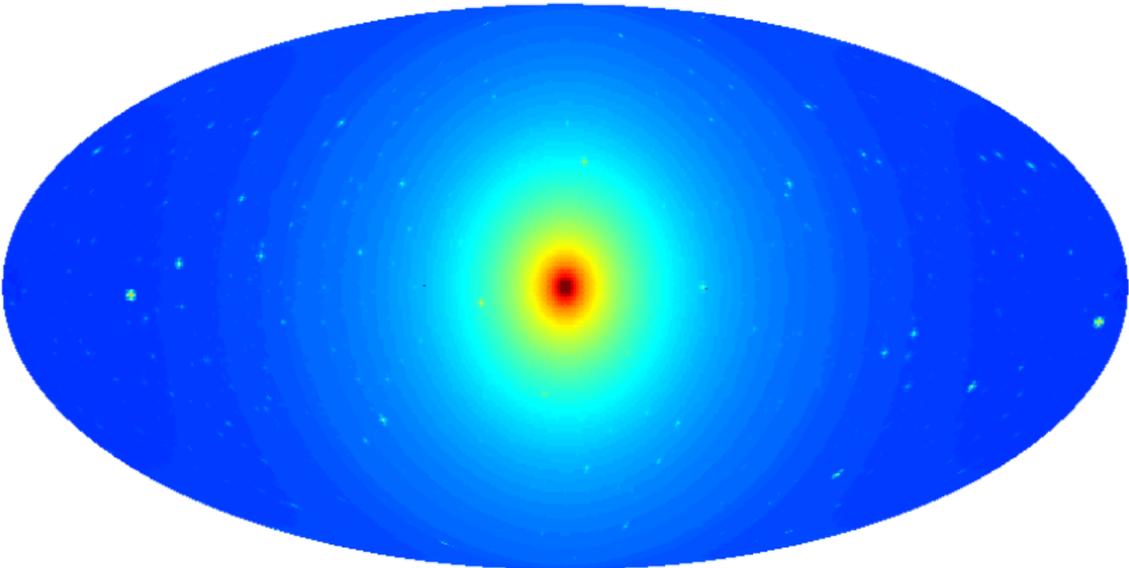
unsub



By Yuan et al [arXiv:1203.5636]

