

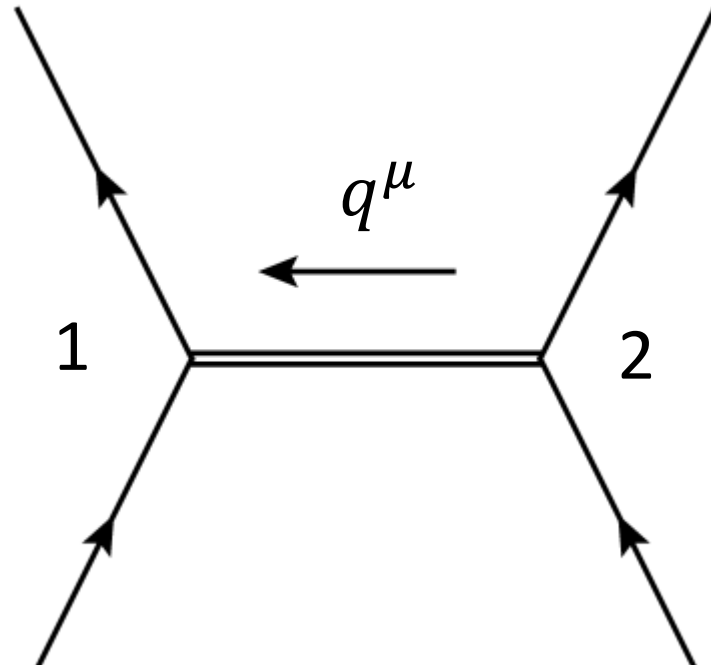
New bosons in atomic spectra

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Sydney

05.12.2022

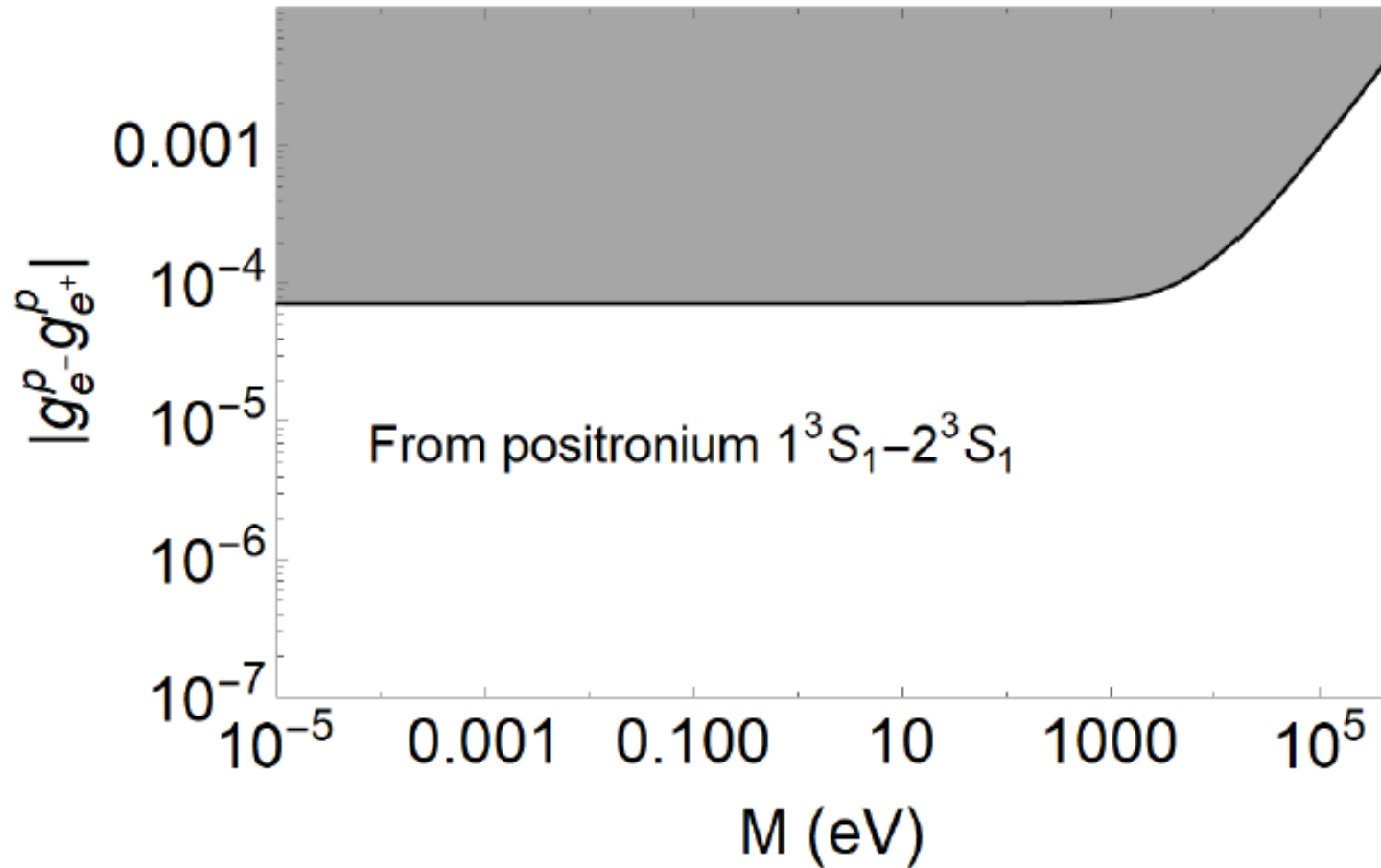
Probing exotic bosons by atomic energy levels



