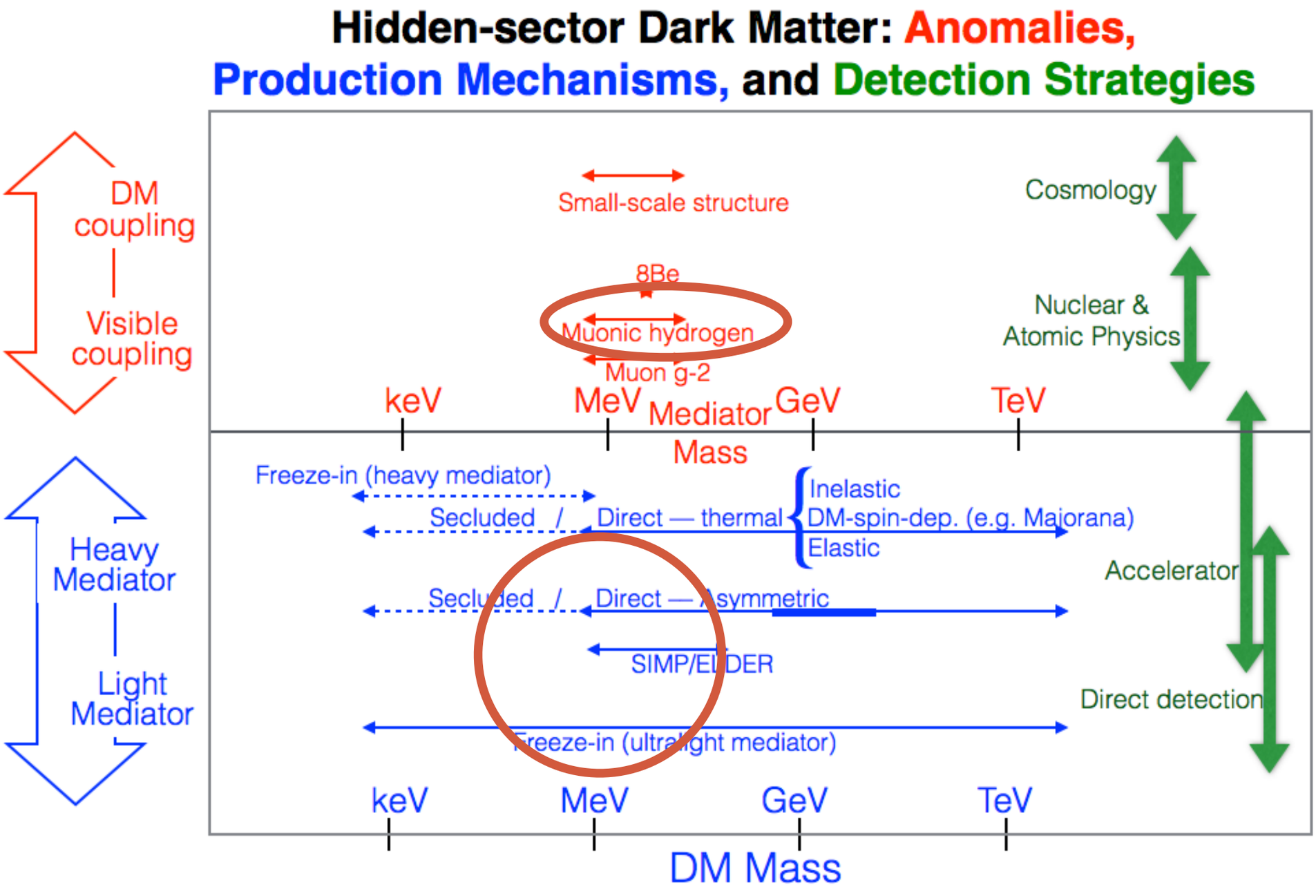
THE GAMMA FROM NUCLEAR DECAYS HIDING FROM INVESTIGATORS (GANDHI) EXPERIMENT

Harikrishnan Ramani
BCTP, Berkeley

GANDHI- arxiv:1810.06467
with Giovanni Benato, Alexey Drobizhev, Surjeet Rajendran