γ -rays: Galactic total

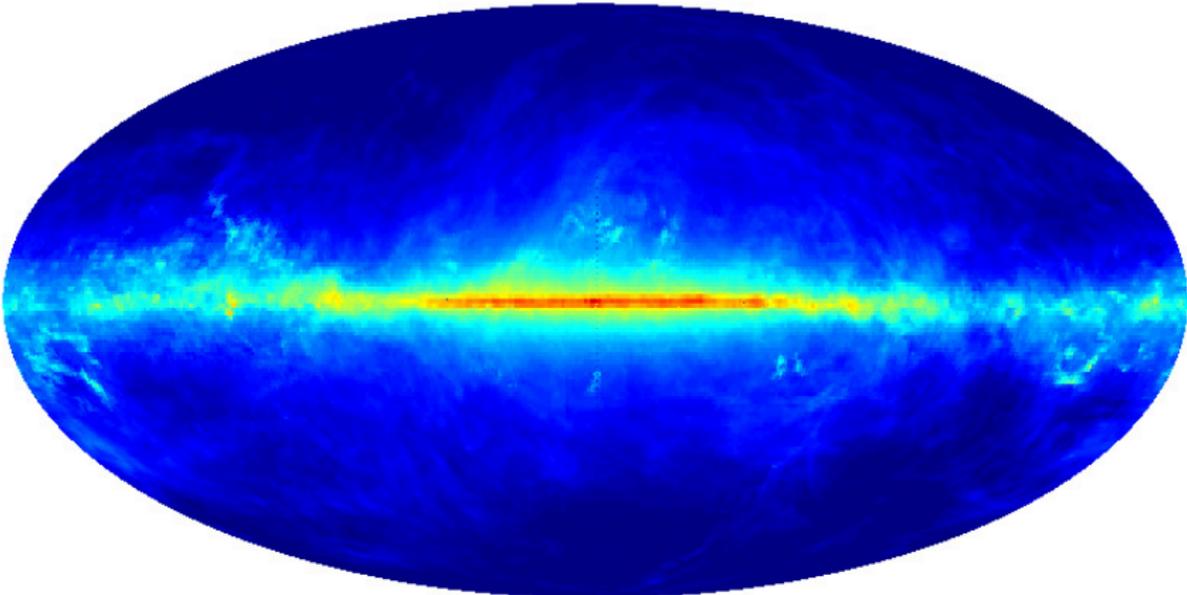
total



By Yuan et al [arXiv:1203.5636]

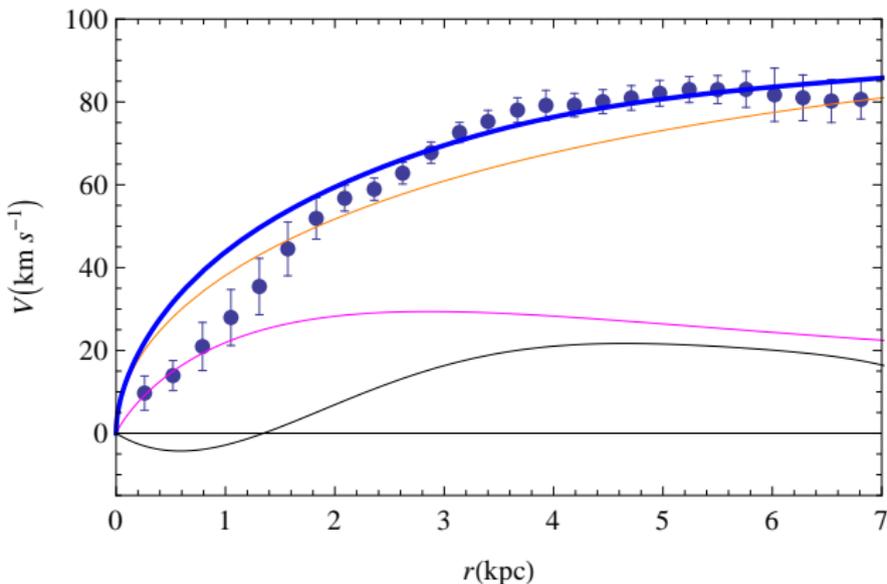
γ -rays: Galactic total + background

cdn+bkg



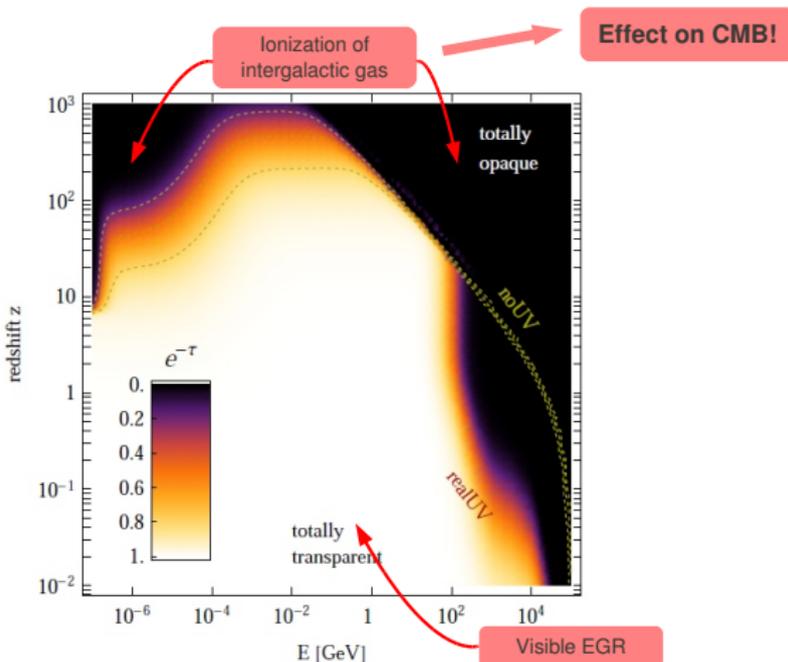
By Yuan et al [arXiv:1203.5636]