“Recent precision atomic-spectroscopy measurements have uncovered several small discrepancies between experiment and theory”

B. M. Henson et. al. *Science* **376**, 199 (2022)

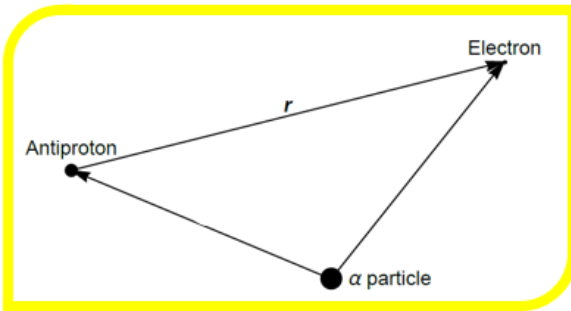
Exclusion plot on pseudoscalar boson



$$V_{pp}(\mathbf{r}) = -\frac{g_1^p g_2^p}{4} \left[\boldsymbol{\sigma}_1 \cdot \boldsymbol{\sigma}_2 \left[\frac{1}{r^3} + \frac{M}{r^2} + \frac{4\pi}{3} \delta(\mathbf{r}) \right] - (\boldsymbol{\sigma}_1 \cdot \hat{\mathbf{r}}) (\boldsymbol{\sigma}_2 \cdot \hat{\mathbf{r}}) \left[\frac{3}{r^3} + \frac{3M}{r^2} + \frac{M^2}{r} \right] \right] \frac{e^{-Mr}}{4\pi m_1 m_2}$$

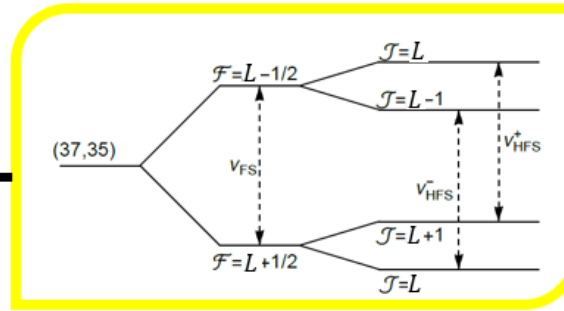
Procedure

Take



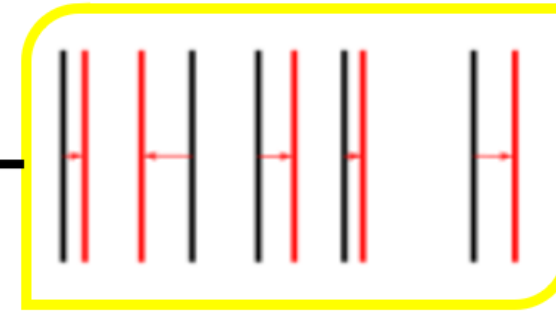
antiprotonic helium $\text{He}^+ \bar{p}$

