UAM

HIDDeν
Hunting Invisibles: Dark sectors, Dark matter and Neutrinos

ift Instituto de Física Teórica UAM-CSIC

in collaboration with L. Merlo (Madrid, IFT), Jean-Loup Tastet (Madrid, IFT)

based on **2212.11290**

Down to the Seesaw Line via the JALZ ALP-HNL Portal

by **Arturo de Giorgi (Madrid, IFT)**

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HNL

- **Neutrinos** need a **mass** ⇒ **right-handed** neutrinos, N_R ?

$$\mathscr{L}_{\mathrm{HNL}} = i\overline{N_R}\not{\partial} N_R - \left(\overline{L_L}\widetilde{H}\boldsymbol{Y}_N N_R + \frac{1}{2}\overline{N_R^c}\boldsymbol{M}_N N_R + \mathrm{h.c.}\right)$$

"**Seesaw** mechanism"

$$m_\nu \sim v^2 Y^2 / M_N$$

- N_R interacts with **gauge bosons** via **mixing** with active neutrinos ν_α

$$\nu_\alpha \to \nu_\alpha + \Theta_\alpha N_R^c$$ **"mixing-angle"**

"Seesaw Line" $$||\boldsymbol{\Theta}||^2 \sim \frac{||\boldsymbol{m}_\nu||}{||\boldsymbol{M}_N||} \lesssim 10^{-12}$$ ⇒ **hardly testable!**

Another portal?

ALP

- **Pseudo-Goldstone boson**
- Generated by spontaneous **breaking** of a **global symmetry**, e.g. **U(1)**
- Part of many **BSM** scenarios, including **String Theory**

- Missing a UV? Mainly studied via **EFT**

$$\mathscr{L}_a = \frac{1}{2}\partial_\mu a\,\partial^\mu a - \frac{1}{2}m_a^2\,a^2 \; - \frac{a}{f_a}\sum_{X} c_{aXX}\,X^{\mu\nu}\,\widetilde{X}_{\mu\nu} - \frac{\partial_\mu a}{f_a}\sum_{\psi}\overline{\psi}\,\boldsymbol{c}_\psi\gamma^\mu\psi$$

anomalous **shift-symmetric**

- **Coupling** proportional to **fermion mass**

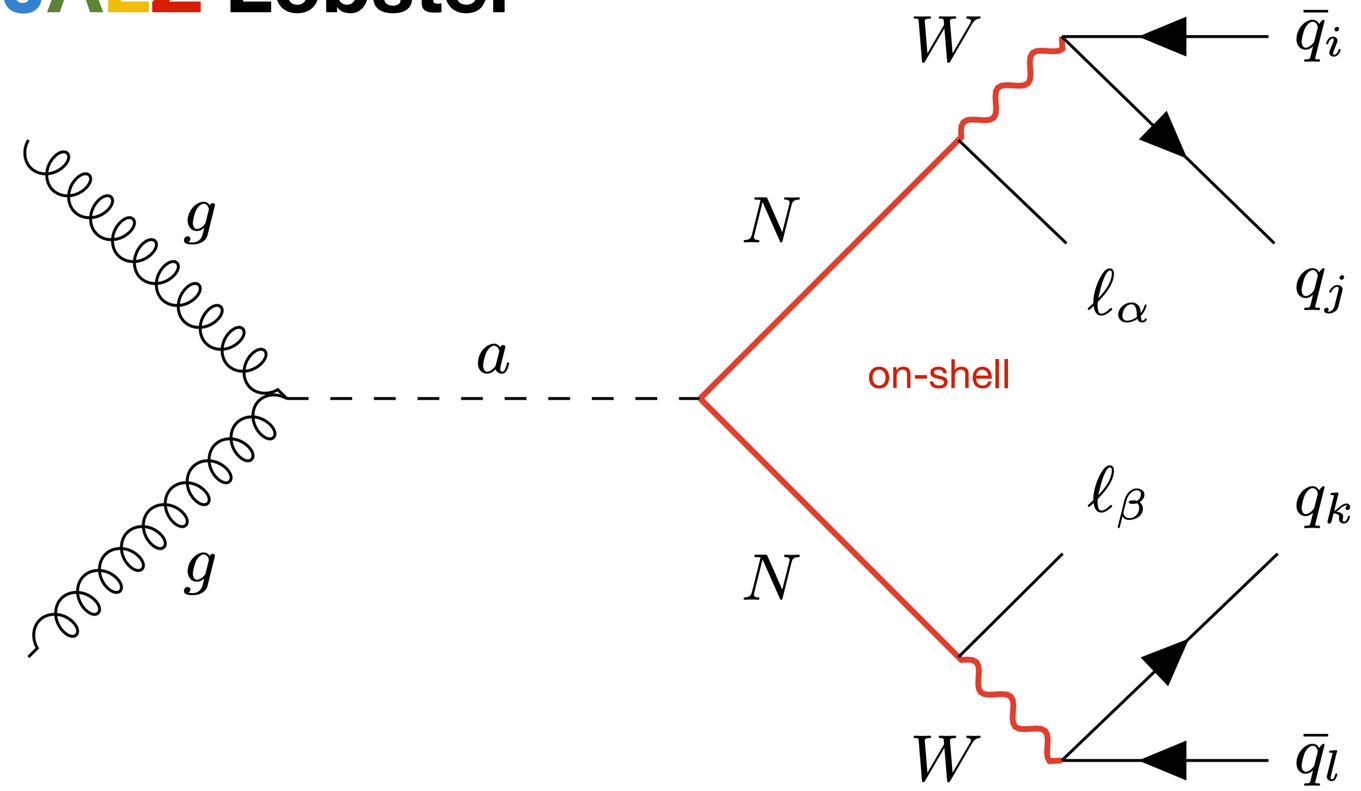
$$\frac{\partial_\mu a}{f_a}\,\bar{\psi}\gamma^\mu\psi \sim \frac{a}{f_a}\,m_\psi\bar{\psi}\psi \qquad \Rightarrow \qquad \textbf{heavier = better!}$$