Problem of the dwarfs

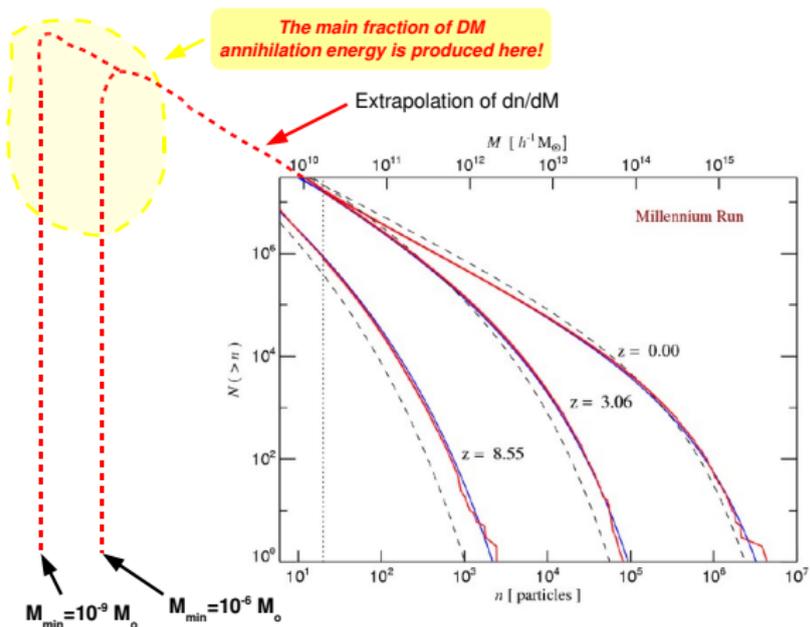


DM profile seems to be different than expected, e.g. Frusciante et al [arXiv:1206.0314]

Cosmological “gamma-ray window”



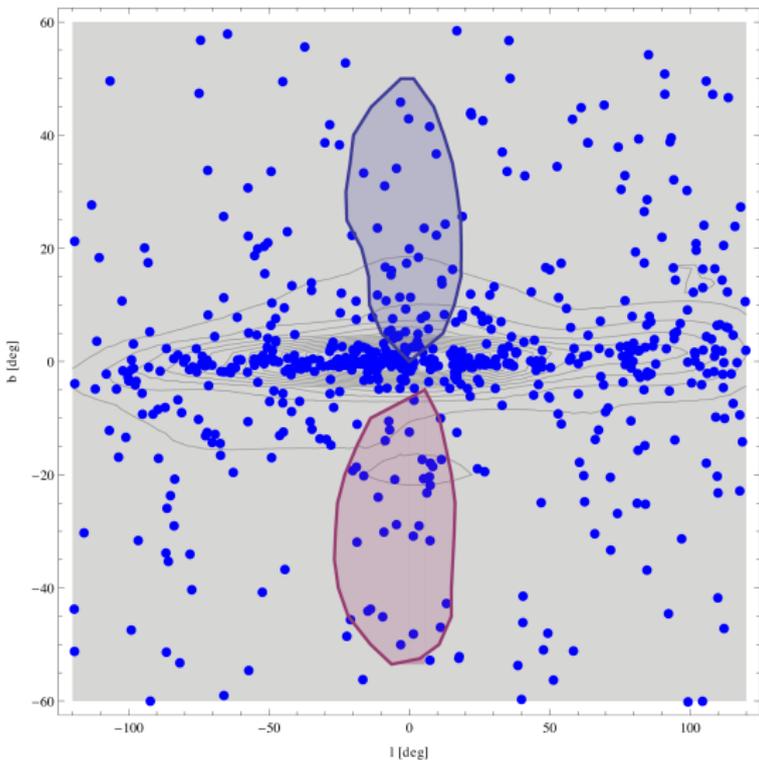
Gamma-ray window and the complementarity between extragalactic γ -rays and CMB observables [Hütsi et al (1004.2036), Cirelli et al (1012.4515)]