Measure & calculate



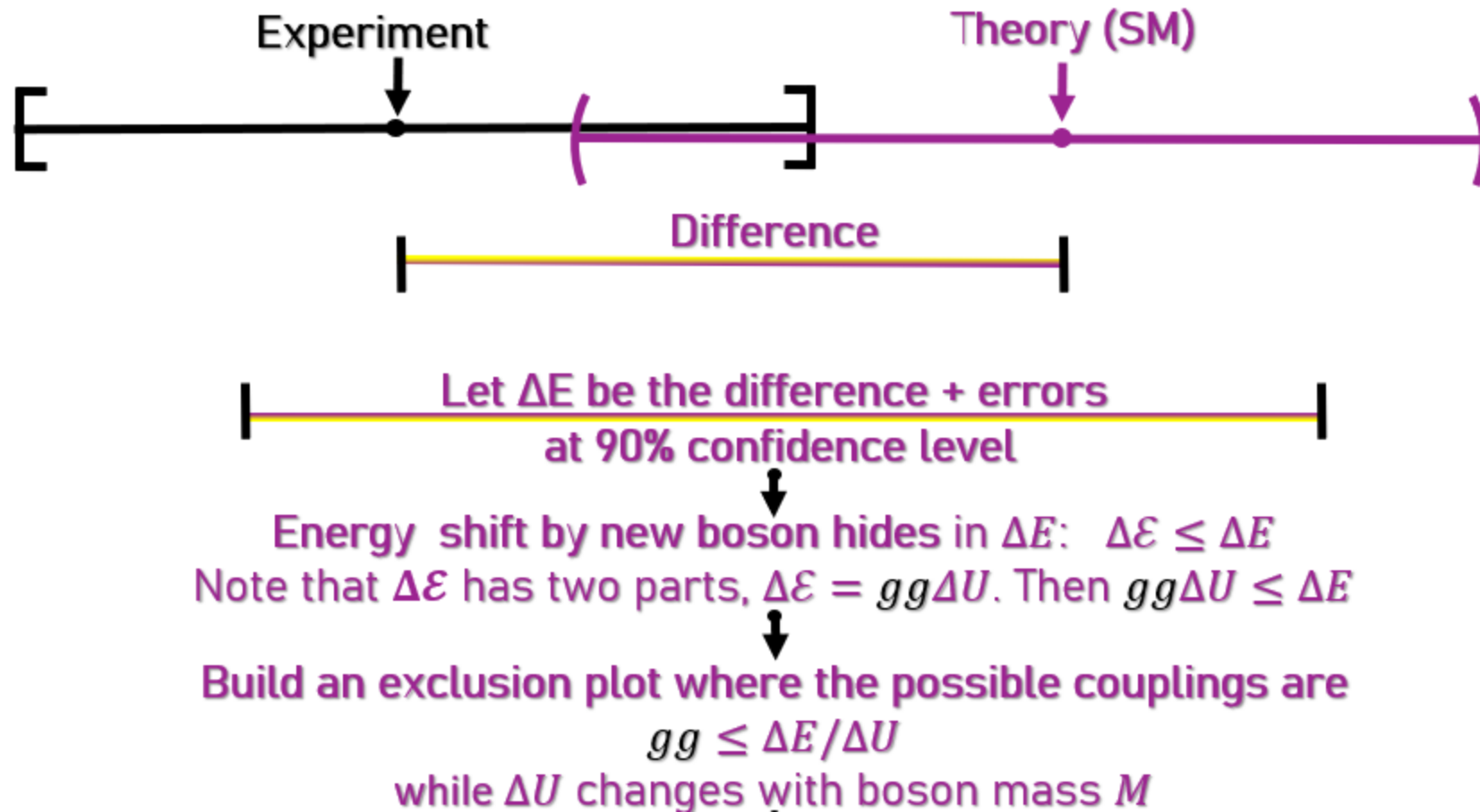
hyperfine transitions of antiproton

