UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

National Research Foundation | SARAO South African Radio Astronomy Observatory

PROBING THE 2HDM+S MODEL WITH MEERKAT

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Pan – African Astro-Particle and Collider Physic Workshop

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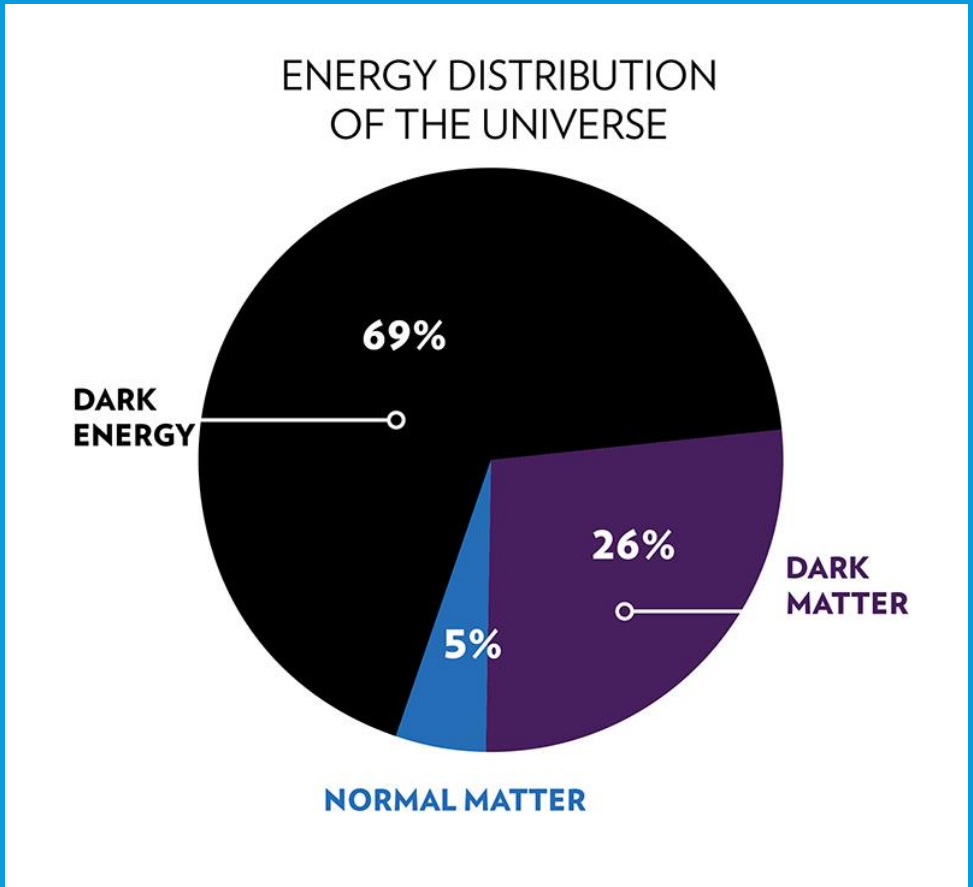
WHY DO WE CARE ABOUT DARK MATTER?



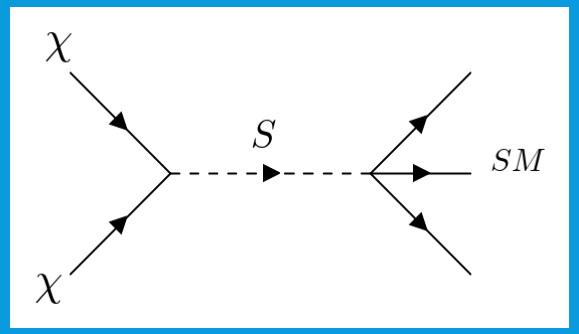
https://chandra.harvard.edu/chronicle/0108/universe/

