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Search for Dark Matter production in association with a hadronically decaying vector boson in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector

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A search for dark matter (DM) particles production in association with a hadronically decaying W/Z/Z′ with 36.1fb^{-1} of pp collision data at a center-of-mass energy of $\sqrt{s}$ = 13 TeV recorded by the ATLAS detector is presented. No significant excess over the Standard Model prediction is observed. The results of the mono-W/Z search are interpreted in terms of limits on the invisible Higgs boson decays into dark matter particles, constraints on the parameter space of the simplified vector-mediator model and generic upper limits on the visible cross sections for the W/Z + DM production. The results of the mono-Z′ search are presented in the frame of several simplified-model scenarios involving the DM production in association with the Z′ boson.

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Several astrophysical observations provide compelling evidence for the existence of dark matter (DM), that is not accounted for in the Standard Model (SM). Thus, many theoretical ideas have been proposed in which DM and SM particles interact with sufficient strength such that DM may be directly produced with the observables at LHC. Among these, weakly interacting massive particles (WIMPs), one of the leading DM candidates, could be produced in proton–proton (pp) collisions at the LHC and detected by measuring the momentum imbalance associated with the recoiling SM particles. A typical DM signature that can be detected by the LHC experiments is a large E_T^{miss} from a pair of DM particles which are recoiling against one or more SM particles. In this report, we present the latest results of the search for DM particles produced in association with a hadronically decaying W or Z boson (mono-W/Z search) as well as the yet unexplored hypothesis of DM particles production in association with a potentially new vector boson Z' (mono-Z' search) using 36.1 fb^{-1} of collision data recorded by the ATLAS detector at 13 TeV centre-of-mass-energy in 2015 and 2016. Event topologies with two well separated jets from the hadronically decaying vector boson are studied (referred to as the *resolved topology*), as well as topologies with one large-radius jet from a highly boosted vector boson (referred to as the *merged topology*). For the mono-Z' search, the categorization into merged and resolved event topologies is only performed for the mediator mass hypothesis of $m_{Z'}$ below 100 GeV. More details of this search procedure, background estimation and statistical interpretation can be found in [1]. Two simplified models are considered in the mono-W/Z search. For the simplified vector-mediator model in which the DM is produced via an s-channel exchange of a vector mediator Z', masses $m_{Z'}$ of up to 650 GeV are excluded for DM masses m_χ of up to 250 GeV assuming $g_{SM} = 0.25$ and g_{DM}=1.0. This agrees well with the expected exclusion of $m_{Z'}$ values of up to 700 GeV for m_χ of up to 230 GeV. This is shown in the Fig.1(a). Limits are also placed on the visible cross section of non-SM events with large E_T^{miss} and W or a Z boson without extra model assumptions as shown in Fig.1(b). In the search for invisible Higgs boson decays, an upper limit of 0.83 is observed at 95% CL on the branching ratio Br($H \to inv.$), while the corresponding expected limit is 0.58.

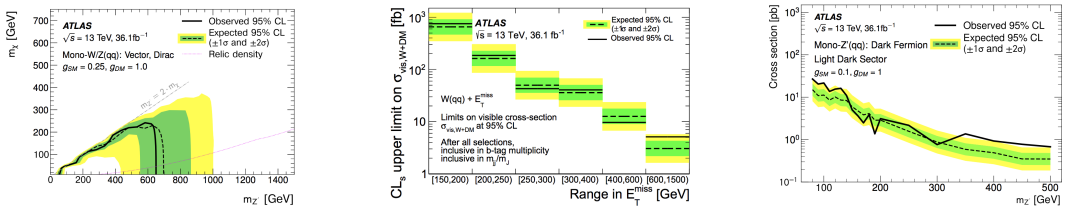

Figure 1: (a) (b) (c)

Two signal models considered for the mono-Z′ search: dark-fermion model and dark-Higgs model. Upper limits at 95% CL on the cross section times branching ratio in mono Z′ models as a function of mediator mass, $m_{Z'}$, for the dark fermion model is shown in Fig.1(c).

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References

[1] ATLAS Collaboration, Search for dark matter in events with a hadronically decaying vector boson and missing transverse momentum in pp collisions at $\sqrt{s}$= 13 TeV with the ATLAS detector, arXiv:1807.11471[hep-ex].