Halo distribution function $dn/dM(M, z)$: extrapolation and cut-off

Blue: Sheth & Tormen; **Dashed:** Press & Schechter; **Red:** N-body simulation;
Vertical horizontal dashed: the limit of the simulations. [Millennium Run]

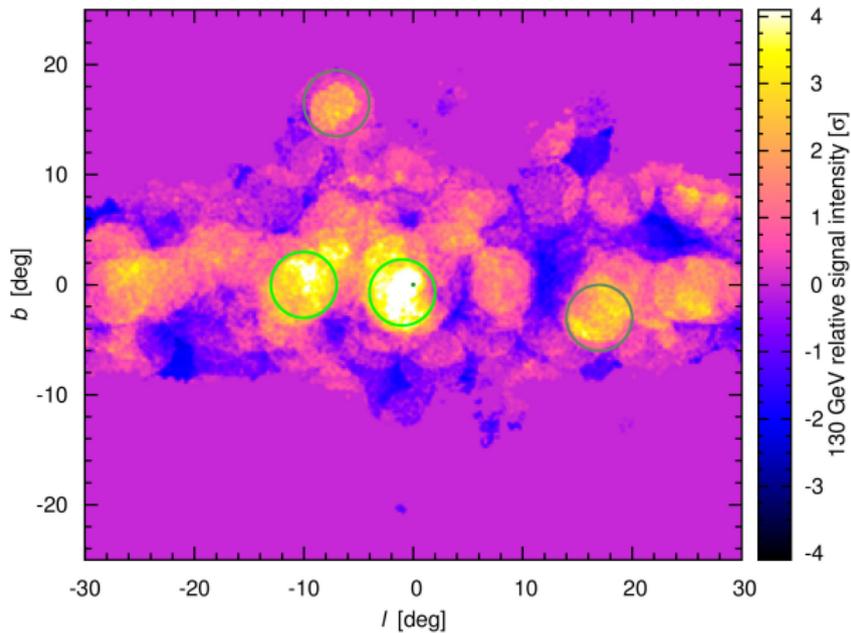
Lines in the γ -ray spectrum

Fermi data, photons in energy range 120...140 GeV



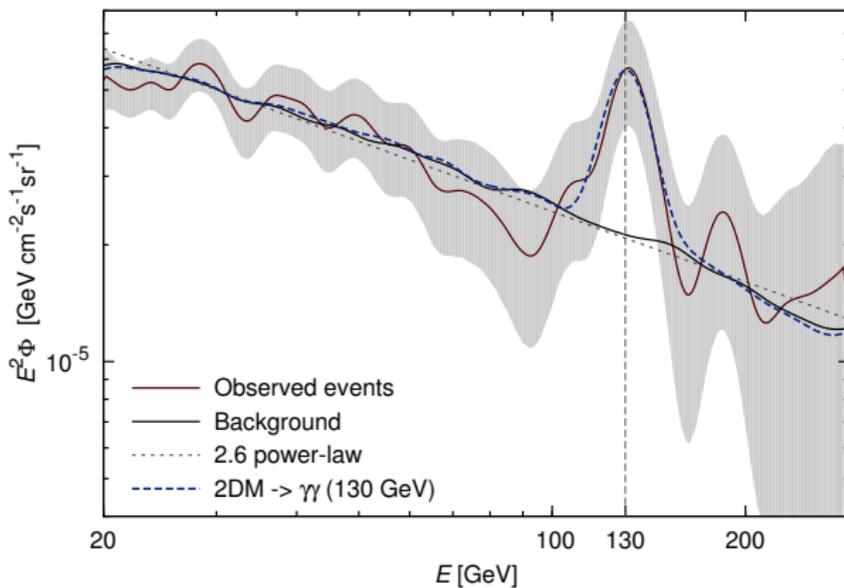
From Tempel et al [arXiv:1205.1045]

