

Multi-frequency views of highish z dark matter halos

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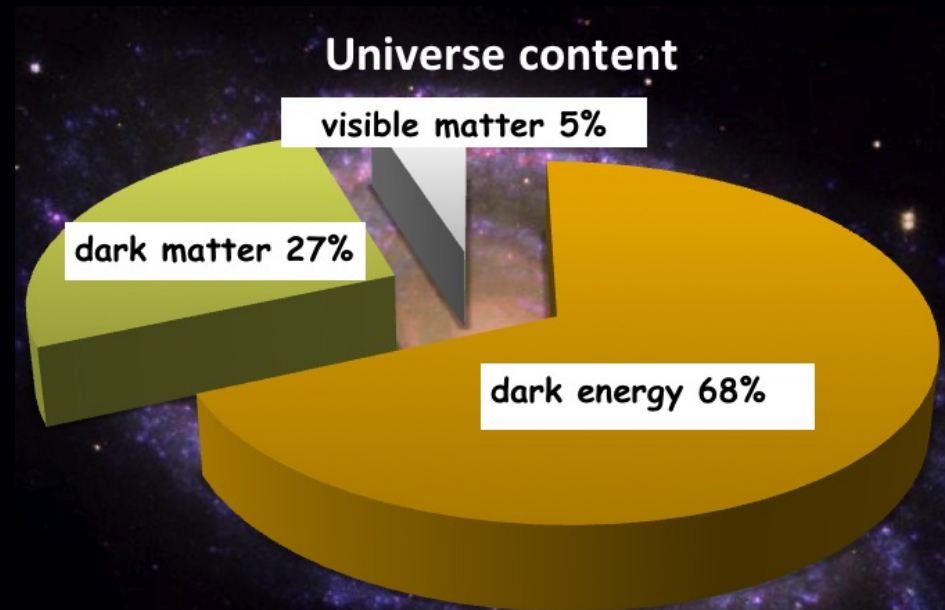
DARK MATTER

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JOHANNESBURG

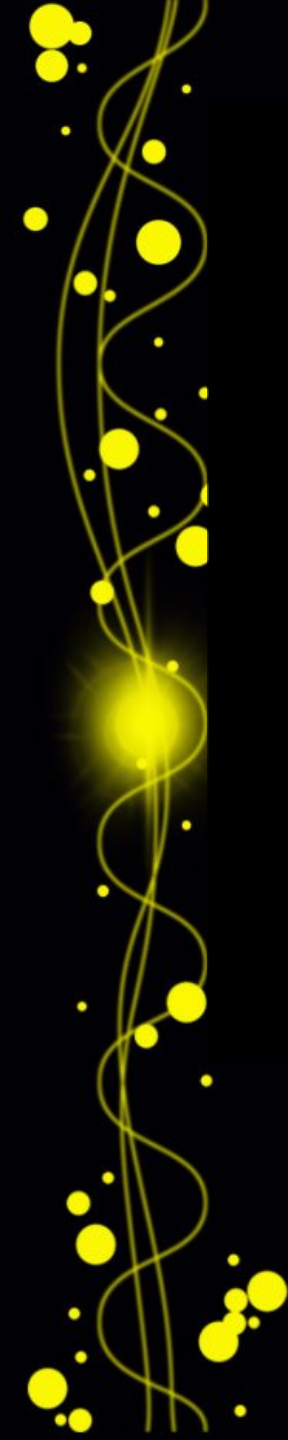


What do we know about dark matter?

- It's important
- It's massive
- It's probably a particle
- Electrically neutral