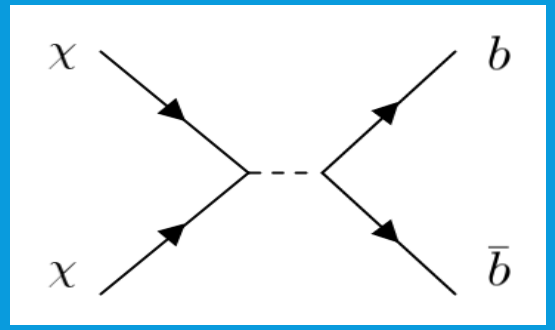
2HDM+S AND DARK MATTER

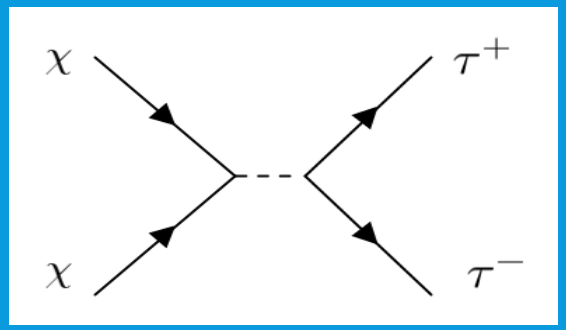
- Introduced as a particle physics model to explain anomalies within LHC data. 8 sigma excesses reported.
- H: heavy Higgs –like boson
- S : mediator scalar boson.
  - 4.8 sigma excess has been reported in the required mass range.
- χ : a dark matter candidate
  - 65-100 GeV

Effective decay vertex $H \rightarrow h\,\chi\chi$

ANNIHILATION CHANNELS



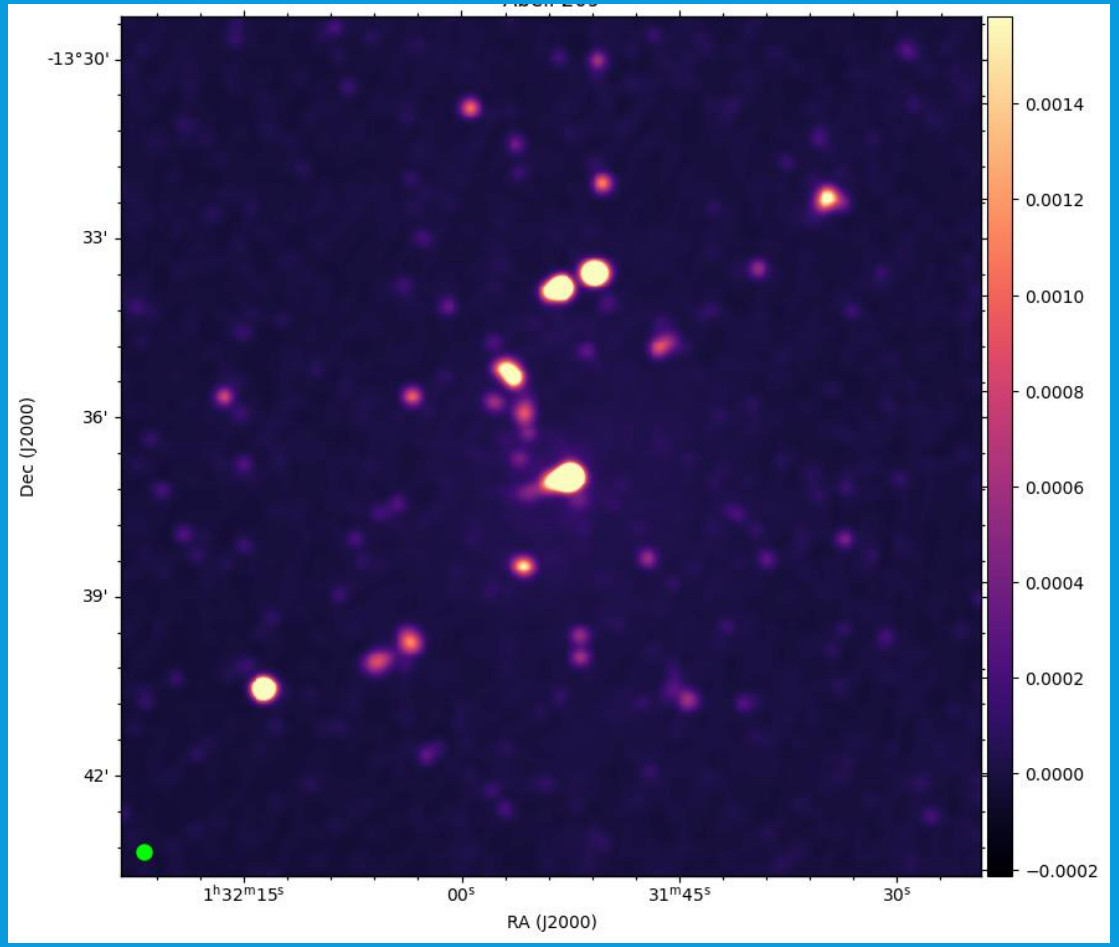




- We consider generic WIMP annihilation channels, bottom quarks and tau leptons, as well as the 2HDM+s model.
- The dark matter candidate interacts with the standard model via the mediator scalar S.

