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Search for Dark Matter at the LHC

Mario Martínez

ICREA/Institut de Fìsica d'Altes Energies, Barcelona 08193, Spain

E-mail: mmp@ifae.es

Abstract. In this contribution, recent results on the search for dark matter candidates at the LHC in monojet and monophoton final states are presented based on the data collected by the ATLAS and CMS experiments at $\sqrt{s} = 7$ TeV.

1. Introduction

Events with an energetic jet or photon and large missing momentum in the final state constitute a clean and distinctive signature in searches for new physics at colliders. In particular, monophoton and monojet final states have been studied [1, 2, 3, 4, 5, 6, 7, 8, 9] in the context of searches for supersymmetry and large extra spatial dimensions (LED), aiming to provide a solution to the mass hierarchy problem, and the search for weakly interacting massive particles (WIMPs) as candidates for dark matter (DM).

The presence of a non-baryonic DM component in the universe is inferred from the observation of its gravitational interactions [10], although its nature is otherwise unknown. A WIMP χ with mass m_χ in the range between 1 GeV and a few TeV is a plausible candidate for DM. It could be detected via its scattering with heavy nuclei [11], the detection of cosmic rays (energetic photons, electrons, positrons, protons, antiprotons, or neutrinos) from $\chi\bar{\chi}$ annihilation in astrophysical sources [10], or via $\chi\bar{\chi}$ pair-production at colliders where the WIMPs do not interact with the detector and the event is identified by the presence of an energetic photon or jet from initial-state radiation. The interaction of WIMPs with Standard Model (SM) particles is assumed to be driven by a mediator with mass at the TeV scale and described using a non-renormalizable effective theory [12] with several operators. The vertex coupling is suppressed by an effective cut-off mass scale $M_* \sim M/\sqrt{g_1 g_2}$, where M denotes the mass of the mediator and g_1 and g_2 are the couplings of the mediator to the WIMP and SM particles.

2. Results

Both the ATLAS and CMS collaborations have carried out measurements on monojet and monophoton production in proton-proton collisions at $\sqrt{s} = 7$ TeV[1]. In all cases, good agreement is observed between the data and the standard model (SM) predictions. 90% confidence level (CL) upper limits on the pair production cross section of dark matter WIMP candidates are determined, and then translated into upper limits on the nucleon-WIMP interaction cross section using the prescription in Refs. [12, 13]. Figure 1 shows 90% CL upper limits on the nucleon-WIMP cross section as a function of m_χ for both monojet and monophoton results. The

[1] At the time of preparing this proceedings 8 TeV results are becoming available.

exclusion in the region 1 GeV $< m_\chi <$ 3.5 GeV (1 GeV $< m_\chi <$ 1 TeV) for spin-independent (spin-dependent) nucleon-WIMP interactions is driven by the results from collider experiments, with the assumption of the validity of the effective theory employed.

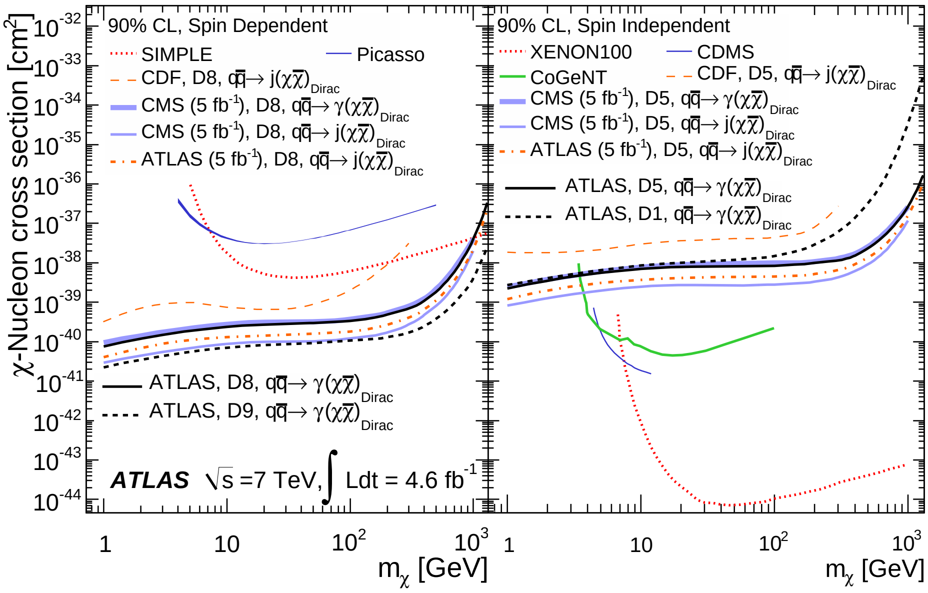

Figure 1. 90% CL upper limits on the nucleon-WIMP cross section as a function of m_χ for spin-dependent (left) and spin-independent (right) interactions [12, 13]. It includes monojet and monophoton results at colliders [4, 5, 6, 8, 9] compared to results from direct detection experiments [11].

References

[1] OPAL Collaboration, Eur. Phys. J. C **18**, 253 (2000); ALEPH Collaboration,Eur. Phys. J. C **28**, 1 (2003); L3 Collaboration, Phys. Lett. B **587**, 16 (2004); DELPHI Collaboration, Eur. Phys. J. C **38**, 395 (2005).
[2] D0 Collaboration, Phys. Rev. Lett. **101**, 011601 (2008).
[3] CDF Collaboration, Phys. Rev. Lett. **101**, 181602 (2008).
[4] CDF Collaboration, Phys. Rev. Lett. **108**, 211804 (2012).
[5] CMS Collaboration, Phys. Rev. Lett. **107**, 201804 (2011); CMS Collaboration, JHEP **09**, 094 (2012).
[6] CMS Collaboration, Phys. Rev. Lett. **108**, 261803 (2012).
[7] ATLAS Collaboration, Phys. Lett. B **705**, 294 (2011).
[8] ATLAS Collaboration, JHEP **04**, 075 (2013).
[9] ATLAS Collaboration, Phys. Rev. Lett. **110**, 011802 (2013).
[10] G. Bertone, D. Hooper, and J. Silk, Phys. Rep. **405**, 279 (2005).
[11] XENON100 Collaboration, Phys. Rev. Lett. **107**, 131302 (2011); CDMS Collaboration, Phys. Rev. Lett. **106**, 131302 (2011); CoGENT Collaboration, Phys. Rev. Lett. **106**, 131301 (2011); M. Felizardo *et al.*, arXiv:1106.3014 (2011); PICASSO Collaboration, Phys. Lett. B **711**, 153 (2012).
[12] J. Goodman *et al.*, Phys. Rev D **82**, 116010 (2010).
[13] In consultation with the authors of Ref.[12], a factor $4.7 \times 10^{-39}\text{cm}^2$ is used in the cross section formula for D8 and D9 operators instead of the quoted $9.18 \times 10^{-40}\text{cm}^2$.