DARK FORCES LANDSCAPE

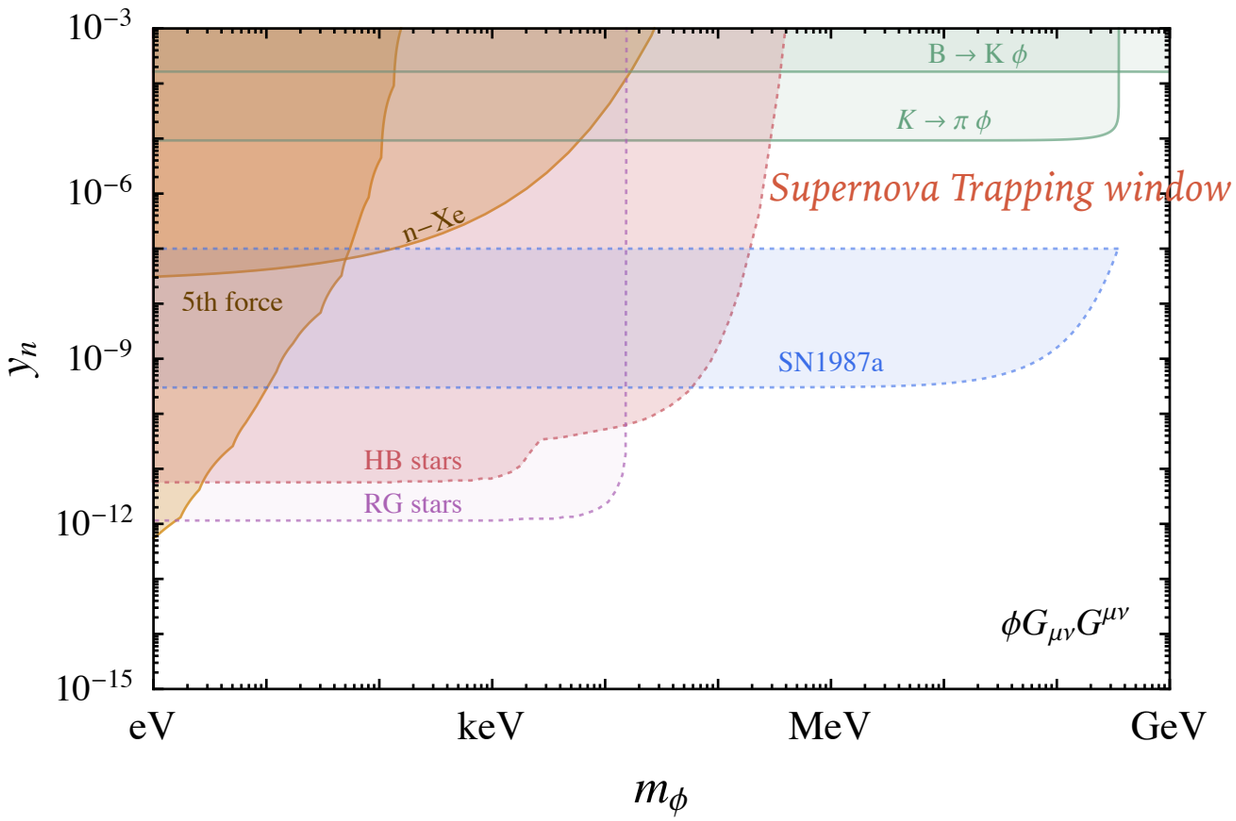


Cosmic Visions : 2017

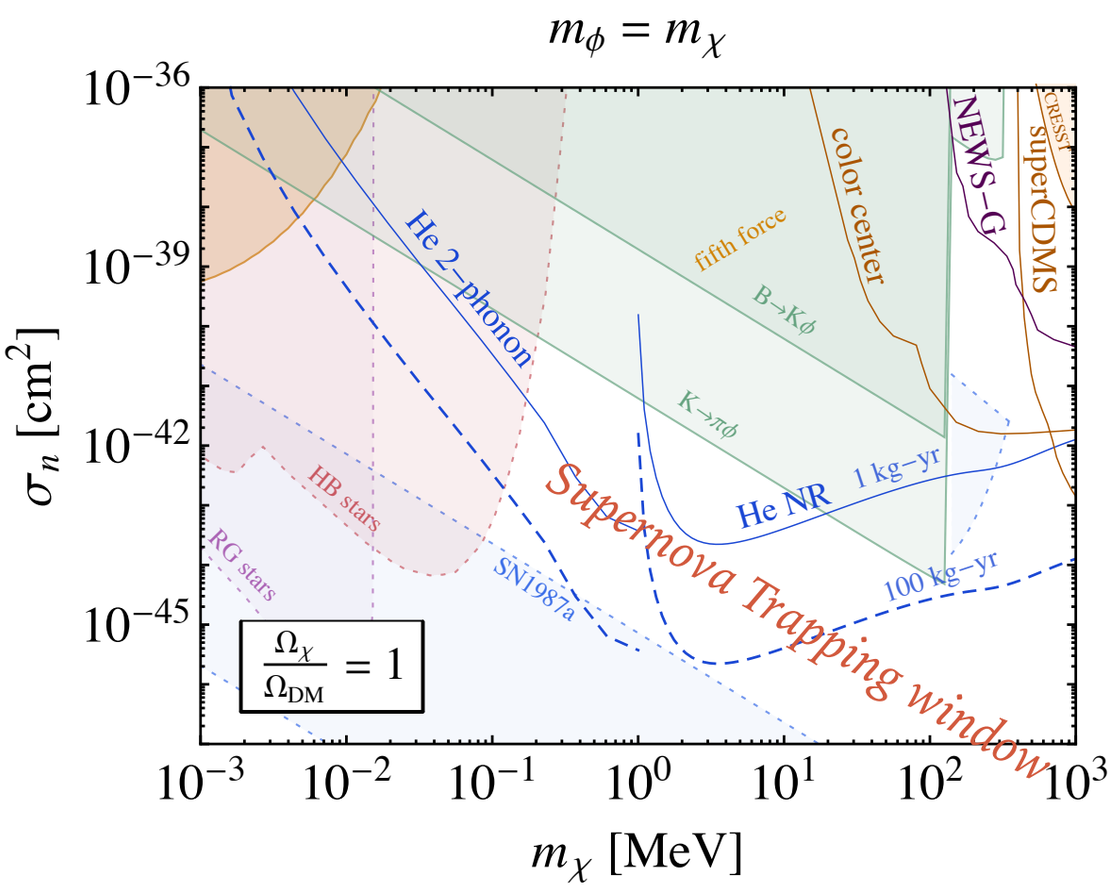
LIMITS ON MODELS FROM MEDIATORS

source:1709.07882, Knapen, Lin, Zurek

Limits on Mediator



Limits on Dark Matter



HOW ABOUT CONSTRAINING THE MEDIATOR ITSELF?

MET

- missing energy experiments stay agnostic to decay modes
- furthermore, pay small factor only once
- how do we do this for a baryonic force though? doing MET search for baryons is a messy enterprise.