GALAXY CLUSTER SAMPLE

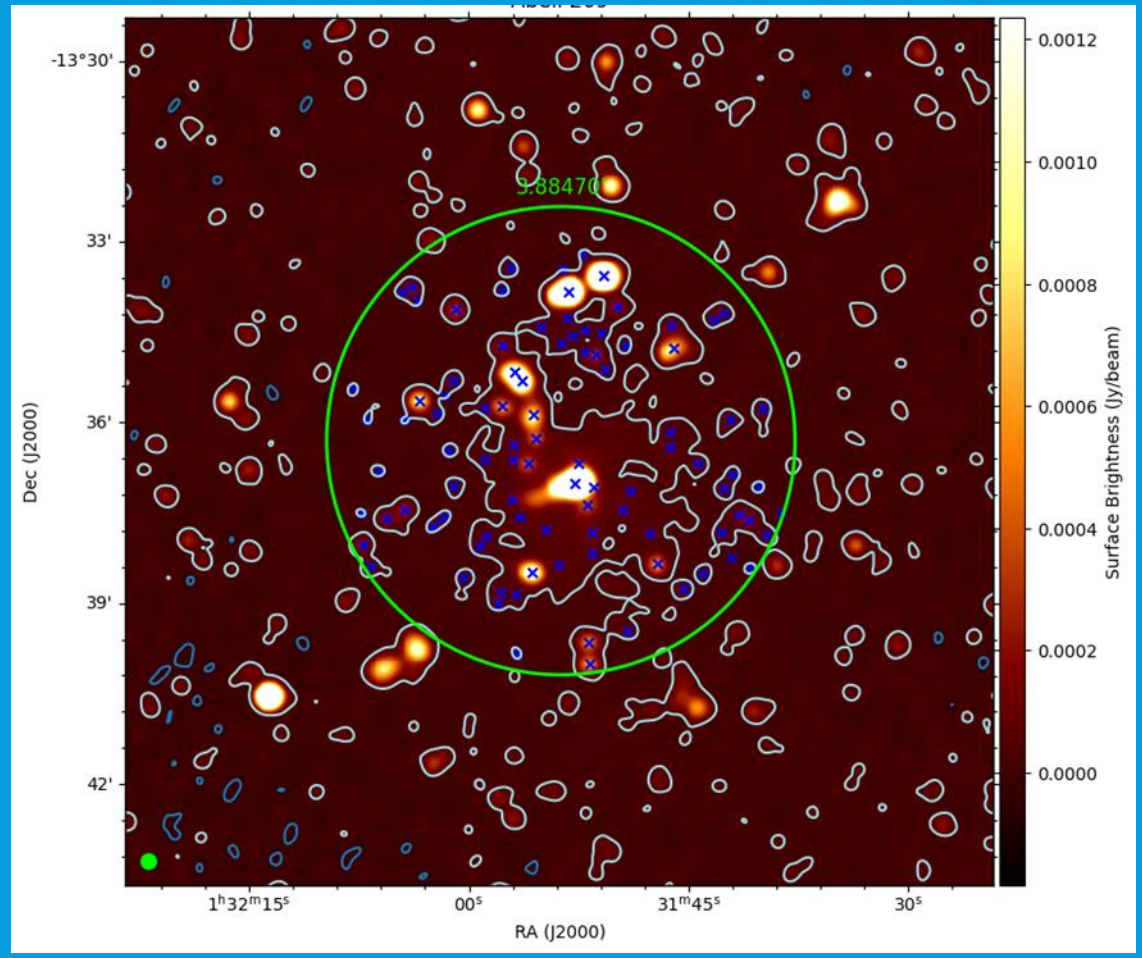
- Currently investigating 8 clusters from the MeerKAT Galaxy Cluster Legacy Survey.
- Properties of sample:
  - Diffuse emission present
  - Identified as halos
  - Mixture of radio and X-ray selected.



