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Investigation of the nature of a massive vector mediator for Dark Matter through e^+e^- collisions

Several studies have been dedicated to study the nature of dark matter (DM) and to try to discover its origin. Different approaches have been employed to understand how DM interacts and what are possible mechanisms to detect it. Theories beyond the Standard Model of Elementary Particles (SM) could achieve this by employing effective, simplified, or more complete models. Direct, indirect, and collider searches have excluded much of the parameter space for DM, however still indicating that DM can be made up of particles and mediators of high mass, the latter believed to be of the order of TeV. Hence, this work aims to investigate the interaction between fermions, more specifically electron-positron pairs, and DM particles through interaction of a new massive vector mediator, Z'. The production of scalar, fermionic, and vector DM pairs via electron-positron annihilation to this new boson was investigated, evaluating the total cross section in terms of the Mandelstam variables in the center of mass frame and in function of the decay width and the couplings to the massive mediator. This approach is based on the opportunities of observing such production mechanism in electron-positron accelerators. As a result, the possible values of the coupling constants between the DM and the SM are mapped according to the exclusion limits obtained by the Compact Muon Solenoid (CMS) experiment and the Planck satellite. Furthermore, we show that there are several possibilities for mass ranges of this new massive mediator and for the particles of DM which are not excluded by the collider and astrophysical limits.

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