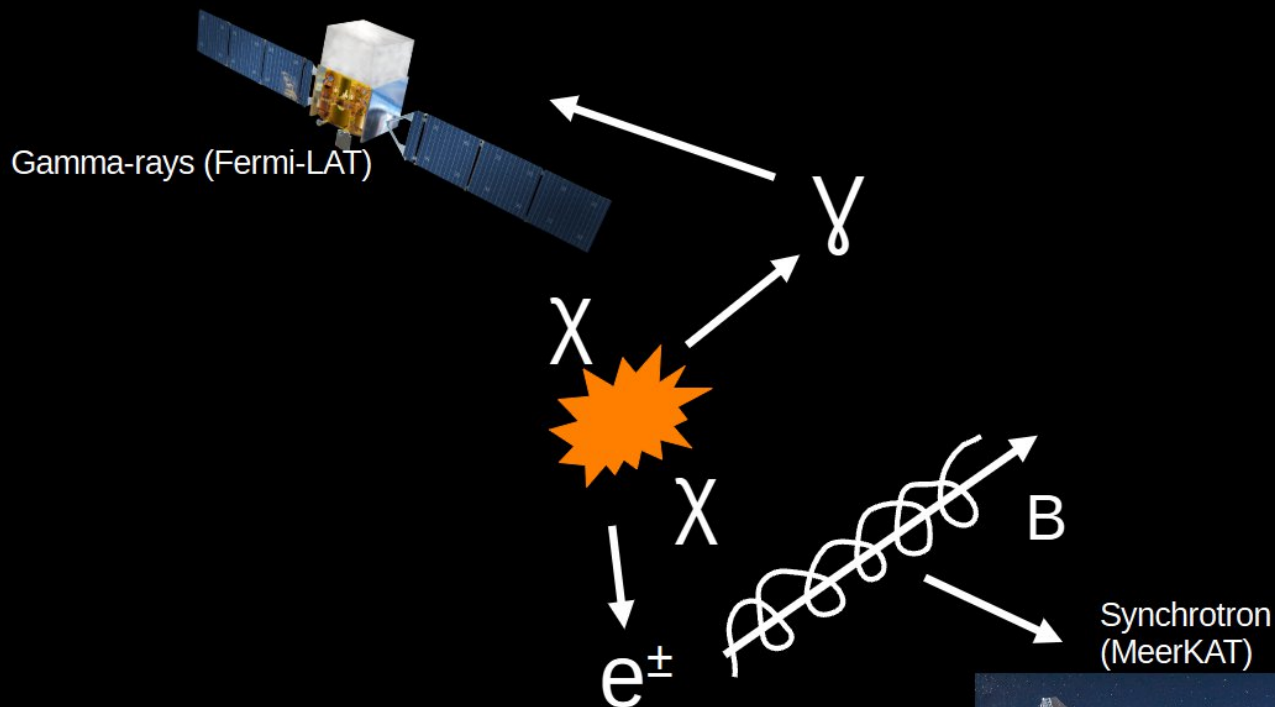
That's not much to go on....



DARK MATTER MATTERS

So how do we search for it?

What to look for?

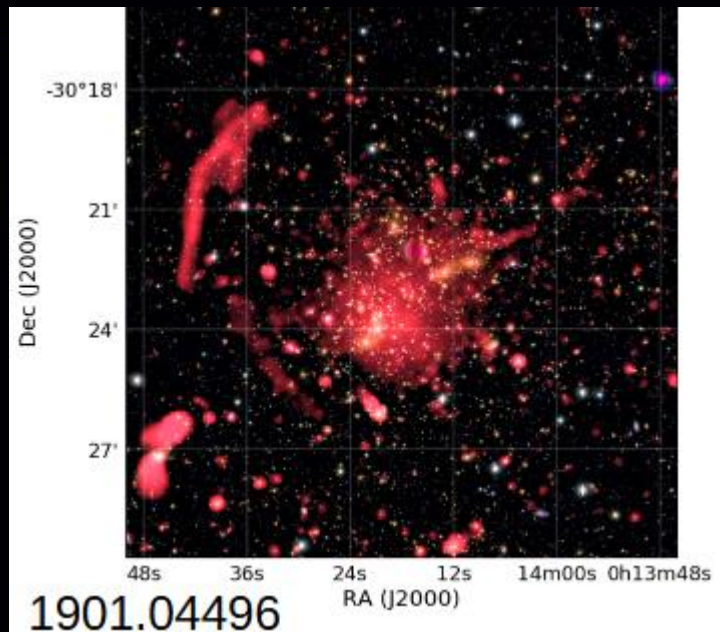


For large DM masses
(> 5 GeV)