Estimate the shift $\Delta\mathcal{E}$

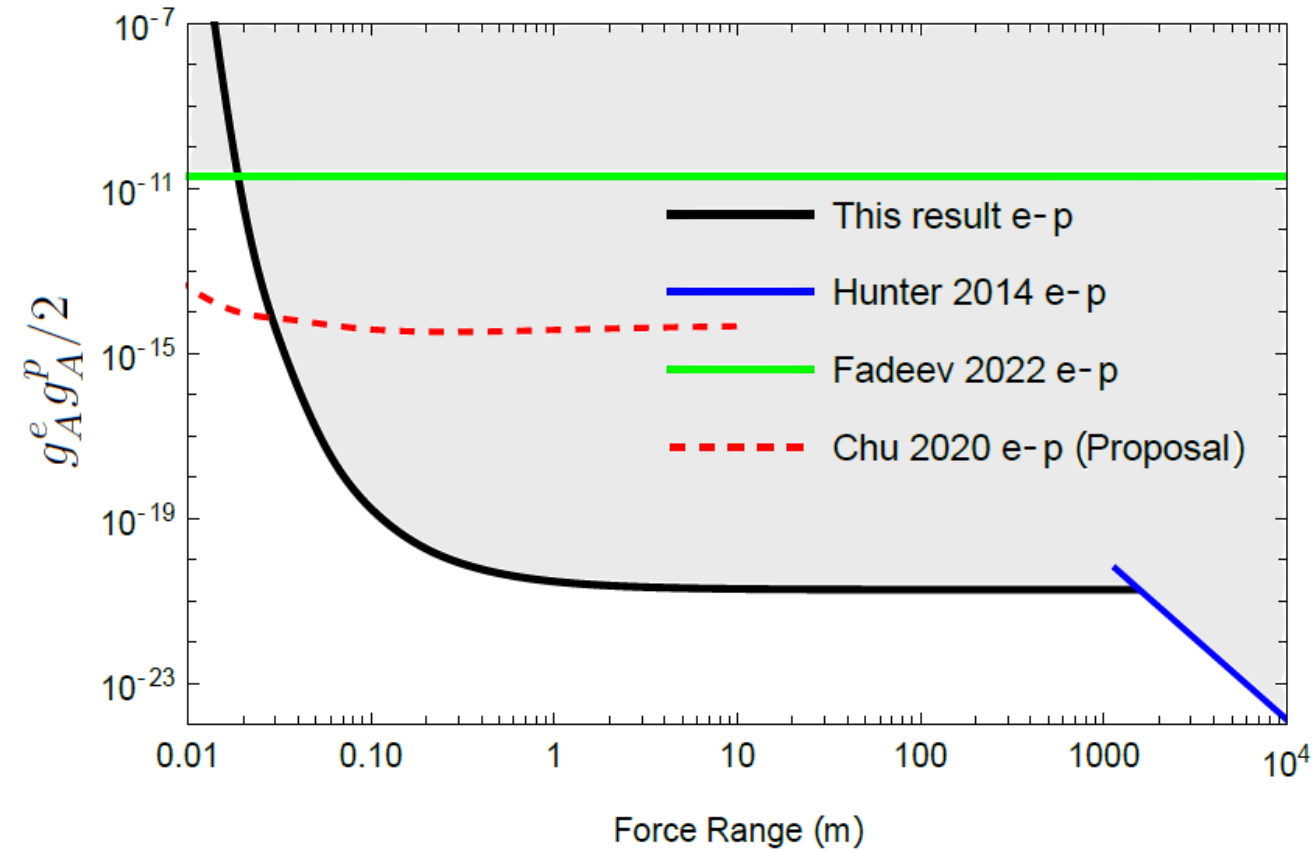
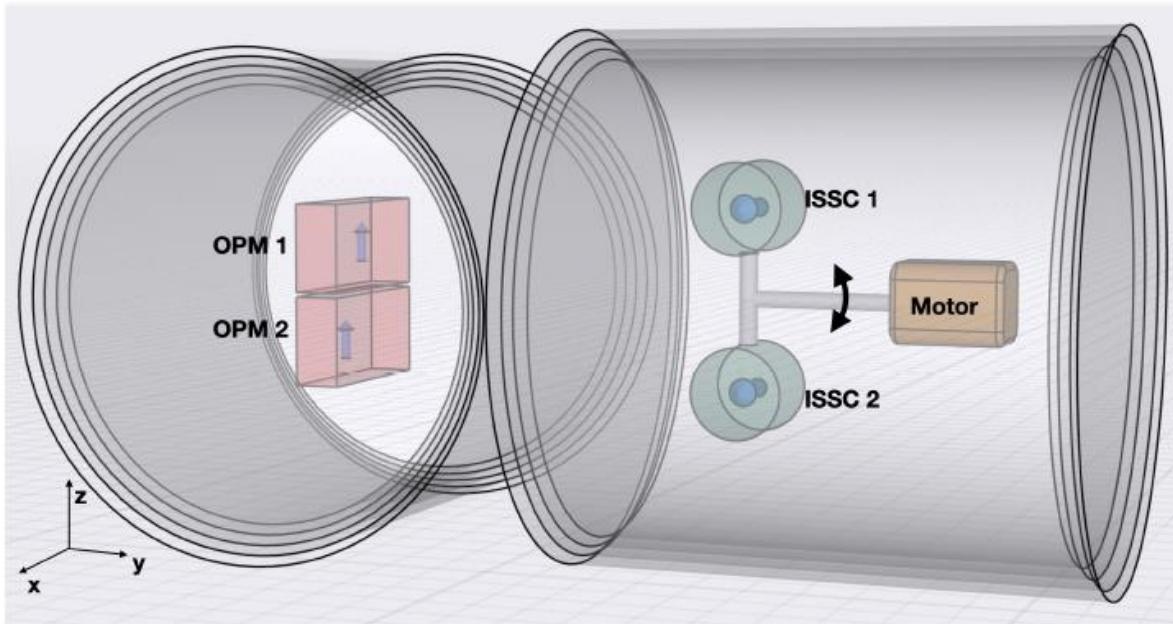


