Dark Matter annihilation in Draco: new considerations of the expected gamma flux [1]

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Abstract. A new estimation of the γ-ray flux that we expect to detect from SUSY dark matter annihilation from the Draco dSph is presented using the DM density profiles compatible with the latest observations. This calculation takes also into account the important effect of the Point Spread Function (PSF) of the telescope. We show that this effect is crucial in the way we will observe and interpret a possible signal detection. Finally, we discuss the prospects to detect a possible gamma signal from Draco for MAGIC and GLAST.

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INTRODUCTION

The Draco galaxy, a satellite of the Milky Way, represents one of the best suitable candidates to search for DM outside our galaxy [1], since it is near (80 kpc) and it has probably more observational constraints than any other known DM dominated system. This fact becomes crucial when we want to make realistic predictions of the expected observed γ-ray flux due to DM annihilation.

The expected total number of continuum γ-ray photons received per unit time and per unit area, from a circular aperture on the sky of width σ_t (which represents the resolution of the telescope) observing at a given direction Ψ_0 relative to the centre of the dark matter halo is given by:

$$F(E > E_{\rm th}) = \frac{1}{4\pi} f_{SUSY} \cdot U(\Psi_0), \qquad \text{with} \qquad f_{SUSY} = \frac{N_\gamma \langle \sigma v \rangle}{2 m_\chi^2}, \qquad U(\Psi_0) = \int J(\Psi) B(\Omega) d\Omega \tag{1}$$

where the factor f_{SUSY} encloses all the particle physics, and the factor $U(\Psi_0)$ involves all the astrophysical properties such as the dark matter distribution, geometry considerations and telescope performances like the PSF, this one directly related to the angular resolution (for a detailed explanation of each of these terms, see e.g. [2]).

DRACO γ-RAY FLUX PROFILES AND THE EFFECT OF THE PSF

We assumed that the dark matter distribution in Draco can be approximated by the formula $\rho_{\rm d}(r) = Cr^{-\alpha} \exp(-\frac{r}{r_{\rm b}})$ proposed by [3], which was found to fit the density distribution of a simulated dwarf dark matter halo stripped during its evolution in the potential of a giant galaxy. Here we will consider two cases, the profile with a cusp $\alpha = 1$ and a core $\alpha = 0$. The calculated γ-ray flux profiles are shown in left panel of Fig.1. For both cusp and core DM density profiles, the flux values should be very similar for the inner region of the dwarf, where signal detection would be easier. It is also necessary to take into account the role of the PSF in the calculations. Its effect on gamma ray flux profiles, usually neglected, may be crucial to correctly interpret a possible signal in the telescope, as it can be clearly seen in right panel of Fig. 1.

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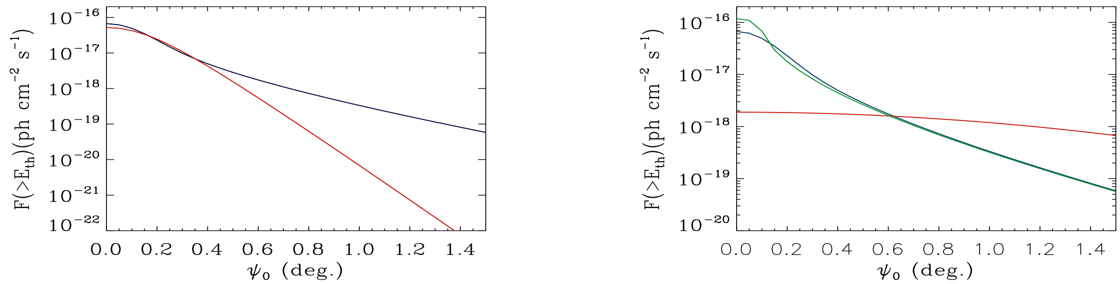

FIGURE 1. Left panel: Draco flux predictions for the core (red line) and cusp (blue line) DM density profiles, computed using a PSF= 0.1°. A value of $f_{SUSY} = 10^{-33} GeV^{-2} cm^3 s^{-1}$ was used (the most optimistic case given by particle physics at 100 GeV). Right panel: Flux predictions for the cusp density profile and using a PSF=0.1° (blue line), PSF=1° (red) and without PSF (green).

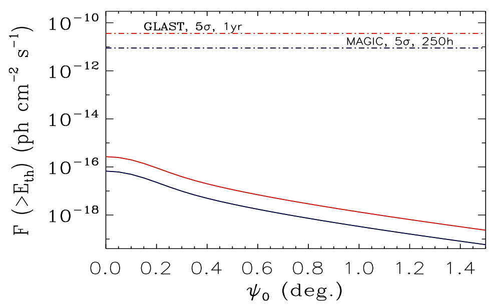

FIGURE 2. Draco flux profile detection prospects for GLAST (red lines) and MAGIC (blue lines), and for the cusp density profile using a PSF=0.1°. Values of $f_{SUSY} = 10^{-33} GeV^{-2} cm^3 s^{-1}$ at 100 GeV and $f_{SUSY} = 4\ 10^{-33} GeV^{-2} cm^3 s^{-1}$ at 10 GeV were used for MAGIC and GLAST respectively (the most optimistic scenarios given by particle physics at those energies.

DETECTION PROSPECTS

We carried out some calculations concerning the possibility to detect a γ-ray signal coming from DM annihilation in Draco for MAGIC and GLAST (Fig.2). According to these calculations, a detection of the gamma ray flux profiles seems to be very hard. We computed also the prospects for an excess signal detection, i.e. we are not interested in the shape of the gamma ray flux profile, only in detectability (Table. 1). According to the results we reached there is no chance to detect a γ-ray signal (flux profiles or just an excess) coming from Draco with current experiments, at least with the preferred particle physics and astrophysics models (for a more detailed study, see the complete work [4]). It will be necessary go a step further with IACTs that join a large field of view with a high sensitivity.

TABLE 1. Prospects of an excess signal detection for MAGIC and GLAST. For F_{Draco}, the most optimistic and pessimistic values are given in the form $F_{Draco,min}$ - $F_{Draco,max}$. F_{min} represents the minimum detectable flux for each instrument. All values refer to the inner 0.5° of the dwarf.

	F_{Draco} $(ph\ cm^2\ s^{-1})$	F_{min} $(ph\ cm^2\ s^{-1})$
MAGIC	$1.6\ 10^{-19}$ - $4.0\ 10^{-16}$	$4.4\ 10^{-11}$ (250 h, 5σ)
GLAST	$1.6\ 10^{-19}$ - $1.6\ 10^{-15}$	$3.9\ 10^{-10}$ (1 yr, 5σ)

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