Fermi data, significance of the signal



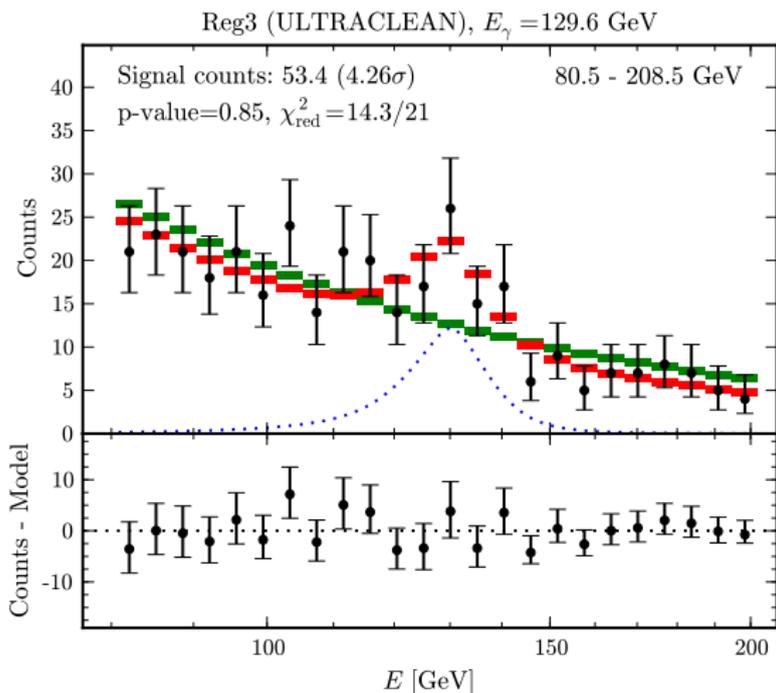
From Tempel et al [arXiv:1205.1045]

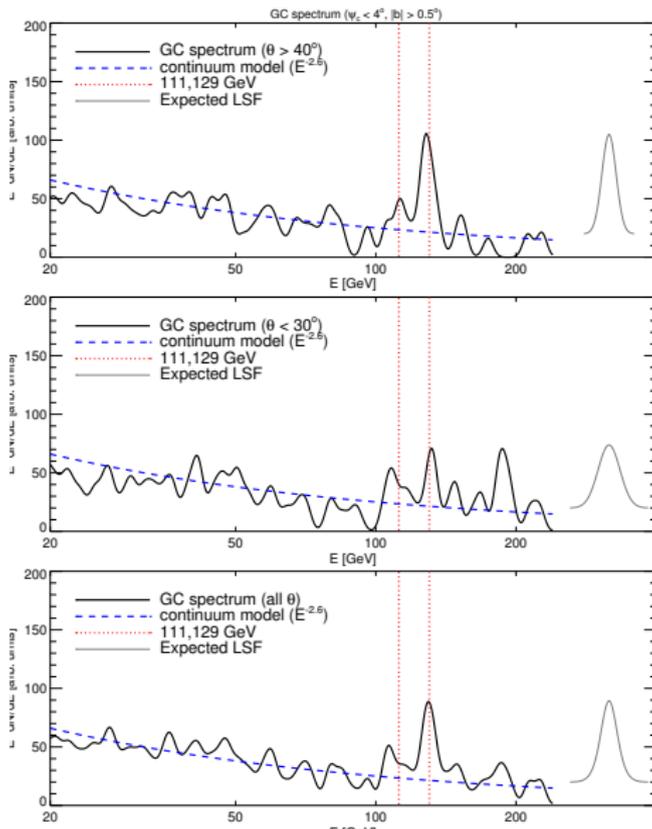
“130 GeV line” in the Fermi LAT data



From Tempel et al [arXiv:1205.1045]

