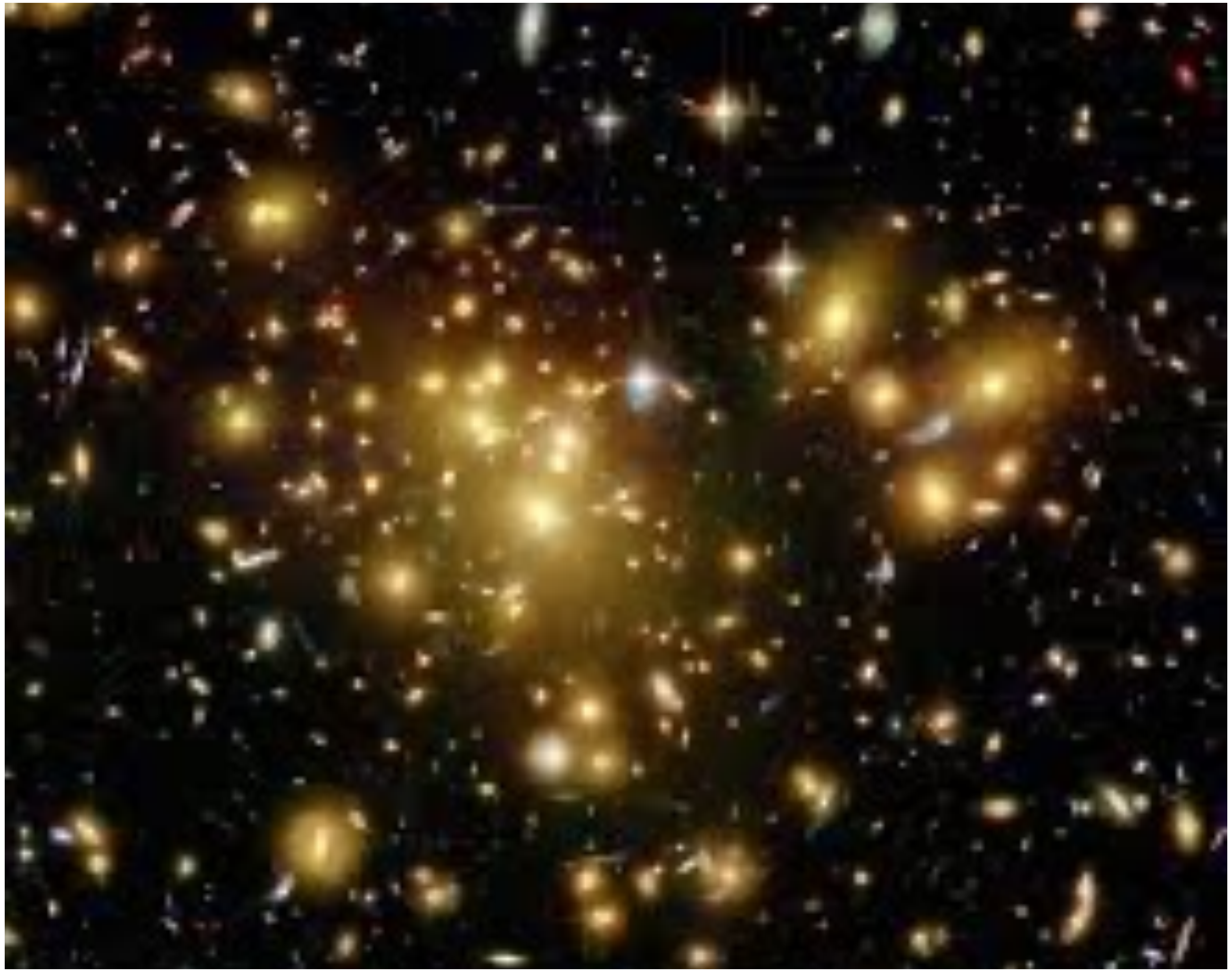
# Optimized dark matter searches in deep observations of Segue 1 with MAGIC