- (Missing) Gamma Decays

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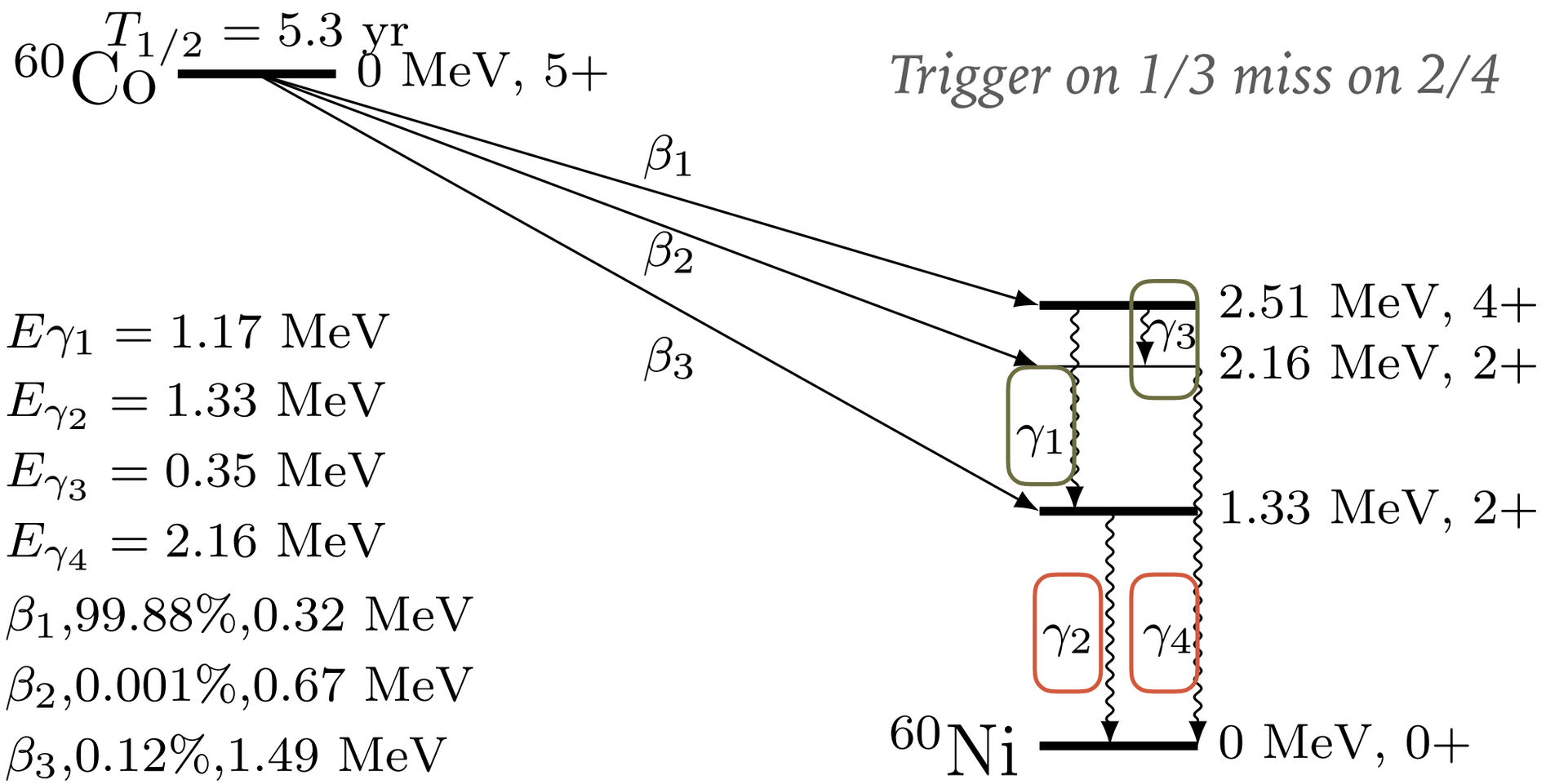
NUCLEAR PHYSICS FOR PEACE

Quotes wrongly attributed to Mahatma Gandhi:

"A gamma for a gamma makes… "