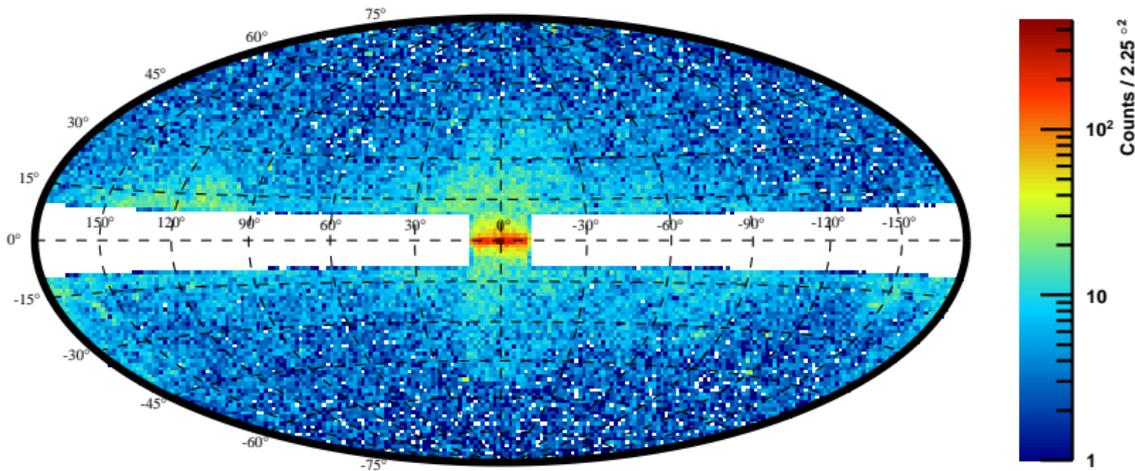
"130 GeV line" in the Fermi LAT data from Weniger





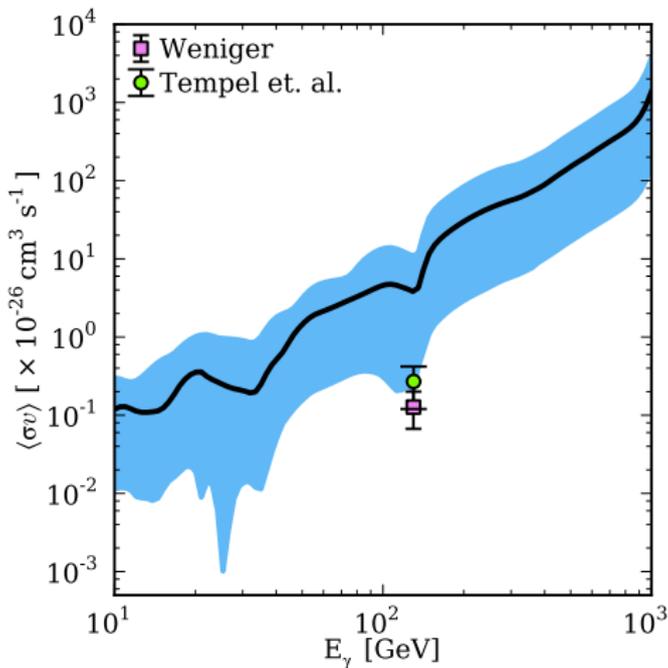
“130 GeV line” in the Fermi LAT data from Su & Finkbeiner [arXiv:1206.1616]

Analysis by the Fermi Collaboration, the region



Fermi Collaboration [arXiv:1205.2739]

