High energy photon flux prediction from neutralino annihilation in the globular cluster Palomar 13

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Abstract. The distant globular cluster Palomar 13 has been found to have a very high mass-to-light ratio. Its profile can be well fitted either by using a King model with a tail, or by a NFW model [1]. This cluster may be the first case of the many clumps predicted by CDM simulations that would not be disrupted by the galactic halo potential. We assume that Pal 13 is made of neutralinos and we run the DarkSuspect code for five benchmark models. This code allows to estimate the gamma-ray flux produced in annihilations of neutralinos. These fluxes may be used as targets to be reached in proposals for future ground-based high altitude Cerenkov telescopes.

1 Introduction

The distant globular cluster Pal 13 has been found to have a very high M/L ratio of 40 $M_{\odot}/L_{\odot}$. Its profile can be well fitted either by using King model with a power-law tail or by NFW model [1] with scale radius 2.4 ± 0.2 pc and central density 80 $M_{\odot} pc^{-3}$. A possible explanation is that this distant cluster ($D = 24.3$ kpc) is one of the numerous dark clumps predicted by CDM scenarios, which has not been destroyed by the galactic tidal field. Pal 13 may also be a disrupted cluster, out of dynamical equilibrium. Here we assume that the NFW profile is the signature of a halo made of cold particles.

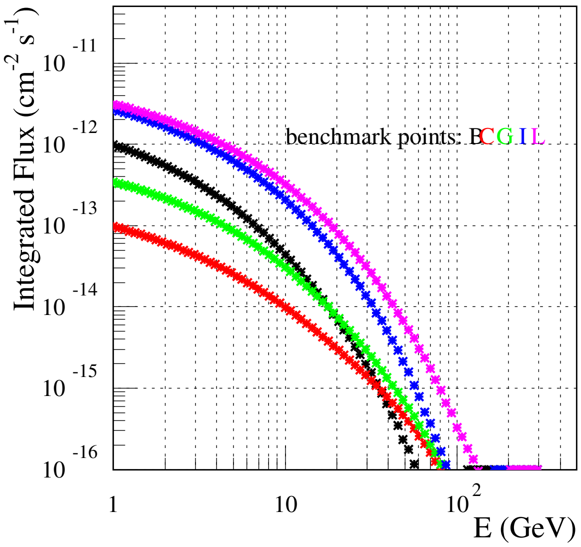
Physics beyond the Standard Model could be Supersymmetry. The lowest-mass Supersymmetric particle called neutralino, is a natural candidate for CDM. If R-parity is conserved then the neutralino is stable and has a very small cross-section for annihilation. We assume that the halo of Pal 13 is made of neutralinos and calculate the flux of high energy γ-rays due to their annihilation.

2 Theoretical physics models, tools and benchmarks

Theoretical physics beyond the Standard Model is reviewed by J. Ellis in this book. The 13 SUSY benchmark models have been proposed to provide a common way of comparing the discovery potential of future accelerators [2]. The models fulfill the conditions imposed by LEP measurements, $g_{\mu} - 2$ result and relic density constraint $0.1 < \Omega_\chi h^2 < 0.3$. We calculate the γ fluxes for five of the benchmark models, designated as BCGIL and placed in the "bulk" region of parameter space, with our current MC simulation programs: DarkSUSY [3] and SUSPECT [4]. The SUSPECT code performs RGE evolution from GUT scale to EWSB one. The DarkSUSY package derives the relic density and fluxes.

3 Predicted fluxes for Palomar 13

The fluxes integrated above energy threshold and within solid angle of 10^{-3} sr in function of the threshold are shown in the figure below.



4 An array of 16-20 Cerenkov telescopes at high altitude

From the above results one can conclude that we must work at low energy threshold and with a very low fluxes ($10^{-12.5}$ $cm^{-2}s^{-1}$). These fluxes are not out of reach but the sensitivity of the existing ground-based instruments will have to be improved by one order of magnitude for that purpose. An array of 5 HESSes (each including four 15-m class telescopes like in HESS), operating in adjacent areas at 5000 m altitude, would reach a flux limit of 2.5×10^{-13} $cm^{-2}s^{-1}$ at 25 GeV in 400 h. **With that flux limit most of the SUSY parameter space could be explored by measuring the Galactic Center.** This is the instrument needed to demonstrate or disprove Supersymmetry in astrophysics.

References

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