Light dark Matter Searches With Positrons

L. Marsicano

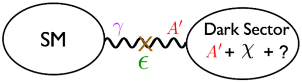
INFN - Genova

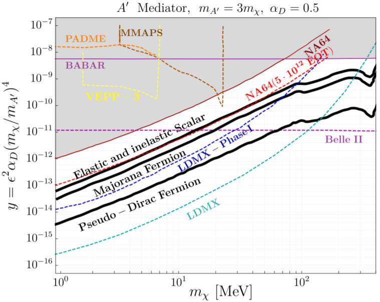
September 17, 2022

Vector Mediated Light Dark Matter (LDM)

The light dark matter hypothesis can explain the (gravitationally) observed relic abundance, **provided a new interaction mechanism between SM and dark sector exists.**

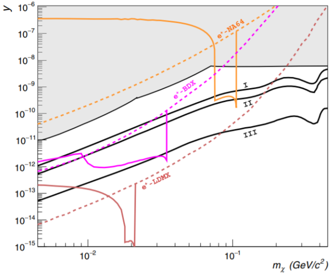
- Simplest possibility: "vector-portal". DM-SM interaction trough a new U(1) gauge-boson ("dark-photon") coupling to electric charge
- Dark-photon mass, m_A and coupling to electric charge ε
- Dark matter mass, m_χ and coupling to dark photon, $g_D(\alpha_D \equiv \frac{g_D^2}{4\pi})$
- Vast ongoing LDM experimental program investigating both the existence of χ particles and of dark photons.

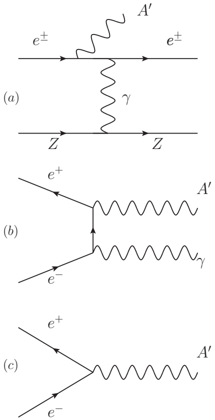




Light Dark Matter Production With Positron Beams

- Experiments using electron beams aim to produce A' via diagram a) - A'-strahlung
- Positron-beam experiments can fully exploit annihilation processes b) and c)
- given the better α scaling, e^+e^- annihilation can be a more efficient production process than a)



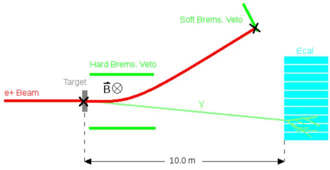


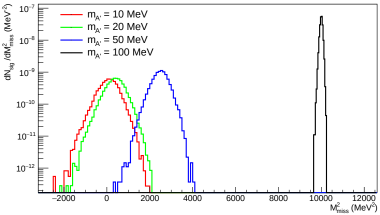
L. Marsicano et al., Phys. Rev. Lett. 121 (2018) 041802.

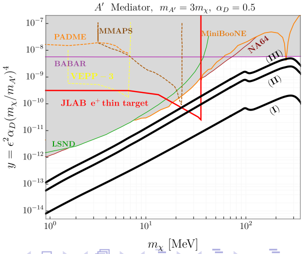
Thin Target Setup @JLab

Thin target approach: PADME-like eperiment

- 100 nA, 11 GeV e^+ beam impinging on 100 μm thin carbon target
- A' produced via $e^+e^- \to \gamma A'$ process
- outgoing photon measured in electromagnetic calorimeter and missing mass computed: $M^2_{miss} = (P_{beam} + P_{target} - P_\gamma)^2$
- search for a M^2_{miss} peak over smooth SM background

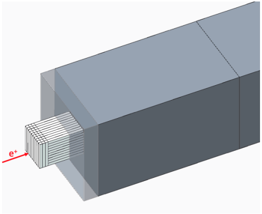


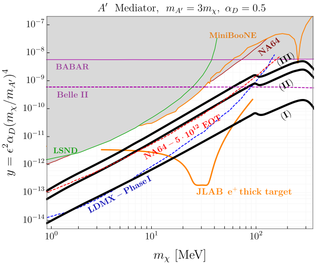




Thick Target Setup @JLab

- Missing energy experiment with a 11 GeV positron beam
- e^+ impinging on active thick target (ECAL); A' produced via resonant process $e^+e^- \to A'$
- large missing energy as LDM production signature: $E_{miss} = E_{beam} - E_{ECAL}$
- HCAL to detect neutral particles escaping the ECAL mimicking signal





Non-trivial beam structure necessary: