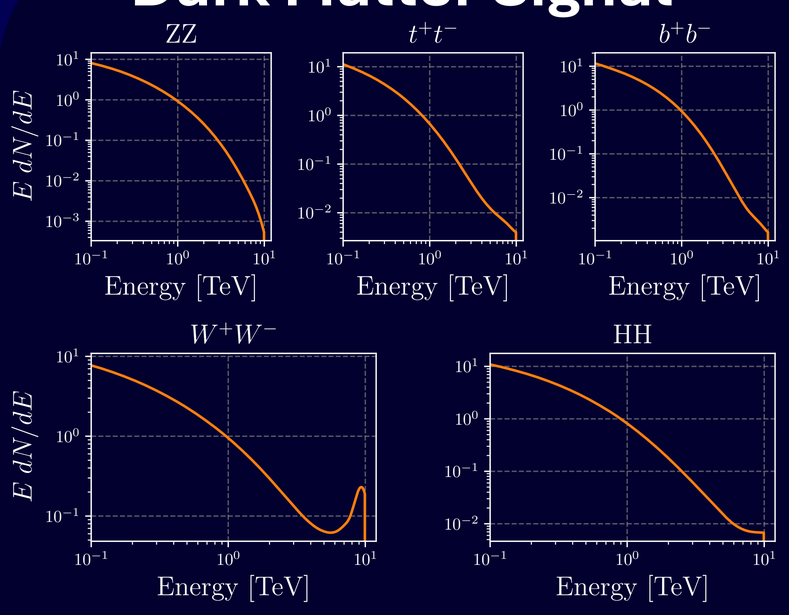
Model independent dark matter detection with GammaBayes

We introduce a statistical framework to extract dark matter annihilation or decay fractions from gamma-ray data. This allows a particle physics model independent approach to looking for a dark matter gamma-ray signature.

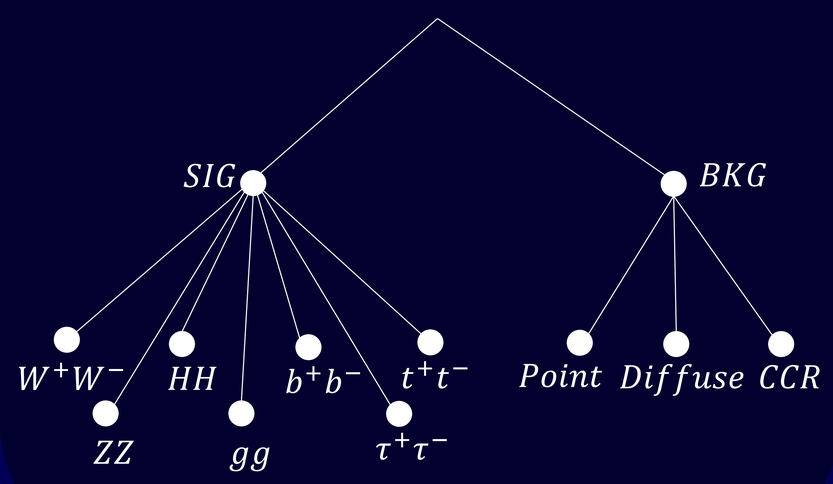
Dark Matter Signal



- Indirect dark matter searches look for by-products of dark matter annihilation/decay.
- Gamma ray by-products offer many benefits due to having no charge.
- The signal would be comprised of a weighted sum of standard model outputs or *channels*
- Most approaches look for a single channel over the backgrounds.
- However, this is still model dependent based on what output you decide is dominant.