due to potential V_{pp}

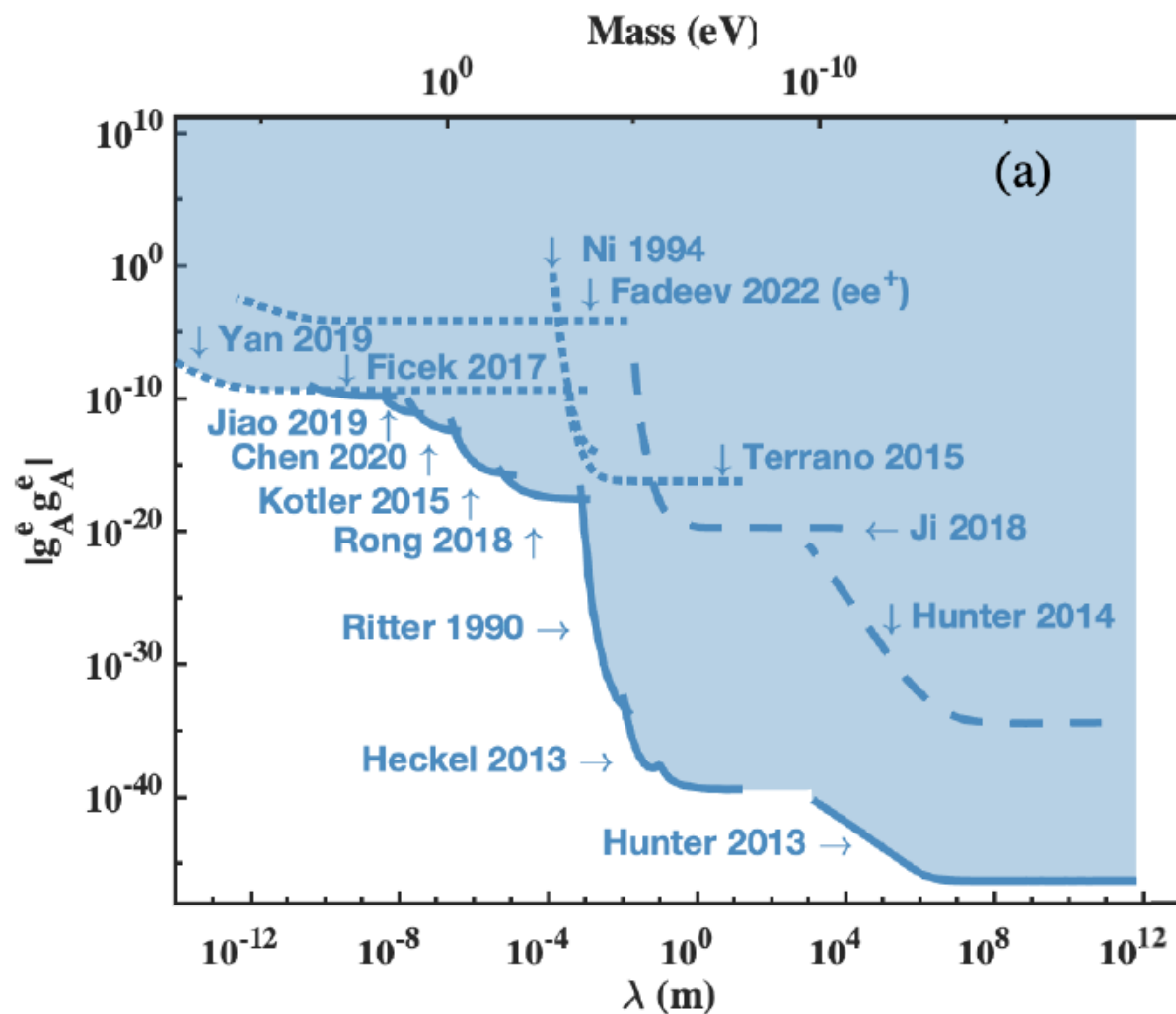
Arriving at a bound



