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Observational Anomalies and New Dark Force

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Astrophysical measurements of positron and electron cosmic ray spectra by PAMELA and ATIC experiments have observed a rise in the positron fraction starting at $E \sim 10$ GeV and extending up to $E \sim 100$ GeV, as well as broad excess in the total $e^+ + e^-$ spectrum extending from several hundred GeV to O (TeV). This could be explained with dark matter annihilation $\chi\chi$ into e^+e^-; but it requires larger annihilation cross section than what is allowed by thermal relic abundance. And also to avoid antiproton constraints from the observational data of the PAMELA experiment and to generate hard e^+e^- spectra, the dark matter should annihilate largely into leptons, pions, kaons and other light states.

Annihilation of the dark matter into the new force carrier, which would then decay into kinematically accessible standard model states. A new GeV-scale force in the dark sector could therefore naturally generate both a large annihilation cross-section via Sommerfeld enhancement and the observed e^+e^- spectra.

If dark matter is self-interacting, either via exchange of standard model gauge boson or due to some new force, then the Sommerfeld enhancement must be taken into account when computing annihilation cross sections in the present day galactic halo.

The presence of light force carriers(GeV) coupling to the dark matter would naturally lead to atypical dark matter annihilation signatures with zero or small branching ratios into hadrons, gauge bosons and hard spectrum of leptons, pions and other lighter states. The provided mass of the force carrier was less than twice the proton mass so, no excess antiprotons would be produced.

In general GeV scale, a new dark force could naturally generate both a large annihilation cross-section via Sommerfeld enhancement and the observed e^+e^- spectra without violating observational antiproton constraints.

In order to consider various dark matter annihilation models, Experimental data of PAMELA and ATIC needs high cross-section values or boost factors than our cosmological expectation. We introduce a new force or mediator particle to address these observational anomalies. In our model, a dark matter particle annihilates in the standard model particle via a new force carrier ϕ. And this force carrier exchanges many times before annihilation in a standard model particle, due to this new force our estimated cross-section enhances via the Sommerfeld factor of Yukawa Potential. Additionally, with this phenomenology, we can naturally fit the astrophysical data from PAMELA and ATIC without the need for a larger boost factor.

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