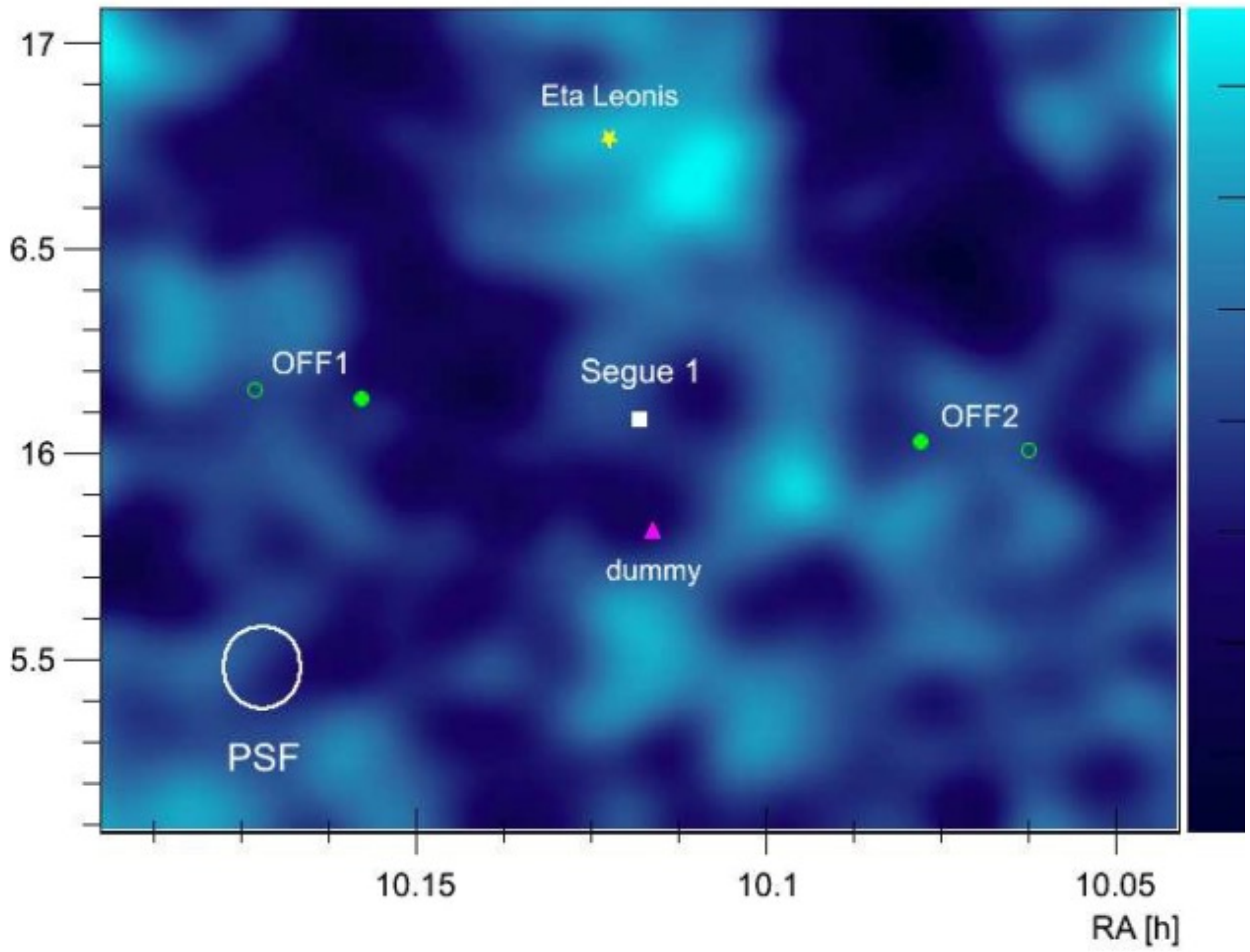
# What is dark matter and where find it?

- Compose 85% of the mass of the universe
- Is neutral, stable and non baryonic
- Particle with this beaviour don’t exist in the standard model
- This study is searcing for a particular type of dark matter particle called WIMPs, weakly interactive massive partiles
- This work present the result of observations of the galaxy Segue 1, one of the most DM dominated object known



# The indirect detection of dark matter particles

- The telescope search for gamma ray created by the products of DM annihilation and decaying.
- With almost 160 hour of good quality data no gamma ray  signal is detected.
- The collected data are used to set the constraints on various model of DM annihilation and decay
- The data is taken from two different area: the ON region, pointing in the direction of Segue 1 and the OFF region, detecting the background noise.



# Full likelihood analysis

- The data is analysed whit the full likelihood method. This approach maximizes the sensitivity to gamma ray signals of DM origin by including the information about the expected spectral shape (depending for a given model).
- P_off is determined from the data, whereas P_on depends by the differential gamma ray flux, predicted by the DM model used.

$$\mathcal{P}(E; M(\theta)) = \frac{P(E; M(\theta))}{\int_{E_{\rm min}}^{E_{\rm max}} P(E; M(\theta)) dE},$$