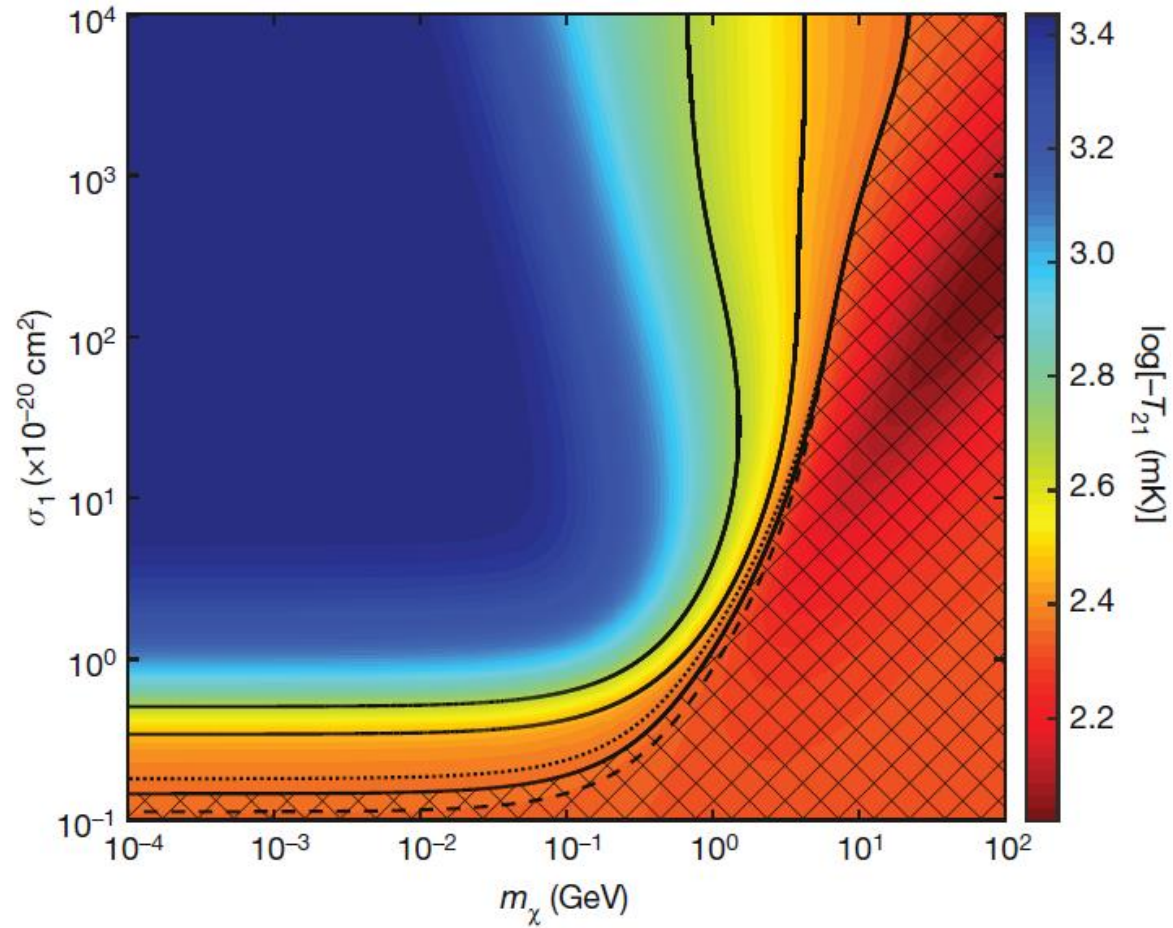
New Result (arXiv:2208.00658)