METHODOLOGY- MEASURED FLUXES

- The measured diffuse fluxes
- These fluxes are obtained by using a 3σ contour over the local RMS to identify region.
- SAODS9 used to measure integrated flux of the whole region (removes background)
- PYBDSF to identify point sources
- Remove the fluxes of the point sources

Abell 209

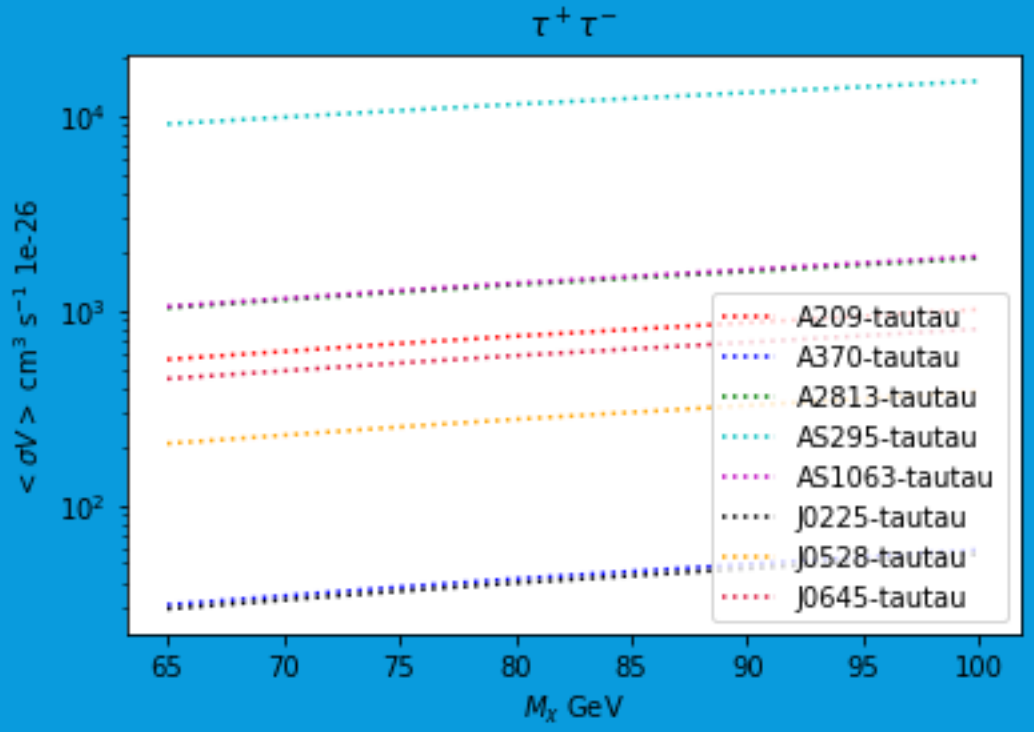


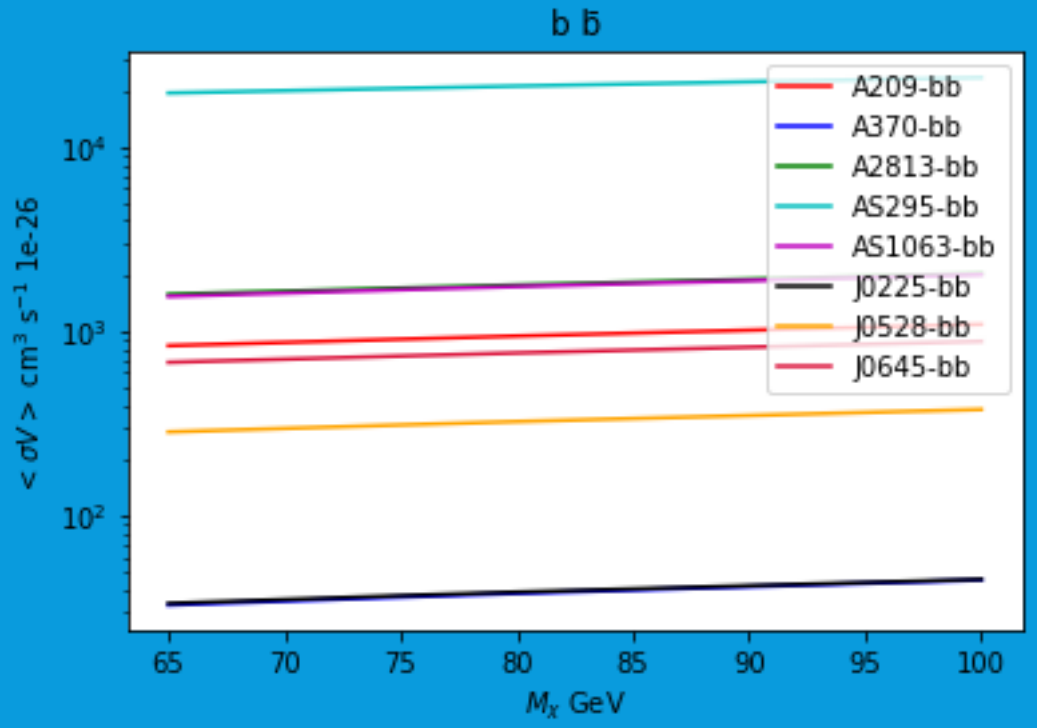
METHODOLOGY – PREDICTIONS

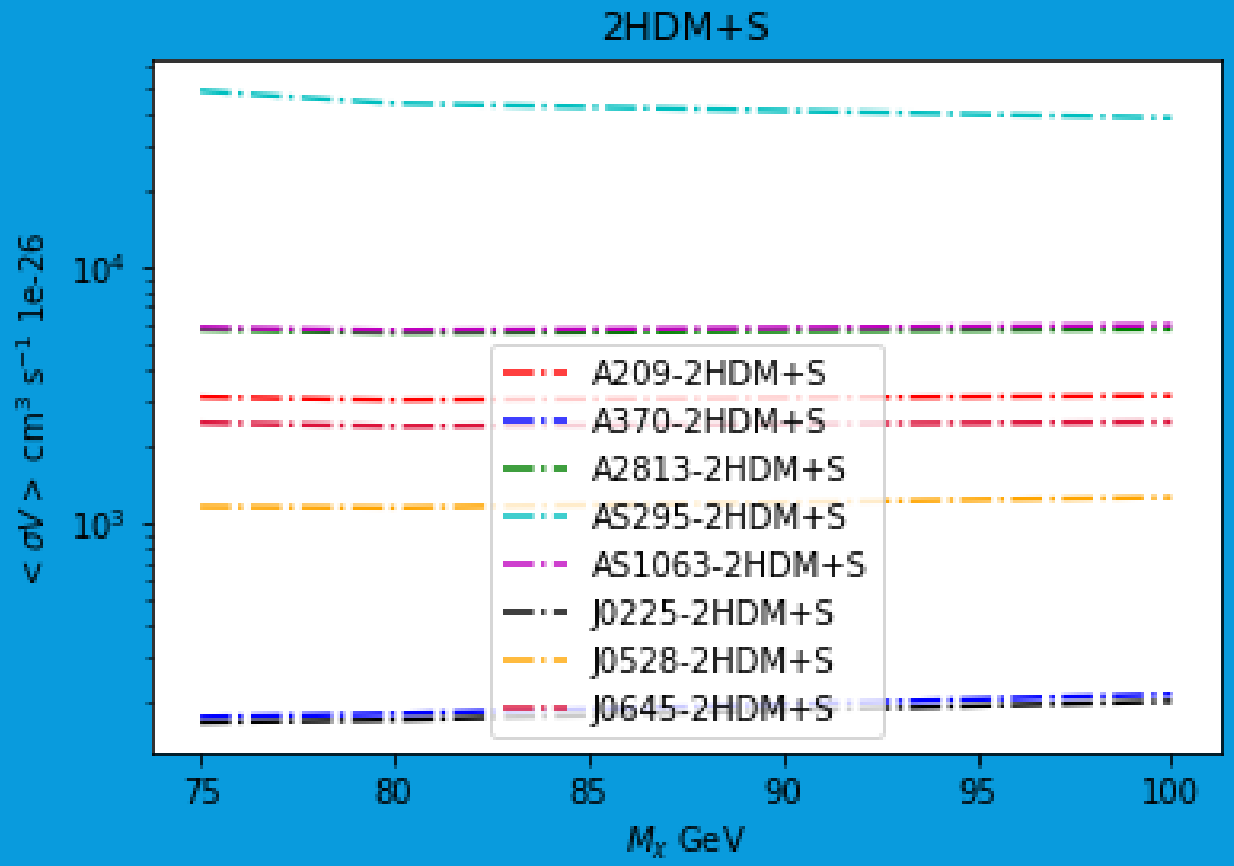
- Dr Beck's 'dark matters' tool is employed for the prediction of the synchrotron flux.
- Predict the synchrotron emission produced as a consequence of the annihilation process
  - Generate electron spectra produced as a result of the annihilation chains
  - Model the halo environment
    - Takes in physical properties of the halo, the characteristic density and the scale radius.
  - Model the diffusion processes
    - Considers the gas distribution, magnetic fields, loss processes
- The physical scales considers ~ 1000 kpc (size of region defined)
- Then left with the unknown $< \sigma V >$