CASCADE GAMMA DECAYS IN COBALT DECAYS

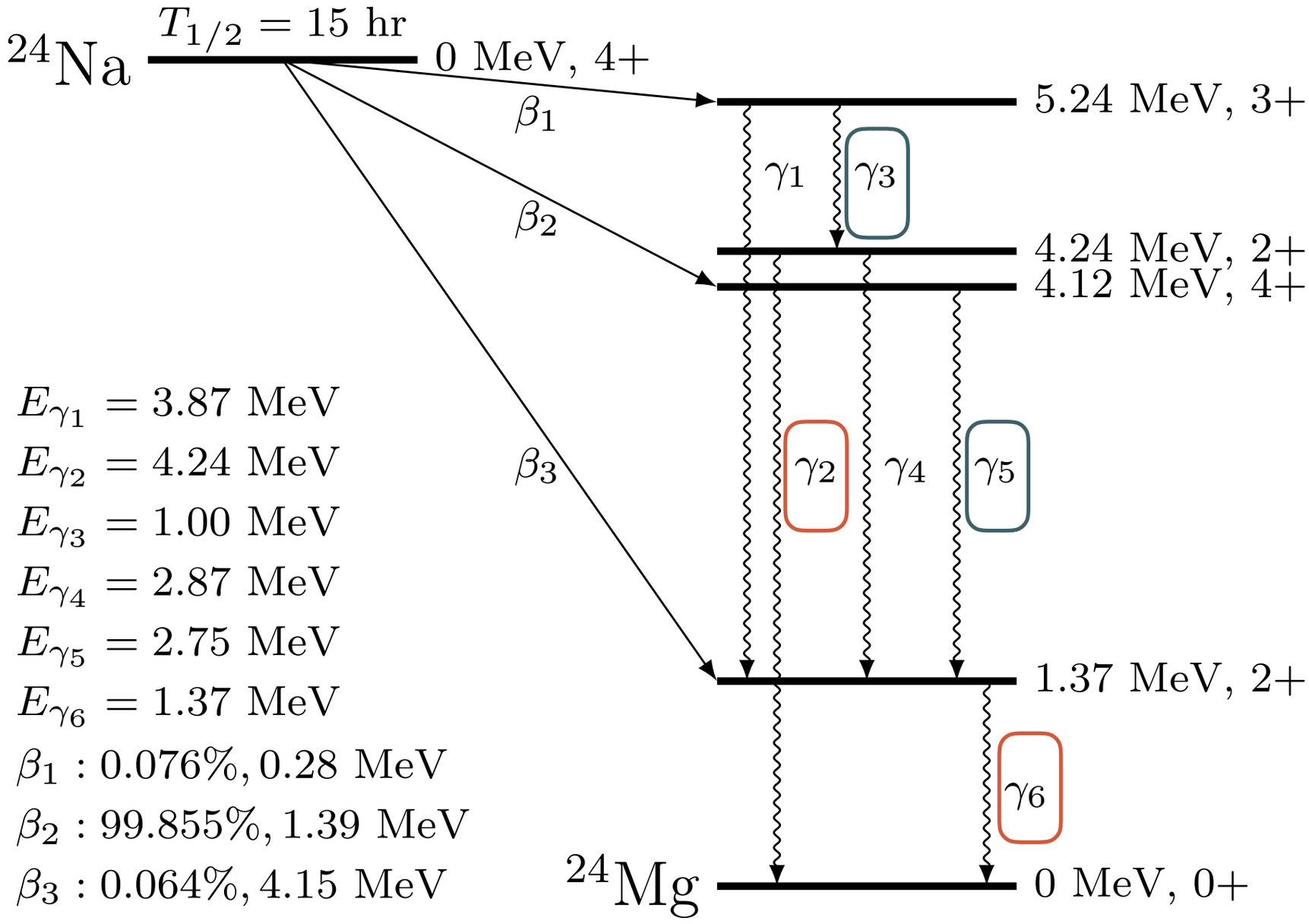


Trigger on 1/3 miss on 2/4

$E\gamma_1 = 1.17$ MeV
$E_{\gamma_2} = 1.33$ MeV
$E_{\gamma_3} = 0.35$ MeV
$E_{\gamma_4} = 2.16$ MeV
β_1,99.88%,0.32 MeV
β_2,0.001%,0.67 MeV
β_3,0.12%,1.49 MeV

Cascades happen because it is easier to shed two units of spin at a time rather than shedding 4 all at once.

^{24}NA



$E_{\gamma_1} = 3.87$ MeV
$E_{\gamma_2} = 4.24$ MeV
$E_{\gamma_3} = 1.00$ MeV
$E_{\gamma_4} = 2.87$ MeV
$E_{\gamma_5} = 2.75$ MeV
$E_{\gamma_6} = 1.37$ MeV
$\beta_1 : 0.076\%, 0.28$ MeV
$\beta_2 : 99.855\%, 1.39$ MeV
$\beta_3 : 0.064\%, 4.15$ MeV

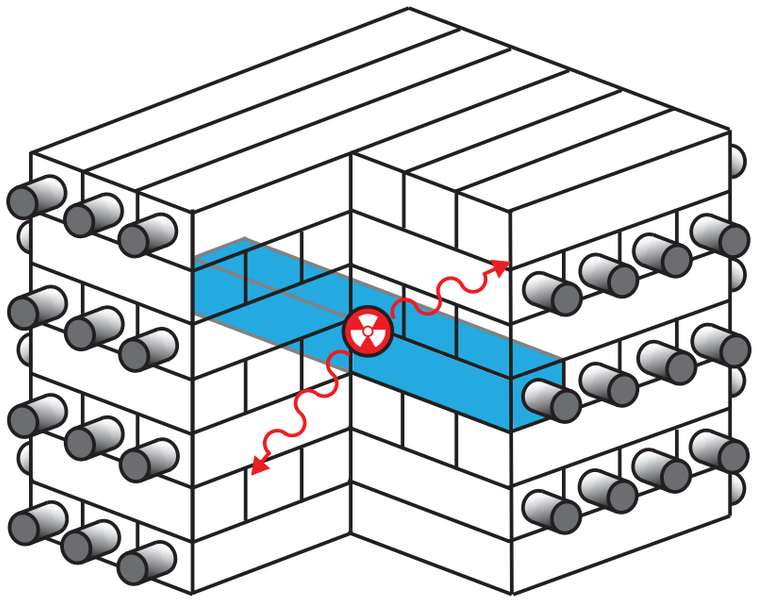
SIGNAL

- Cobalt foil inside a hermetically sealed detector
- Trigger on first gamma
- Signal event is a (beta) + (first gamma) + (missing subsequent second gamma)

PHOTON DETECTION

- Photon detection with minimum dead-time
- Energy resolution, very important.
- Minimal dead regions/cracks, hermeticity sealed.
- Intrinsic Radioactivity needs to be kept low
- Large detector volumes might be required to make sure second gamma was not missed, difficult to grow crystals.
- Plastic Scintillators are ideal choice - BC-404
- A Hybrid plastic Scintillator core + liquid scintillator body might work also.

DETECTOR SCHEME



- Hermetic Detector divided into 3 modules
- Central modules to completely stop betas ~ cm
- Inner module to detect majority of the gammas ~ 10cm. Require detection of first gamma here
- Outer module depending on the efficiency required.

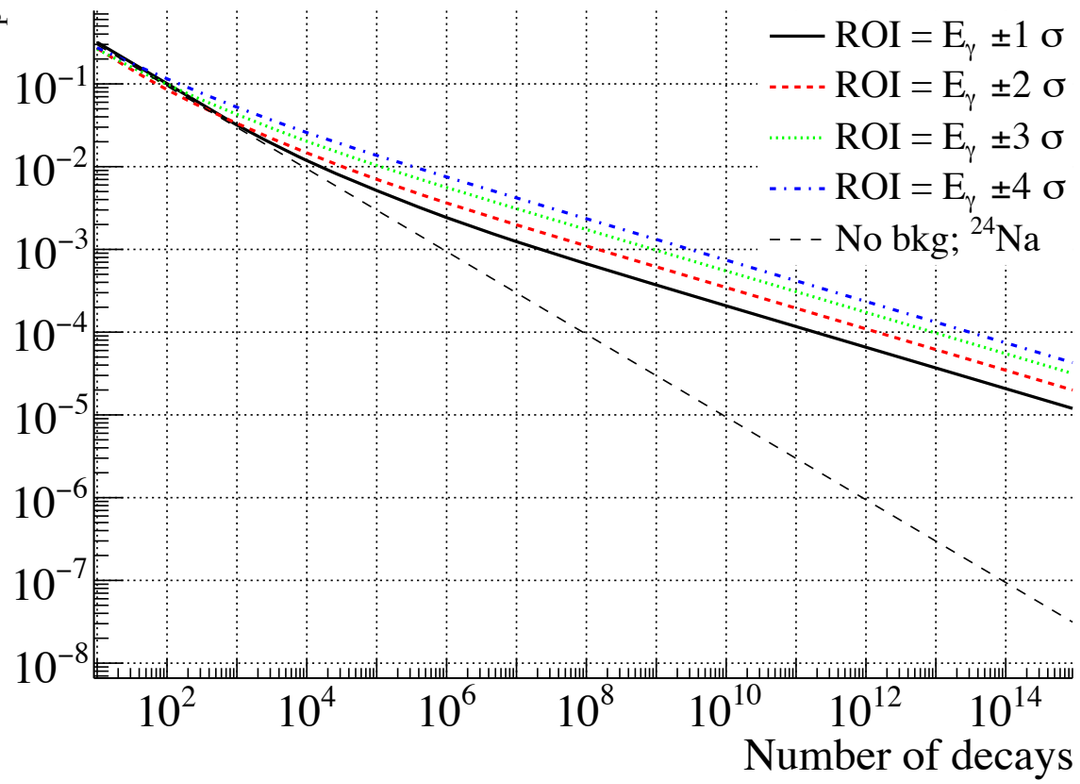
INVISIBLE BRANCHING FRACTION

$$\mathcal{L} = g_p \phi \bar{p} p$$

$$\frac{\Gamma(\phi)}{\Gamma_{\gamma, E_2}} \sim \frac{1}{2} \left(\frac{g_p}{e} \right)^2 \left(1 - \frac{m_\phi^2}{\omega^2} \right)^{\frac{5}{2}}$$

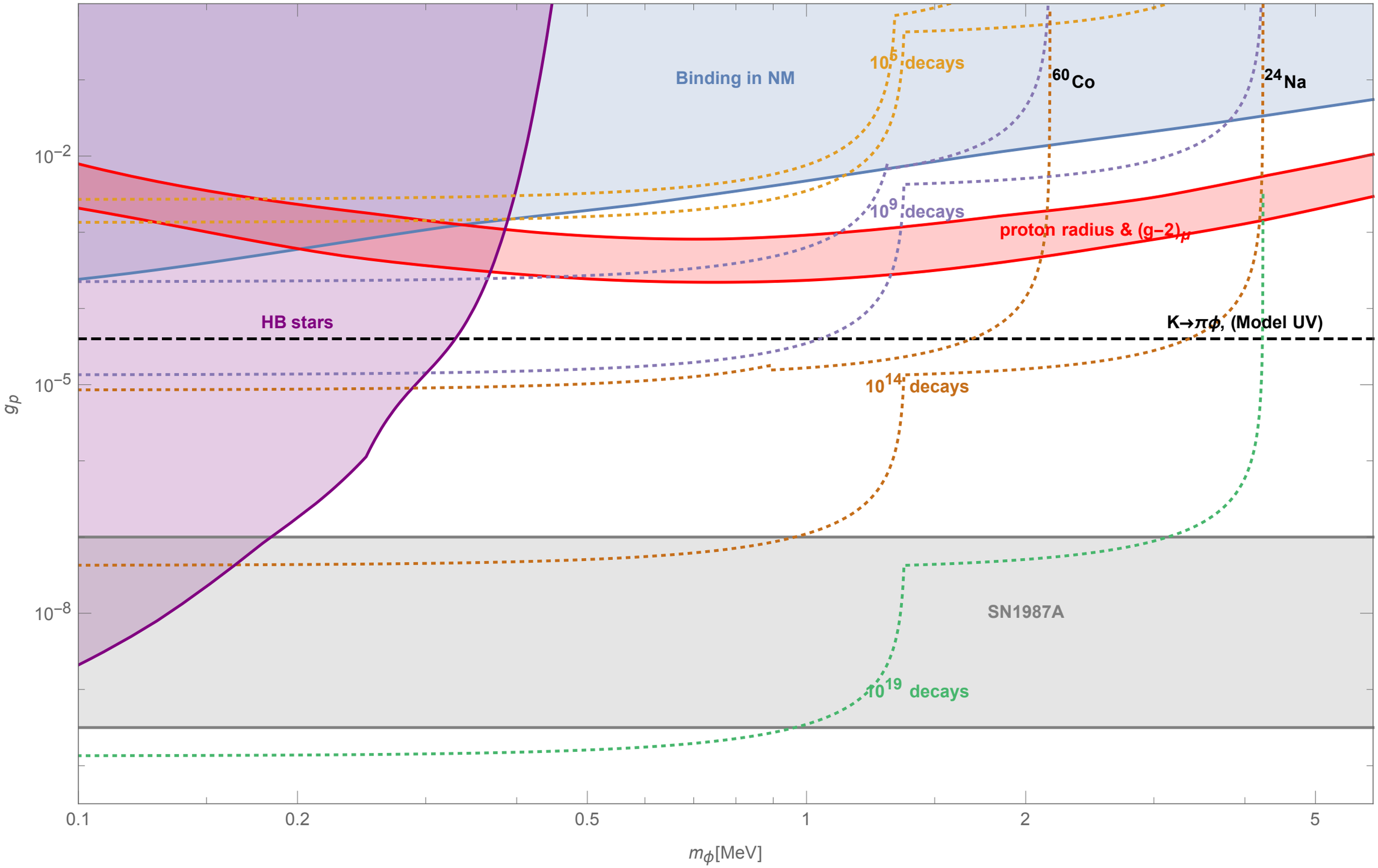
1.33 MEV GAMMA MIMICKING 1.17 MEV GAMMA

Mixing angle



- As statistics increase, need tighter cuts in order to keep the tails of the singular second gamma from causing fakes. Happens mainly because $E_2 > E_1$
- 24Na does not suffer from this….

REACH



Source for existing limits: Knapen et al. and Y.-S. Liu, D. McKeen, and G. A. Miller ,1605.04612