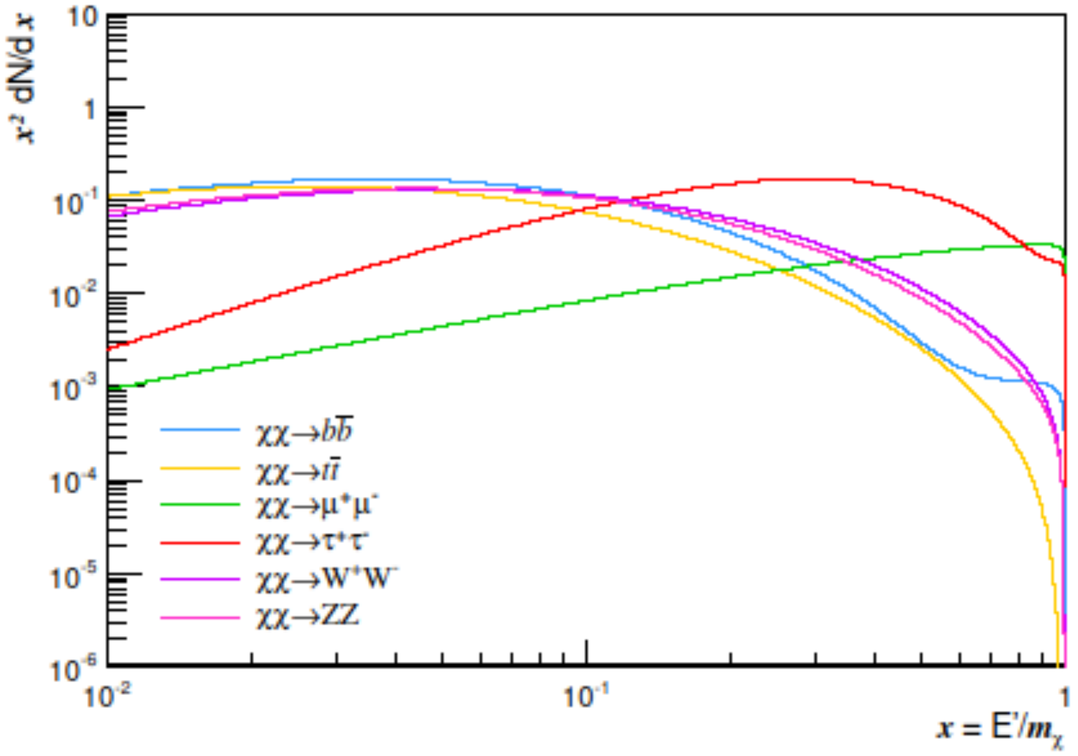
$$P_{\rm ON}(E; M(\theta)) = \frac{1}{\tau} P_{\rm OFF}(E) + \int_0^\infty \frac{d\Phi(M(\theta))}{dE'} R(E; E') dE'.$$

$$\frac{d\Phi(\Delta\Omega)}{dE'} = \frac{d\Phi^{\rm PP}}{dE'} \times J(\Delta\Omega).$$

$$\frac{d\Phi^{\rm PP}}{dE'} = \frac{1}{4\pi}\frac{\langle\sigma_{\rm ann}v\rangle}{2m_\chi^2}\frac{dN}{dE'},$$

