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Cosmic Rays from Heavy Dark Matter from the Galactic Center

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The gamma-ray fluxes observed by the High Energy Stereoscopic System (HESS) from the J1745-290 Galactic Center source is well fitted by the secondary photons coming from Dark Matter (DM) annihilation in particle-antiparticle standard model pairs over a diffuse power-law background. The spectral features of the signal are consistent with different channels: light quarks, electro-weak gauge bosons and top-antitop production. The amount of photons and morphology of the signal localized within a region of few parsecs, require compressed DM profiles as those resulting from baryonic contraction, which offer large enhancements in the signal over DM alone simulations. The fits return a heavy WIMP, with a mass above 10 TeV, but well below the unitarity limit for thermal relic annihilation. The fitted background spectral index is compatible with the Fermi-Large Area Telescope (LAT) data from the same region. This possibility can be potentially tested with the observations of other high energy cosmic rays.

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1. Gamma rays from the galactic center and the dark matter hypothesis

We have studied the possibility of explaining the gamma ray data [1] observed by the High Energy Stereoscopic System (HESS) from the central part of our galaxy by being partially produced by Dark Matter (DM) annihilations or decays [2, 3]. The complexity of the region and the amount of delocalized emitting sources justifies the hypothesis of a non-negligible background. DM annihilations or decays into single standard model particle-antiparticle channels provide good fits if the DM signal is complemented with such a background, that it is consistent with Fermi-LAT measurements [4].

The fits return a DM mass between 15 and 110 TeV depending on the studied channel [5]. Leptonic channels are clearly disfavored, but hadronic channels such us the $d\bar{d}$, or electroweak channels such as the W^+W^- and ZZ channels, offer very good consistency with $\chi^2/dof = 0.73$, 0.84 and 0.85 respectively [2]. The morphology of the signal requires compressed dark halos as the ones that take into account baryonic dissipation [6].

A motivated DM candidate which could have high enough masses and account for the right abundance of DM as a thermal relic, is the branon field [7, 8], which corresponds to brane fluctuations in flexible brane-world models. We have proved that a branon mass of $M \simeq 50.6$ TeV provides a good fit to the mentioned HESS data [2].

2. Conclusions and future work

The heavy DM masses required for fitting the HESS data are practically unconstrained by direct detection searches or colliders experiments [9]. On the contrary, this possibility can be tested with the observations of other cosmic-rays [10] from the GC and from other astrophysical objects. For example, high energy neutrinos could confirm this hypothesis at IceCube or ANTARES for angular resolutions below one degree.

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References

[1] F. Aharonian, A. G. Akhperjanian, K.M. Aye et al., *Very high-energy gamma rays from the direction of Sagittarius A**, *A&A* 425 (2004) L13; *Spectrum and variability of the Galactic Center VHE gamma-ray source HESS J1745-290*, *A&A* 503 (2009) 817.

[2] J. A. R. Cembranos, V. Gammaldi and A. L. Maroto, *Possible dark matter origin of the gamma ray emission from the galactic center observed by HESS*, *Phys. Rev. D* **86** (2012) 103506 [arXiv:1204.0655 [hep-ph]]; *Spectral Study of the HESS J1745-290 Gamma-Ray Source as Dark Matter Signal*, *JCAP* **1304** (2013) 051 [arXiv:1302.6871 [astro-ph.CO]].

[3] A. V. Belikov et al., *Study of the Gamma-ray Spectrum from the Galactic Center in view of Multi-TeV Dark Matter Candidates*, *Phys. Rev. D* **86** (2012) 083516 [arXiv:1207.2412 [astro-ph.HE]].

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[4] V. Vitale, A. Morselli and f. t. F. /L. Collaboration, *Indirect Search for Dark Matter from the center of the Milky Way with the Fermi-Large Area Telescope*, arXiv:0912.3828 [astro-ph.HE]; M. Chernyakova *et. al.*, *The high-energy, Arcminute-scale galactic center gamma-ray source*, *ApJ* **726** (2011) 60.

[5] J. A. R. Cembranos et al., *Photon spectra from WIMP annihilation*, *Phys. Rev. D* **83** (2011) 083507 [arXiv:1009.4936 [hep-ph]]; *Photon spectra from quark generation by WIMPs*, *AIP Conf. Proc.* **1343** (2011) 595-597 [arXiv:1011.2137 [hep-ph]]; *Fitting formulae for photon spectra from WIMP annihilation*, *J. Phys. Conf. Ser.* **314** (2011) 012063 [arXiv:1012.4473 [hep-ph]]; *Reliability of Monte Carlo event generators for gamma ray dark matter searches*, *JHEP* **1309** (2013) 077 [arXiv:1305.2124 [hep-ph]].

[6] G.R. Blumenthal, S.M. Faber, R. Flores, J. R. Primack, *Contraction of Dark Matter Galactic Halos Due to Baryonic Infall*, *ApJ*, **301** (1986) 27; F. Prada et al., *Dark Matter Annihilation in the Milky Way Galaxy: Effects of Baryonic Compression Phys. Rev. Lett.*, **93** (2004) 241301 [astro-ph/0401512].

[7] A. Dobado and A. L. Maroto, *The Dynamics of the Goldstone bosons on the brane*, *Nucl. Phys. B* **592** (2001) 203 [hep-ph/0007100]; J. A. R. Cembranos, A. Dobado and A. L. Maroto, *Brane world dark matter*, *Phys. Rev. Lett.* **90** (2003) 241301 [hep-ph/0302041]; *Cosmological and astrophysical limits on brane fluctuations*, *Phys. Rev. D* **68** (2003) 103505 [hep-ph/0307062]; *Dark geometry*, *Int. J. Mod. Phys.* **D13** (2004) 2275 [hep-ph/0405165]; A. L. Maroto, *The Nature of branon dark matter*, *Phys. Rev. D* **69** (2004) 043509 [hep-ph/0310272]; *Brane oscillations and the cosmic coincidence problem*, *Phys. Rev. D* **69** (2004) 101304 [hep-ph/0402278]; J. A. R. Cembranos *et al.*, *Is the CMB Cold Spot a gate to extra dimensions?*, *JCAP* **0810** (2008) 039 [0803.0694 [astro-ph]].

[8] J. A. R. Cembranos, A. de la Cruz-Dombriz, V. Gammaldi, A.L. Maroto, *Detection of branon dark matter with gamma ray telescopes*, *Phys. Rev. D* 85 (2012) 043505 arXiv:1111.4448 [astro-ph.CO].

[9] J. Alcaraz *et al.*, *Limits on the brane fluctuations mass and on the brane tension scale from electron positron colliders*, *Phys. Rev. D* **67** (2003) 075010 [hep-ph/0212269]; P. Achard *et al.*, *Search for branons at LEP*, *Phys. Lett.* **B597** (2004) 145 [hep-ex/0407017]; J. A. R. Cembranos, A. Dobado and A. L. Maroto, *Brane skyrmions and wrapped states*, *Phys. Rev. D* **65** (2002) 026005 [hep-ph/0106322]; *Branon search in hadronic colliders*, *Phys. Rev. D* **70** (2004) 096001 [hep-ph/0405286]; *Branon radiative corrections to collider physics and precision observables*, *Phys. Rev. D* **73** (2006) 035008 [hep-ph/0510399]; *Dark matter clues in the muon anomalous magnetic moment*, *Phys. Rev. D* **73** (2006) 057303 [hep-ph/0507066]; *Some model-independent phenomenological consequences of flexible brane worlds*, *J. Phys. A* **40** (2007) 6631 [hep-ph/0611024]; J. A. R. Cembranos, J. L. Diaz-Cruz and L. Prado, *Impact of DM direct searches and the LHC analyses on branon phenomenology*, *Phys. Rev. D* **84** (2011) 083522 [arXiv:1110.0542 [hep-ph]]; J. A. R. Cembranos, R. L. Delgado and A. Dobado, *Brane-Worlds at the LHC: Branons and KK-gravitons*, arXiv:1306.4900 [hep-ph].

[10] S. Rudaz and F. W. Stecker, *Cosmic ray anti-protons, positrons and gamma-rays from halo dark matter annihilation*, *Astrophys. J.* **325** (1988) 16; J. A. R. Cembranos, J. L. Feng, A. Rajaraman and F. Takayama, *SuperWIMP solutions to small scale structure problems*, *Phys. Rev. Lett.* **95** (2005) 181301 [hep-ph/0507150]; J. A. R. Cembranos, J. L. Feng and L. E. Strigari, *Resolving Cosmic Gamma Ray Anomalies with Dark Matter Decaying Now*, *Phys. Rev. Lett.* **99** (2007) 191301 [arXiv:0704.1658 [astro-ph]]; *Exotic Collider Signals from the Complete Phase Diagram of Minimal Universal Extra Dimensions*, *Phys. Rev. D* **75** (2007) 036004 [hep-ph/0612157]; J. A. R. Cembranos and L. E. Strigari, *Diffuse MeV Gamma-rays and Galactic 511 keV Line from Decaying WIMP Dark Matter*, *Phys. Rev. D* **77** (2008) 123519 [arXiv:0801.0630 [astro-ph]]; J. A. R. Cembranos, *The Newtonian limit at intermediate energies*, *Phys. Rev. D* **73** (2006) 064029 [arXiv:gr-qc/0507039]; *Dark Matter from R2-gravity*, *Phys. Rev. Lett.* **102** (2009) 141301 [arXiv:0809.1653 [hep-ph]].

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