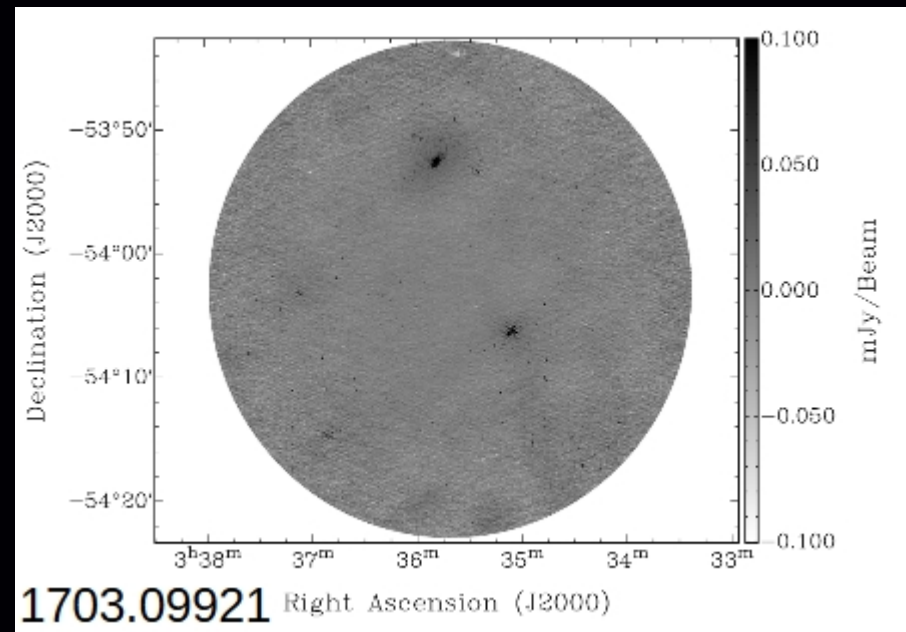


Signatures in radio

- Diffuse emission: no clear point source
- Dark matter exists in a halo
- Strong central emission from high density



Diffuse



Point sources

Solving diffusion equations

$$\frac{d\psi}{dt} = \nabla(D(E,r)\nabla\psi) + \frac{d}{dE}(b(E,r)\psi) + Q(E,r)$$

- Our own code: DarkMatters (publicly available)
- Crank-Nicolson discretisation
- Accelerated ADI solver like Galprop
- Matrix equations solved with sparse solver
- Fast and accurate