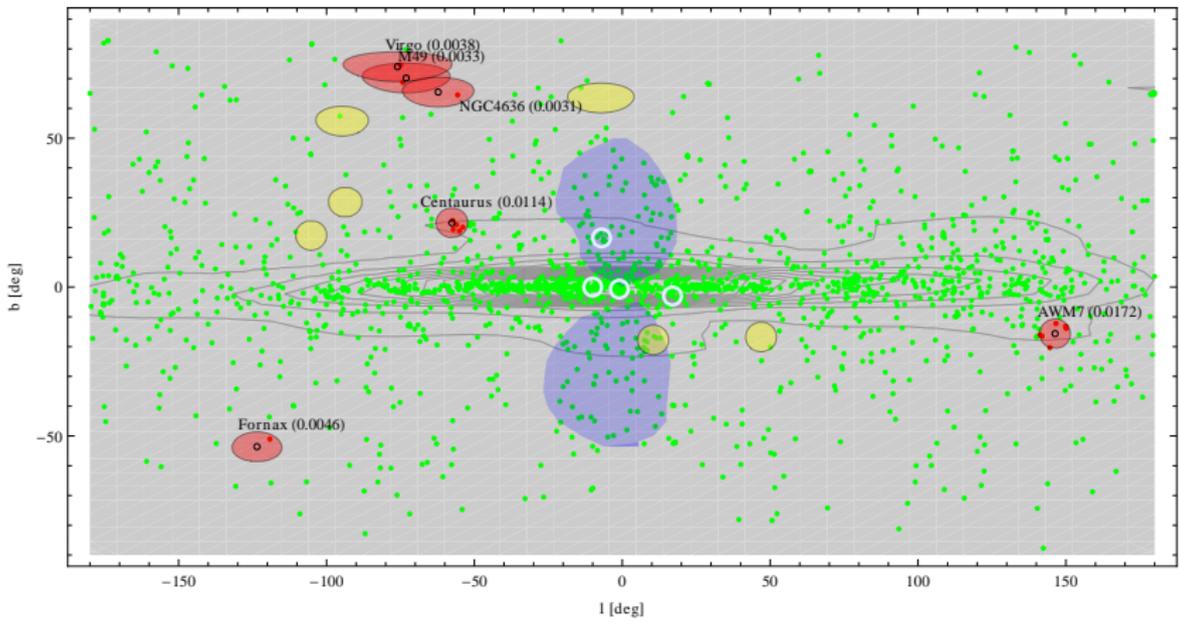
Constraint of dwarf galaxies



Geringer-Sameth & Koushiappas [arXiv:1206.0796]

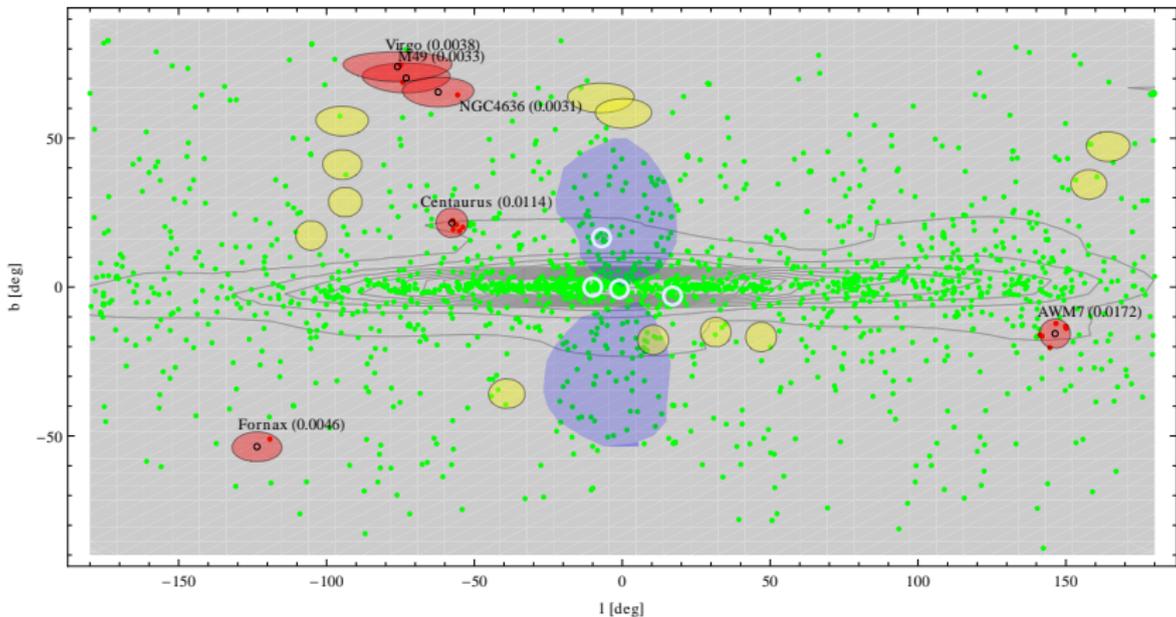
What about galaxy clusters?