Upcoming review



Road ahead: signals 1



R. Barkana, Nature 555, 71
(2018)

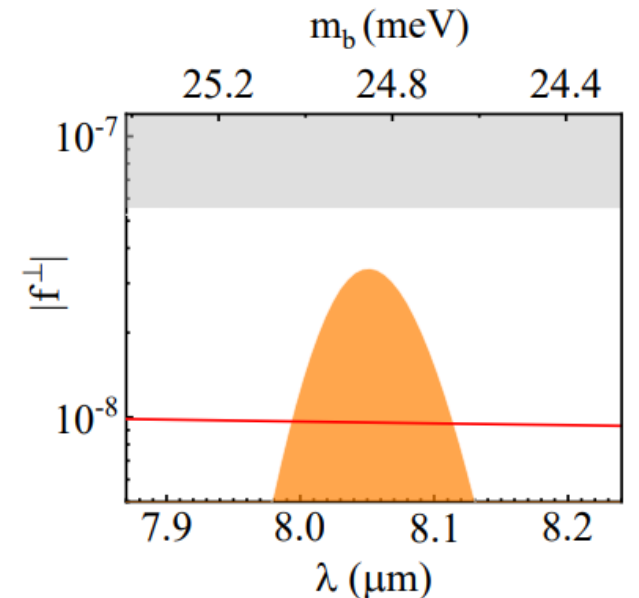
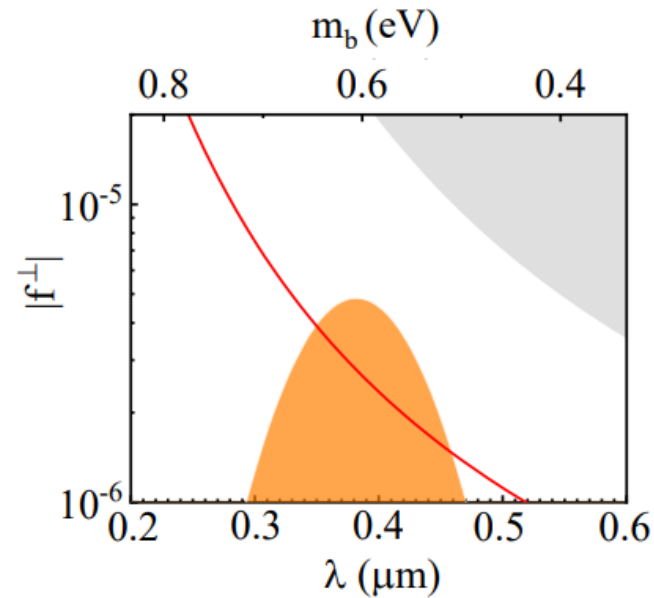
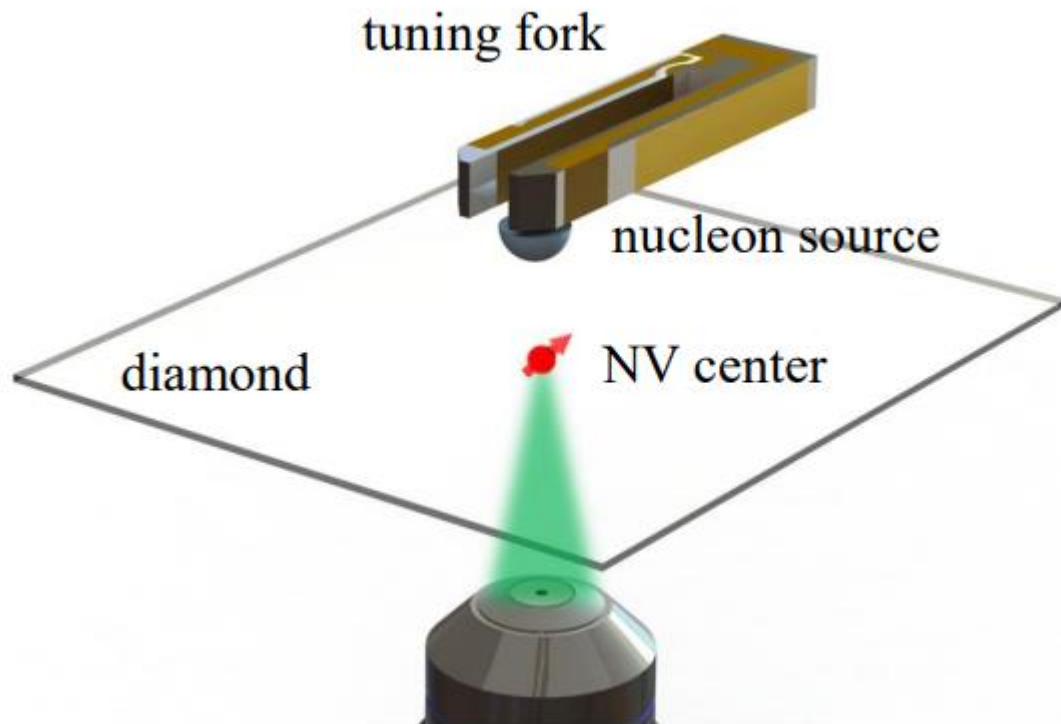
Figure 3 | Constraints on dark-matter properties using cosmic dawn observations.