Particle physics

+

Dark matter halo

+

Magnetic field

+

Diffusion environment



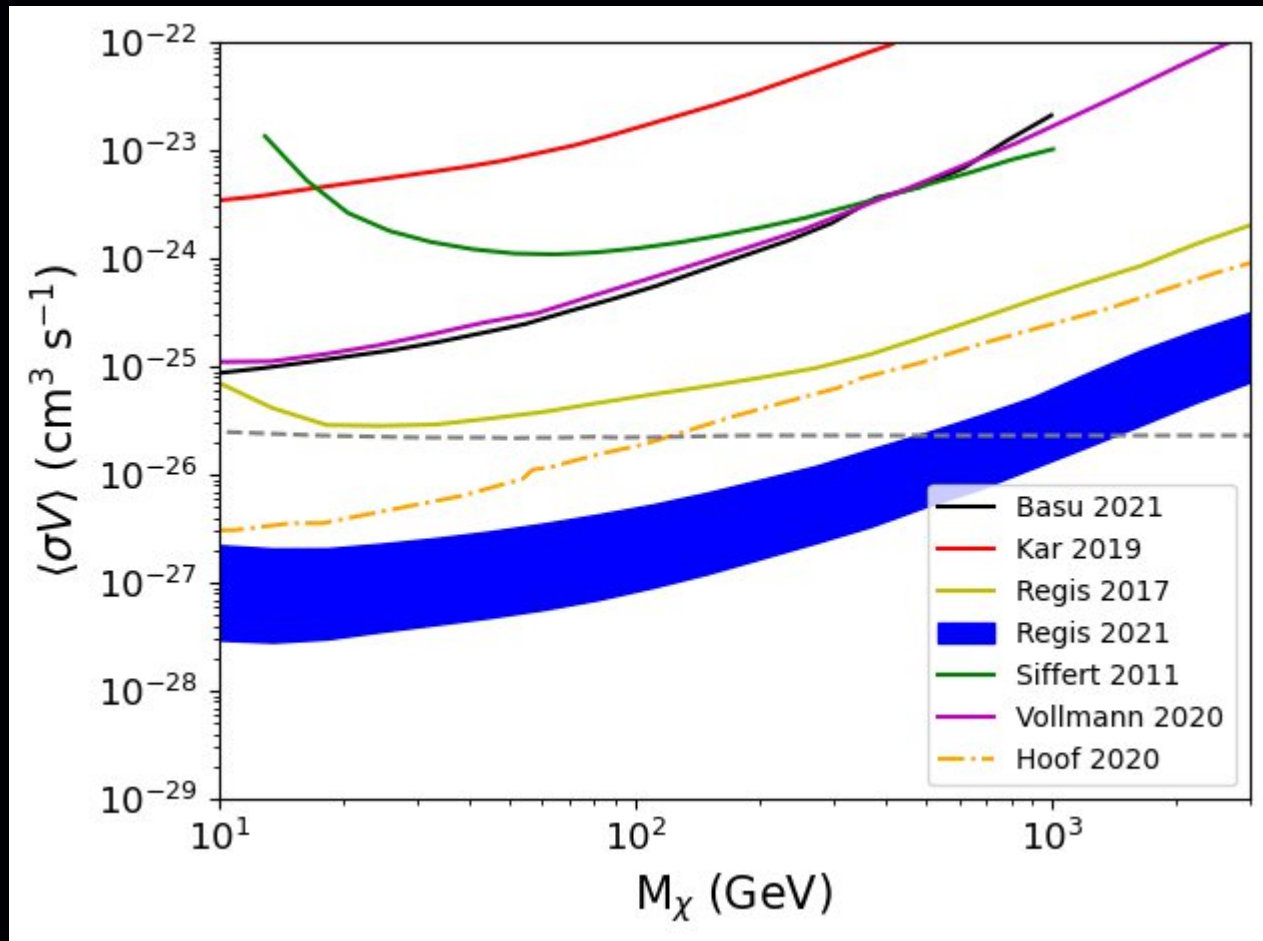
DarkMatters



Radio
predictions

Searches for WIMPs

- Haven't found DM
- Placed limits on annihilation rate

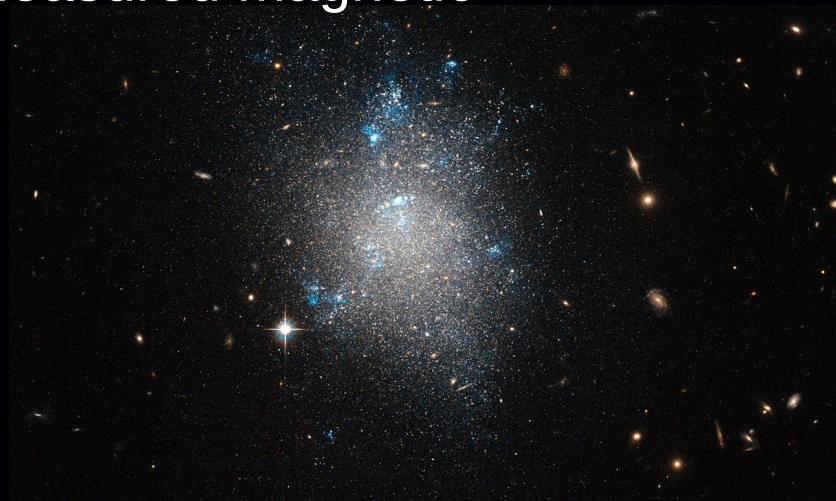


Galaxy clusters for dark matter

- Dark matter dominated
- Mass information via X-ray and SZ
- Magnetised (peak fields 2 - 8 μG)
- Lots of clusters at $z > 0.1$

What's the catch?

