Searching a Dark Photon with HADES *

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Introduction

The unexpected excess observed at high momenta in the cosmic e^+/e^- flux [1] can not easily be reconciled with known astrophysical sources. Alternative explanations have been proposed, in particular scenarios in which the excess radiation stems from the annihilation of weakly interacting dark matter particles [2]. There is indeed compelling evidence from various astronomical and cosmological observations [3] that non-baryonic matter of some sort, so-called dark matter (DM), is responsible for 20-25% of the total energy density in the Universe. To accommodate DM in elementary particle theory and to allow it to interact with visible matter, the Standard Model (SM) must be extended, e.g. with an additional sector characterized by another $U(1)'$ gauge symmetry [4]. The corresponding vector gauge boson — called U boson or *dark photon* — could thereby mediate the annihilation of DM particles into charged lepton pairs. The mixing parameter ϵ relating the respective coupling strengths α‘ and α of the dark and SM photons to visible matter ($\epsilon^2 = \alpha'/\alpha$) is expected to be of order $10^{-2} - 10^{-8}$ [5]. A number of experimental searches have been conducted looking at e^+e^- pair distributions produced either in electron scattering [6, 7] or in the electromagnetic decays of light mesons [8,9]. Finally, from the very precisely measured values of the anomalous gyromagnetic factor $(g-2)$ of the muon and electron [10], additional constraints can be put on the allowed range of the mixing parameter ϵ and the mass M_U [11].

The HADES dark photon search

We present results of a search for a narrow $U \rightarrow e^-e^+$ decay signal in dielectron spectra obtained with HADES in 3.5 GeV p+p and p+Nb reactions, as well as in the 1.756 GeV/u Ar+KCl reaction. In contrast to previous experiments [8,9] focussing on a specific decay channel, our analysis is based on the inclusive measurement of all e^+e^- pairs produced in a given mass range, i.e. from Dalitz decays of the π^0, η, and Δ mostly. Using the method proposed in [12] we have extracted an upper limit (UL) at a confidence level CL = 90%. Details of the procedure are published in [13]. With known detector efficiencies and decay branching fractions, this UL has then been transformed into an UL on the mixing parameter ϵ^2 as shown in Fig. 1 together with limits from the searches conducted by BaBar [14], KLOE-2 [9], APEX [7], WASA at COSY [8], and A1 at MAMI [6]. At low masses ($M_U < 0.1$ GeV/c^2) we improve on the recent result obtained by WASA [8], excluding now to a large degree the parameter range allowed by the muon $g-2$ anomaly. At higher masses, the sensitivity of our search is compatible with, albeit somewhat lower than the KLOE-2 analysis of ϕ decays.

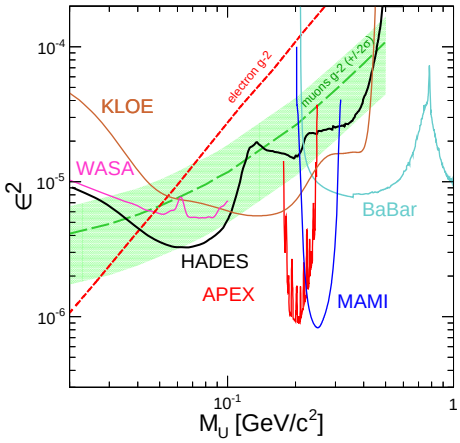

Figure 1: The 90% CL upper limit on ϵ^2 versus the U-boson mass obtained from the combined analysis of HADES data (solid black curve).

References

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