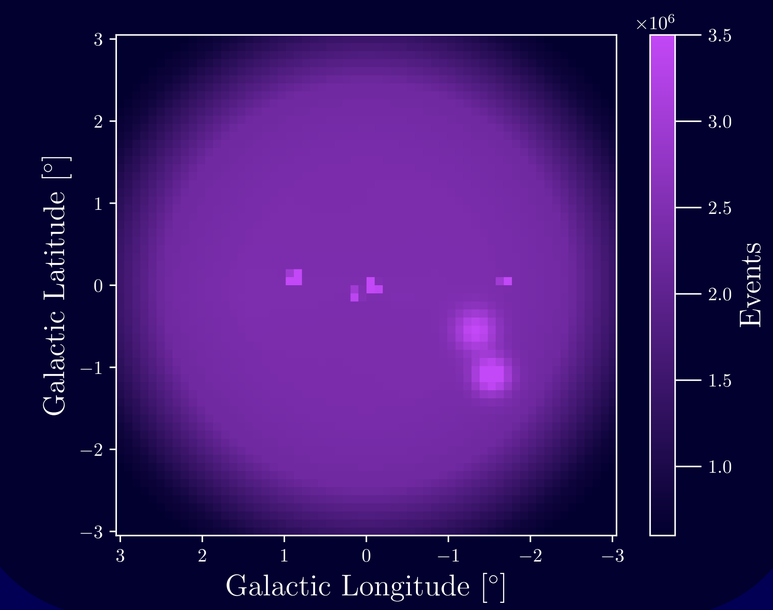
Mixture Modelling

- In this study we create a mixture model describing emission from individual annihilation/decay channels.
- The component weights of this model would correspond to the annihilation/decay channel ratios.
- We can use the same approach to handle the backgrounds.
- This allows robust inference on the overall signal fraction and the underlying physics through the fitted ratios.



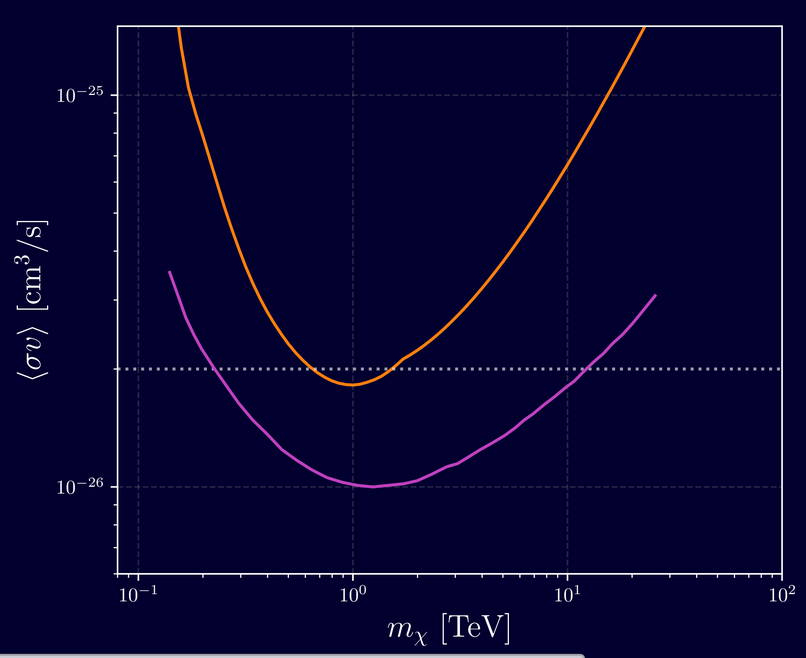
Where, why and how?

- We choose to investigate the Galactic Centre with CTAO.
- CTAO is an example of an imaging atmospheric Cherenkov telescope array that detects cosmic rays hitting the atmosphere.
- The Galactic Centre is expected to have large amounts of dark matter, leading to a larger signal.
- This region is complex and CTAO offers viable energy and angular resolution to resolve many possible confounding sources in the region.



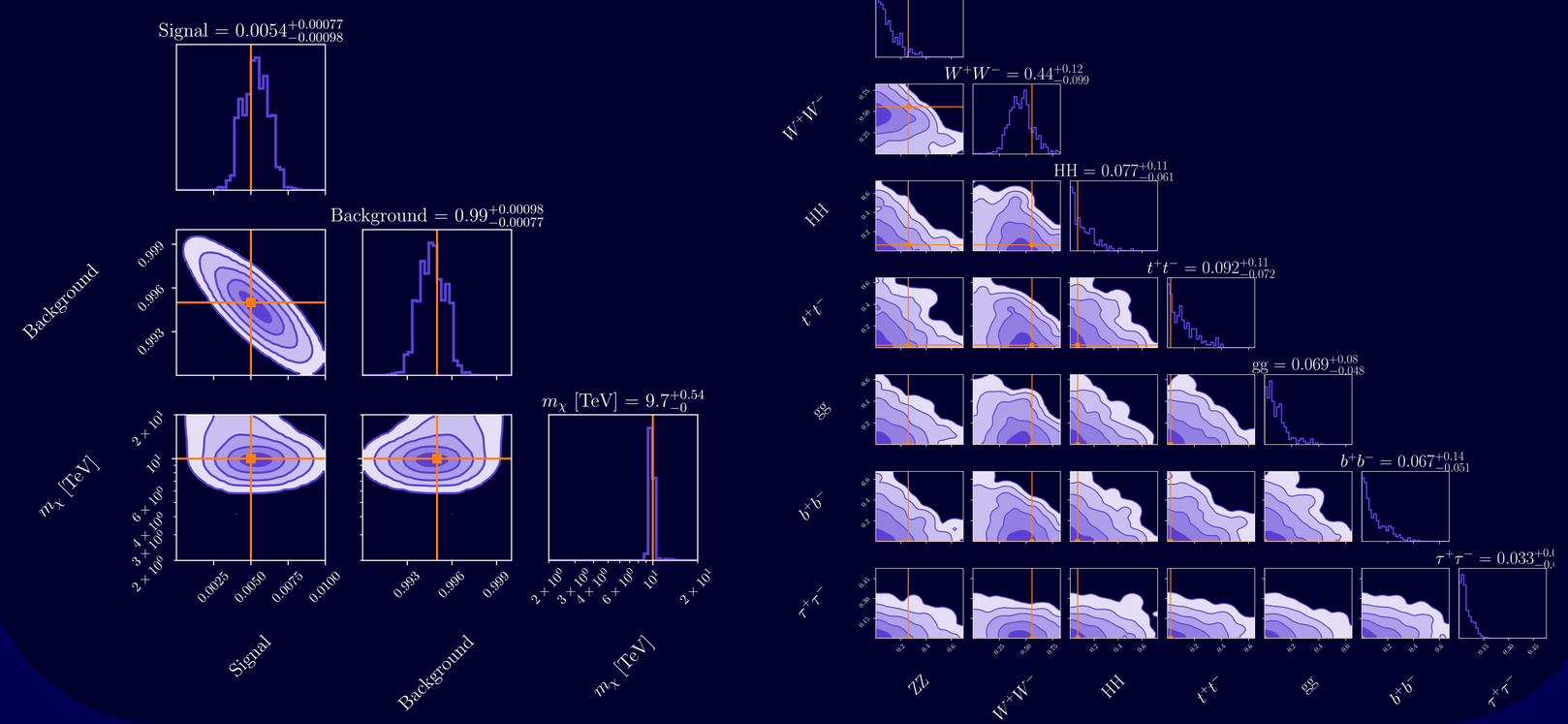
Non-detection information

- What kind of information can we extract in the case of a non-detection?
- Here, we can extract constraints on parameters related to the flux, such as the velocity-weighted annihilation cross-section (σv).
- Simulating 10^8 we can see what are the smallest values of $\langle\sigma v\rangle$ that we can exclude with 95% credibility.



5σ Detection Information

- What kind of information can we extract in the case of a 5σ detection?
- We simulated 10^8 gamma ray events detected by CTAO with 5×10^5 events originating from Z_2 scalar singlet dark matter with an Einasto density profile and mass of 1 TeV.
- We use *GammaBayes* to extract the signal fraction, dark matter mass, background weights and channel contributions



Next Steps

- To further increase the realism, we will need to increase the complexity of our background models.
- We can further generalise the dark matter model by using more generalised models, such as for the dark matter density profile.
- We can also ask "if a signal is detected, what kind of follow ups would the community require to fully believe this detection?"

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