- Baryonic backgrounds
- Few clusters have well-measured magnetic fields
- Bad gamma-ray limits
- Far away





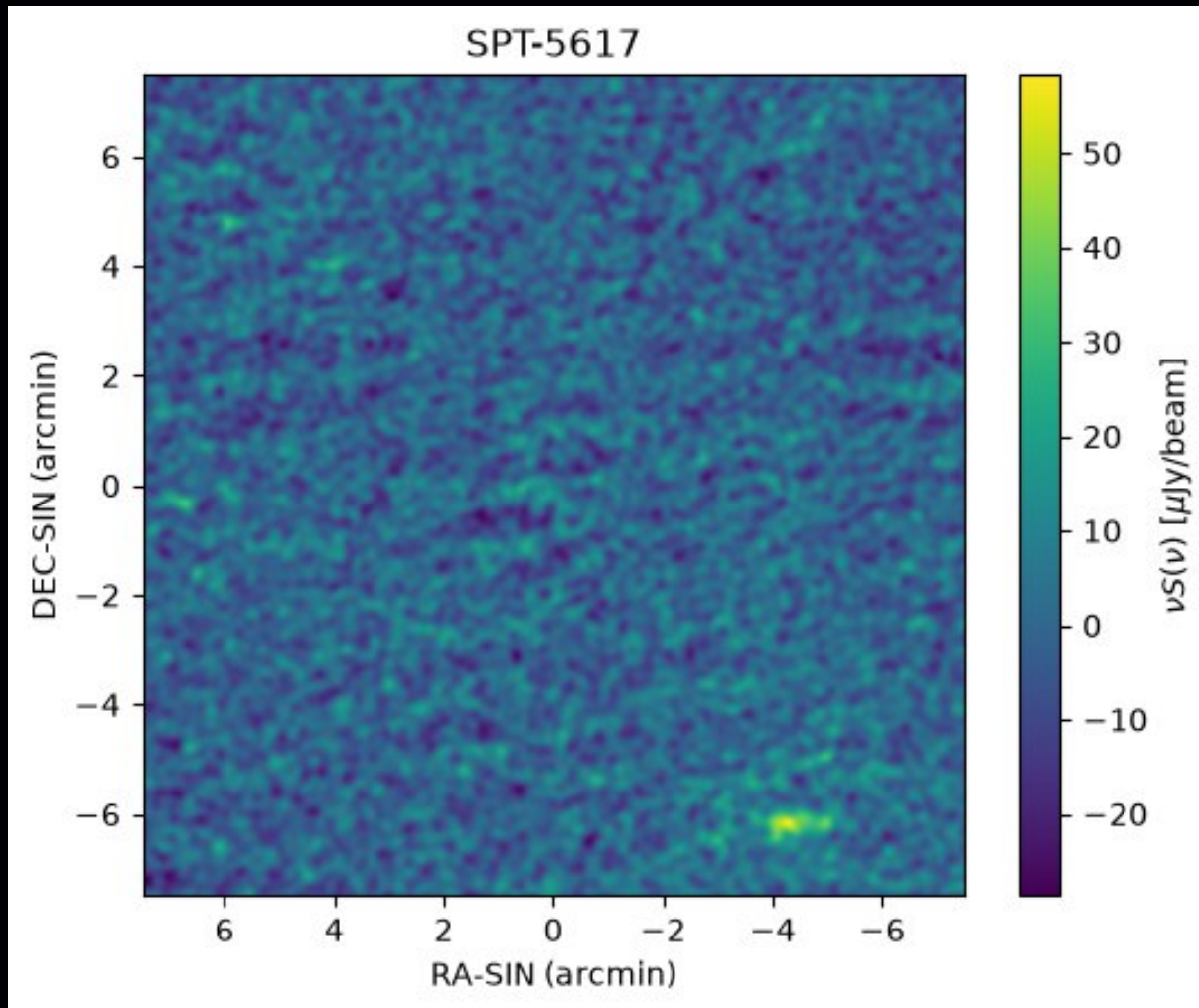
Our method

For each target we do the following:

- Subtract point sources (image plane only - PYBDSF)
- Compare residual map and DarkMatters map
- Perform MCMC search to get 95% confidence exclusion
- Targets:
 - SPT clusters 5331,5617,5522 (all of them $z > 0.15$)
 - From MeerKAT SPT survey data (Magalego et al)
 - M500 information available (SZ)
 - Halo geometry inferred from numerical fit averages
 - Virial masses $\sim 5 \times 10^{14}$ solar masses
 - Magnetic field has central value of 5 μG with a β profile