Monte Carlo trials



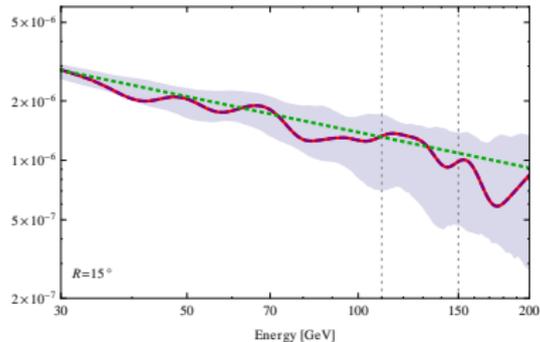
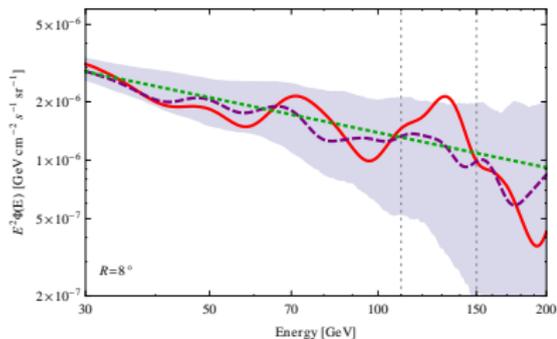
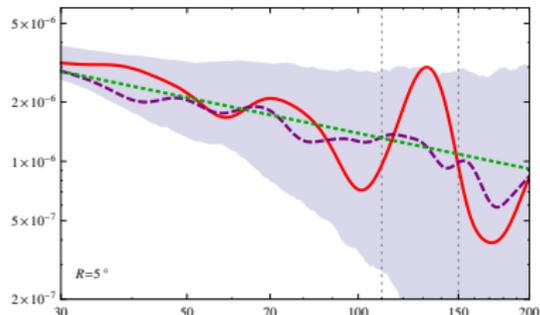
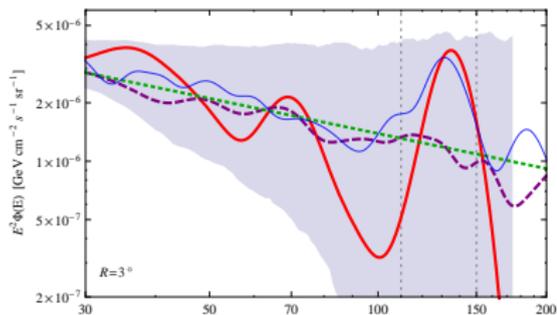
1 set...

Monte Carlo trials



2 sets...

Results: spectrum



Conclusions

Conclusions

Conclusions

- Excess in the γ -ray spectrum at 130 GeV and at the Galactic centre (4–6 σ) and galaxy clusters ($\sim 3\sigma$)
- Probably **annihilation** of DM
- Only γ -ray line signal is very restrictive for particle physics model building

Next?

- From Fermi LAT Collaboration: clarification of possible detector effects
- Next1: the morphology of the signal at the Galactic centre signal
- Next2: better energy resolution (CALET, TANSUO)

Thank you!