LIMITS

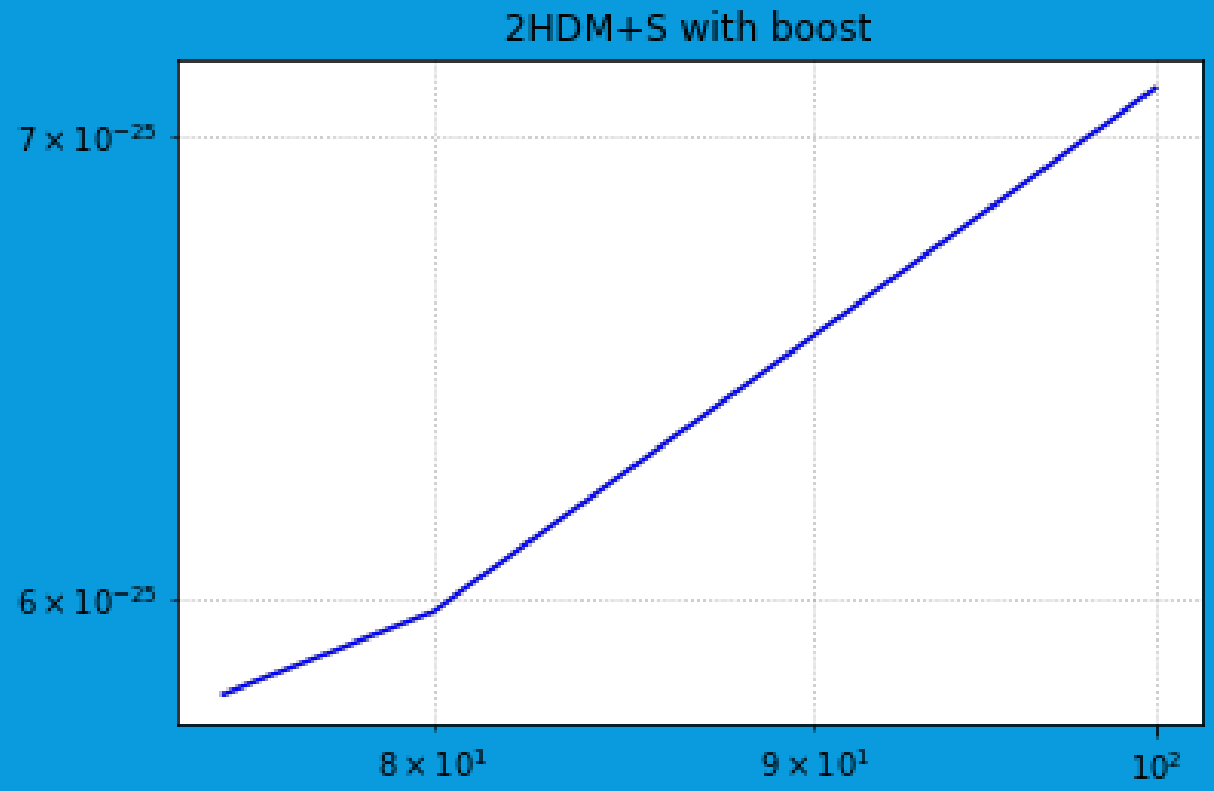
Limits on the cross section using a 95% confidence level







Have found cross sections that lie between 1e-24 to 1e-22



The cross section limits for Abell 370

The effects of substructure boost the signal and produce tighter constraints.
Scaled boosts calculated using relation presented in Jiang et al 2016

UNCERTAINTIES

- Uncertainties within the measured values:
  - Systematic uncertainty 5%
  - Various statistical uncertainties within measurement process
- Uncertainties within the modelling:
  - Unknown properties – gas distribution , magnetic field distribution.
  - Scaled using Coma properties
-

FURTHER WORK

- Moving forward we hope to obtain better limits by considering :
  - 10 additional clusters.
  - Stack individual cluster likelihoods.

Surface brightness profiles- clash between baryonic and DM cases.

Also consider clusters without diffuse signals - limited to just the noise.

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THANK YOU