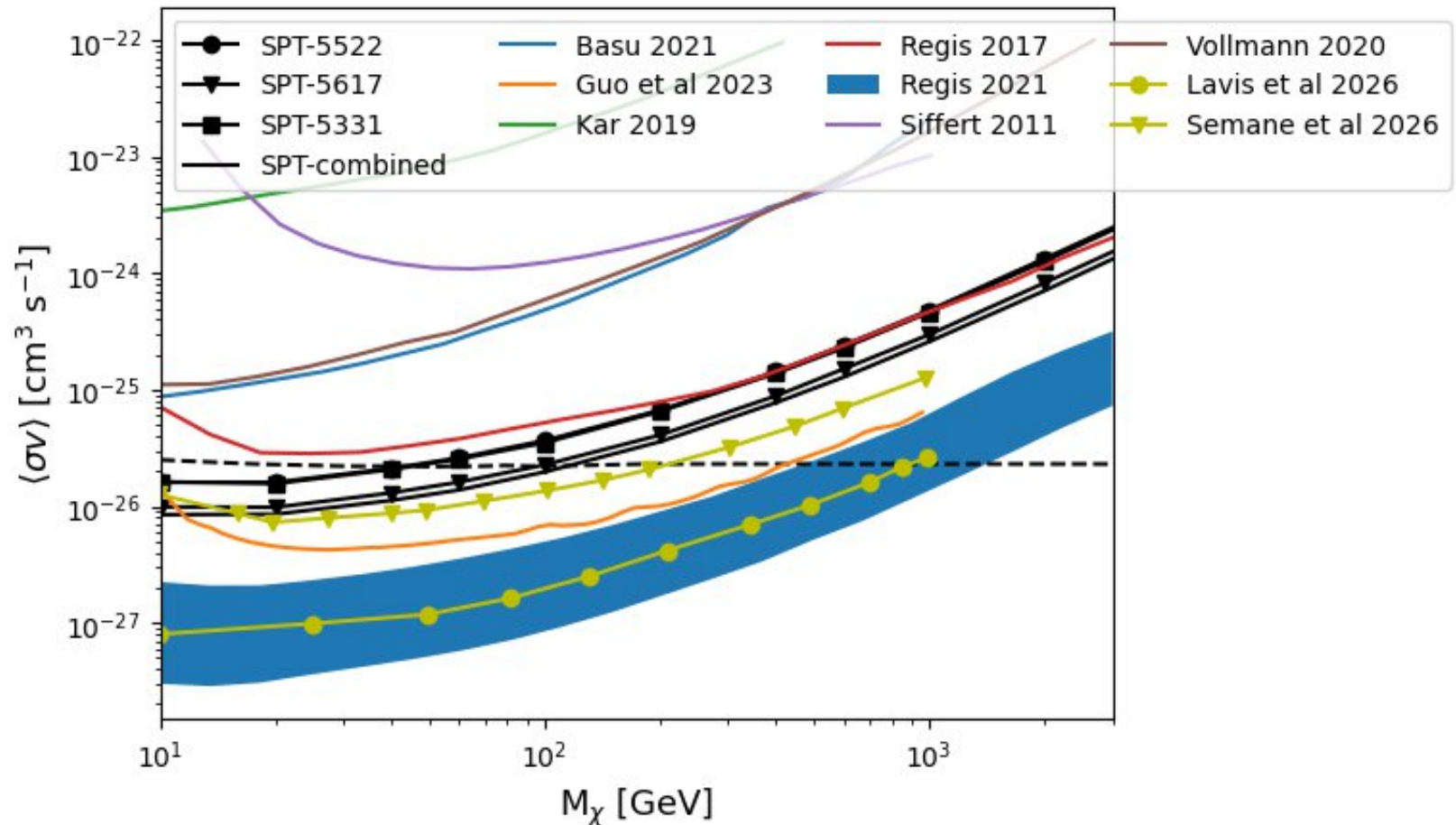
Results: SPT-5617

Preliminary residual map



Results: SPT Clusters

Preliminary!





Conclusions and the future

- MeerKAT has surprising constraining power at high redshifts
- Can combine many clusters to “average out” B-field assumptions
- Helps with the issue of radio limit robustness
- Multi-frequency? Gamma-ray limits are two orders of magnitude weaker.