Road ahead: signals 2

Observation of a new interaction between a single spin and a moving mass

Xing Rong, Man Jiao, Maosen Guo, Diguang Wu, Jiangfeng Du

arXiv:2010.15667v2 (2020)



Road ahead Challenge Bound from below

Thank you

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$1/M^2$ term (Phys. Rev. A 105, 022812 (2022))

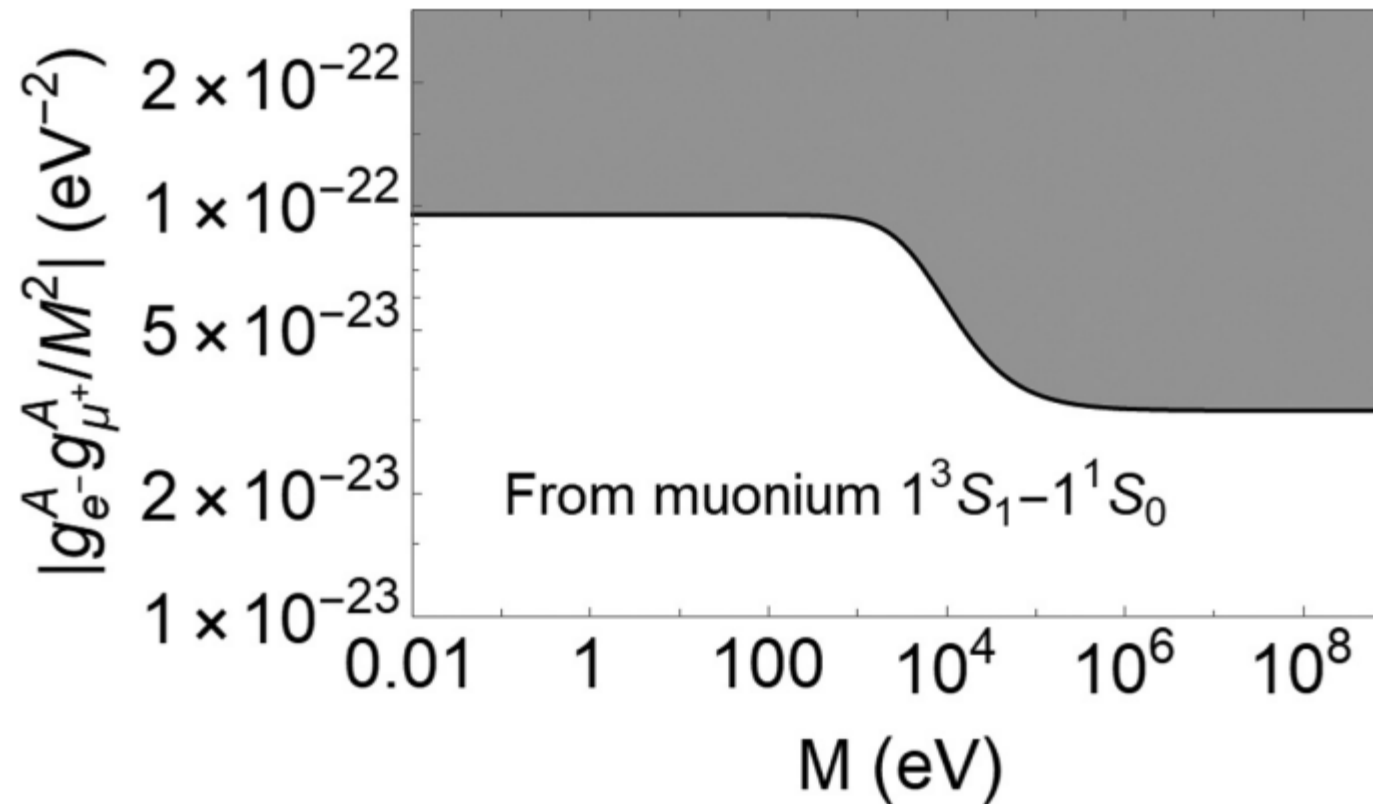


FIG. 3. Constraints for the interaction between an antimuon and an electron, at 90% confidence level.

Millicharged DM: Viable Parameter Space?

(Creque-Sarbinowski, Ji, EDK and Kamionkowski, to appear in PRD 2019)

Taking into account the thermal history, no room for the standard scenario:

