



# CTA sensitivity to branon dark matter models

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**in collaboration with**

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Main goal: Study CTA sensitivity to branon dark matter, i.e. a specific type of WIMP

## Branons

- Branching ratios
- Spectra

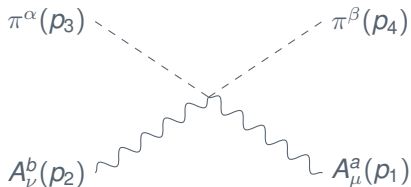
## Analysis plan

- Simulation
- Analysis
- Cross sections

## Conclusions



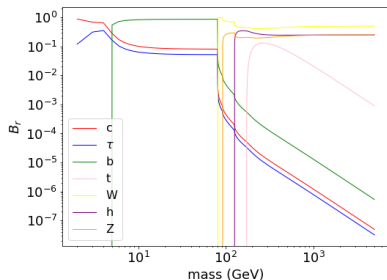
- ▶ theory: brane-world extension of SM [Cembranos+03]
- ▶ the existence of large extra dimensions has been proposed as a new setting for a possible solution to the hierarchy problem
- ▶ branons are brane vibrations
- ▶ they are an interesting example of WIMP which could have high enough mass and account for the right amount of DM in the form of a thermal relic in the GC [Cembranos, Gammaldi+12, Cembranos, Gammaldi+13]





- ▶ WIMPs that annihilate producing SM particles [Cembranos+11]
- ▶ Branching ratios depend on branon mass:  $B_r^i = B_r^i(m_\chi)$

$$\frac{dN}{dE} = \underbrace{\int_{los} \rho_A^2(r) dr}_{\text{J-factor}} \underbrace{\frac{\langle \sigma v \rangle_{th}}{8\pi m_\chi^2} \sum B_r^i \frac{dN_i}{dE}}_{\text{particle physics factor}}$$

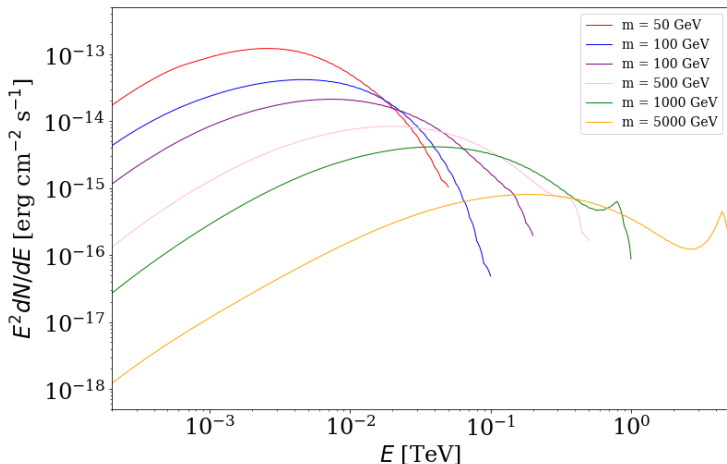


Plot generated following expressions in Cembranos+03

# Branons spectra



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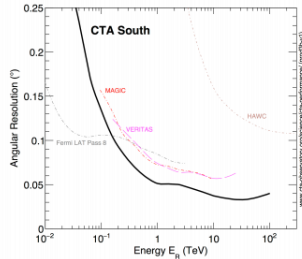
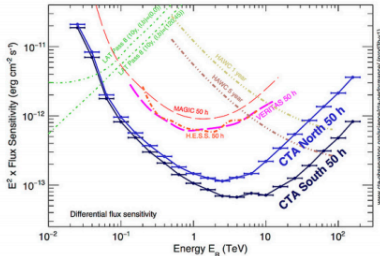
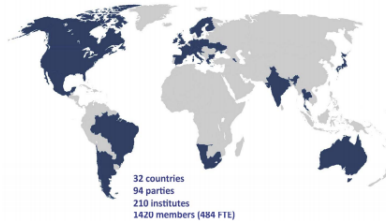


plot computed using PPC4DMID [Cirelli+11] and applying electroweak corrections

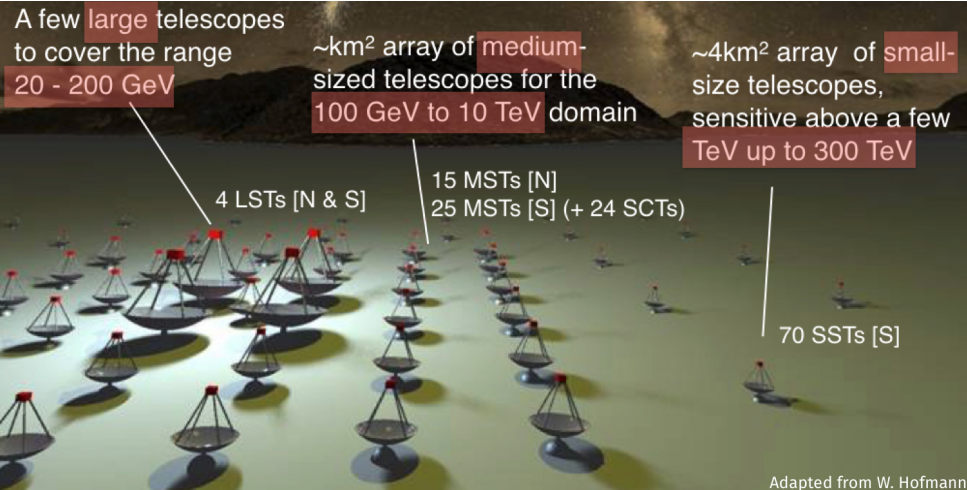
# Cherenkov Telescope Array (CTA)



Big international effort: more than 30 countries and 200 institutions



# CTA layout



Adapted from W. Hofmann



1. Simulate branon spectra as will be measured by CTA
2. Use CTA standard tools for analysis: `ctools`
3. Full CTA energy range
4. We will consider different observation times
5. J-factor from a promising DM source (still under debate)
6. Aim: obtain  $\langle\sigma v\rangle$  values needed to
  - i) get a signal detection
  - ii) set 95 % c.l. upper limits in absence of a signal

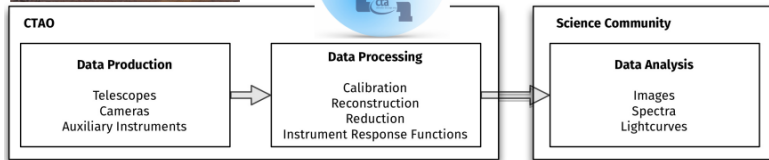
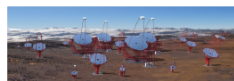


# Analysis workflow



## ctools

- ▶ Set of Fermi tools-like executables for data analysis by users; utilities for operating on CTA event data
- ▶ Use latest “prod3b” instrument response functions (IRFs)
  - ▶ Energy resolution
  - ▶ Angular resolution
  - ▶ Effective area
- ▶ `ctobssim` - simulate photon events from the chosen source
- ▶ `ctlike` - analysis: Maximum likelihood ratio test

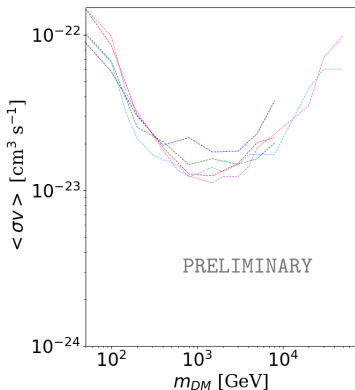


# Results

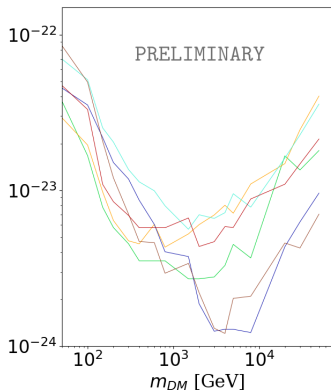
Cross section as a function of the branon mass



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$\langle \sigma v \rangle$  values for detection



$2\sigma$  upper limits for  $\langle \sigma v \rangle$

2h obs, different MC seeds  
currently running many more simulations  
goal: mean values  $\pm 1\sigma$  expectation bands



- ▶ Study of CTA sensitivity to branons with `ctools`
  - ▶ Realistic observation times and latest IRFs
  - ▶ Spectra already in place
  - ▶ Now generating plenty of simulated data
- ▶ Obtain the cross section for detection and set 95 % u.l. in absence of a signal
- ▶ Example of CTA's super capabilities to probe specific models of TeV DM



**Thank you!**



Back-up

# DM predicted sensitivities for CTA