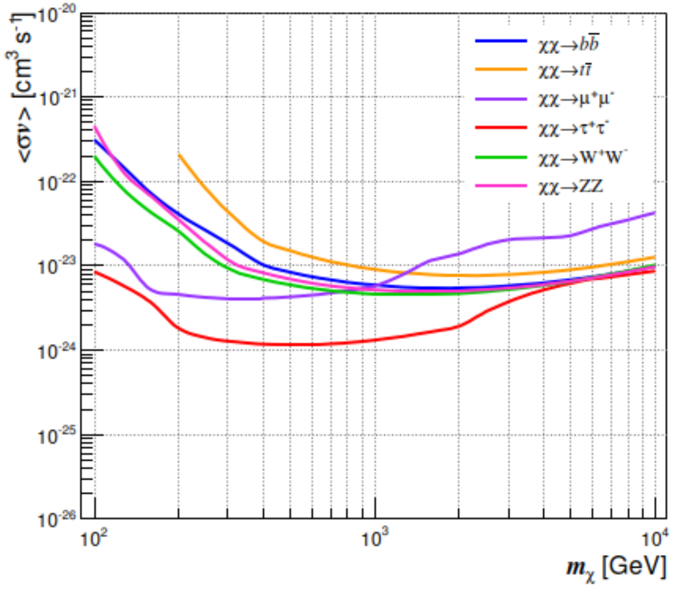
# Expected DM flux

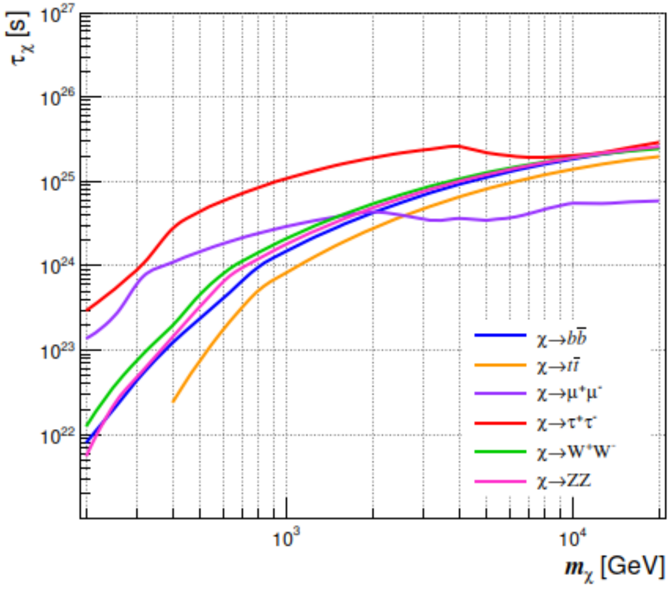
- The gamma ray flux produced in annihilation or decay of DM particles is given as a product of two terms: the particle physics term and the astrophysical term
- The particle physics term, depend on the chosen DM model and is the same for all sources of DM.
- The astrophysical term, depends on the observed source, the DM distribution, his geometry and distance.
- m_x is the mass of the particle, <sigma v> is the average product of the annihilation cross section and velocity of the DM particles. dN/dE contains all the information about the spectral shape.

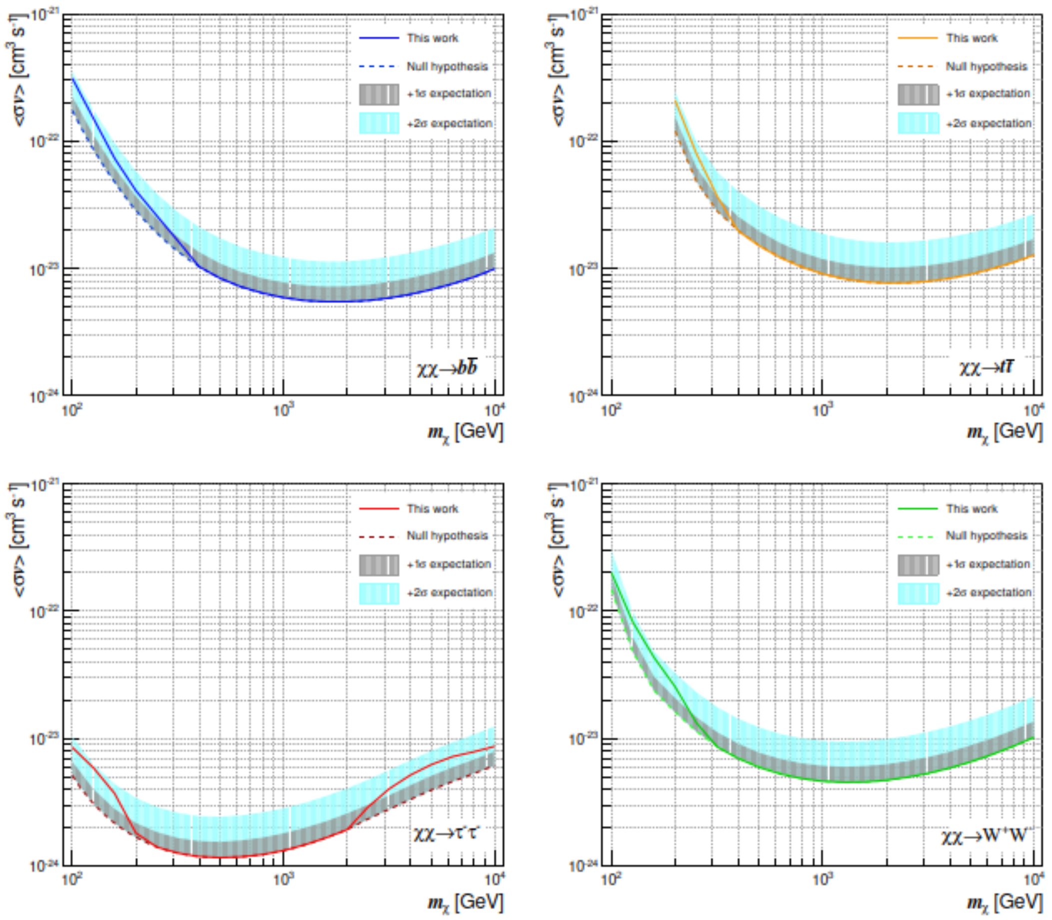


# Limits for DM annihilation and decaying

- There is no relevant peak of signal from the background noise that can detect any trace of DM.




- These limits on gamma ray signal can be translated in limits on DM properties. With a CL of 95% are given an upper limit on <sigma v> and a lower limit on tau.