Can we take advantage of that?

$$\mathscr{L}^{\text{eff}} = \mathscr{L}_{\text{SM}} + \mathscr{L}_{\text{HNL}} + \mathscr{L}_a \qquad \mathscr{L}_a \supset -\frac{\partial_\mu a}{f_a}\,\overline{N_R}\,\gamma^\mu\, c_N\, N_R$$

Where to look?
Promising signal with **4-jets** and **2-leptons**

The JALZ Lobster



Astonishing bounds

- Dynamical origin of $M_N \Rightarrow \bar{N}_R^c M_N N_R \to \phi \bar{N}_R^c Y_N N_R \Rightarrow c_N = 1$

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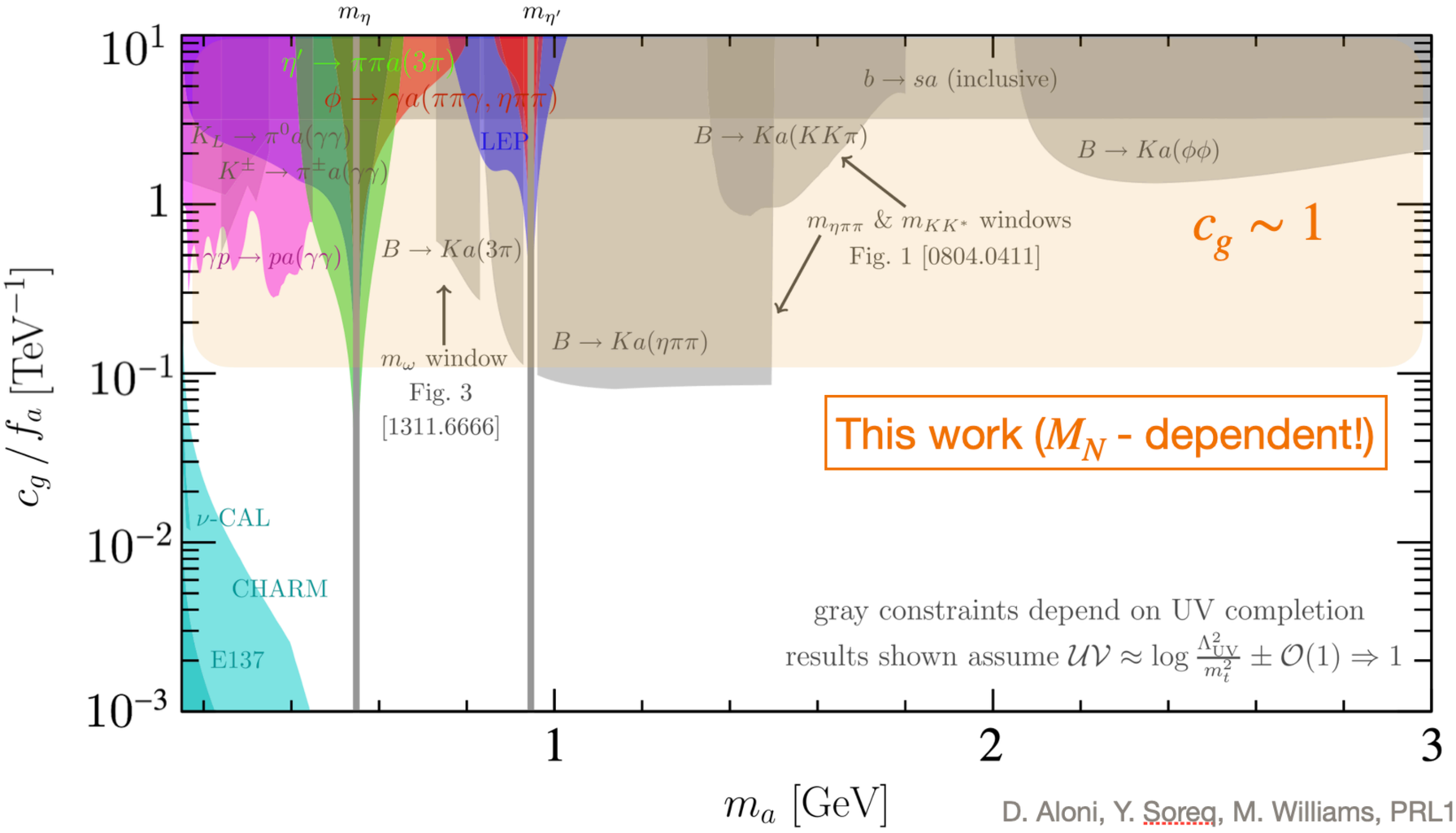

D. Aloni, Y. Soreq, M. Williams, PRL123(3) (2019)

Do you want to discuss and know more?

Come visit me!