Multi-scattering Dark Matter at Neutrino Experiments

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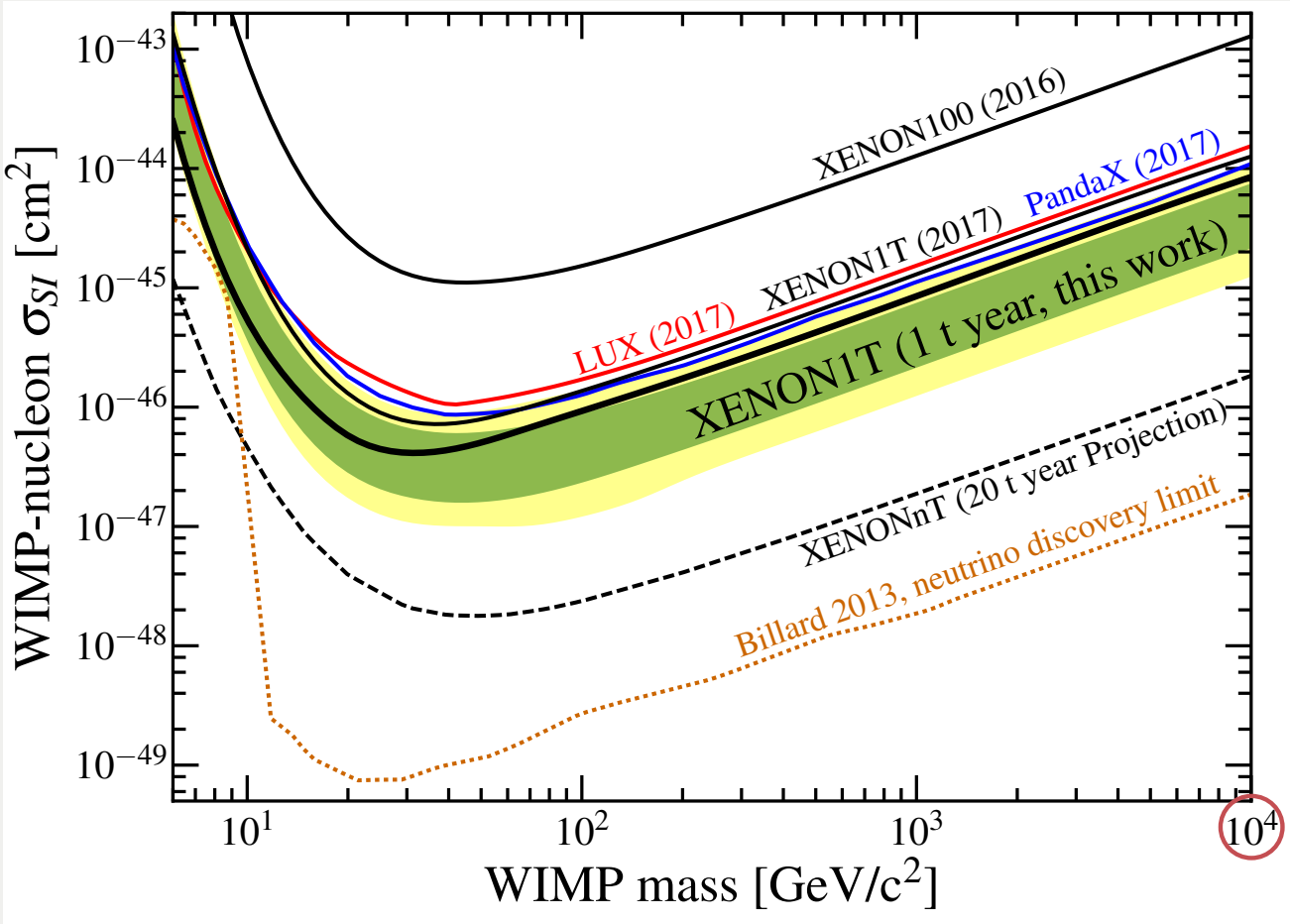
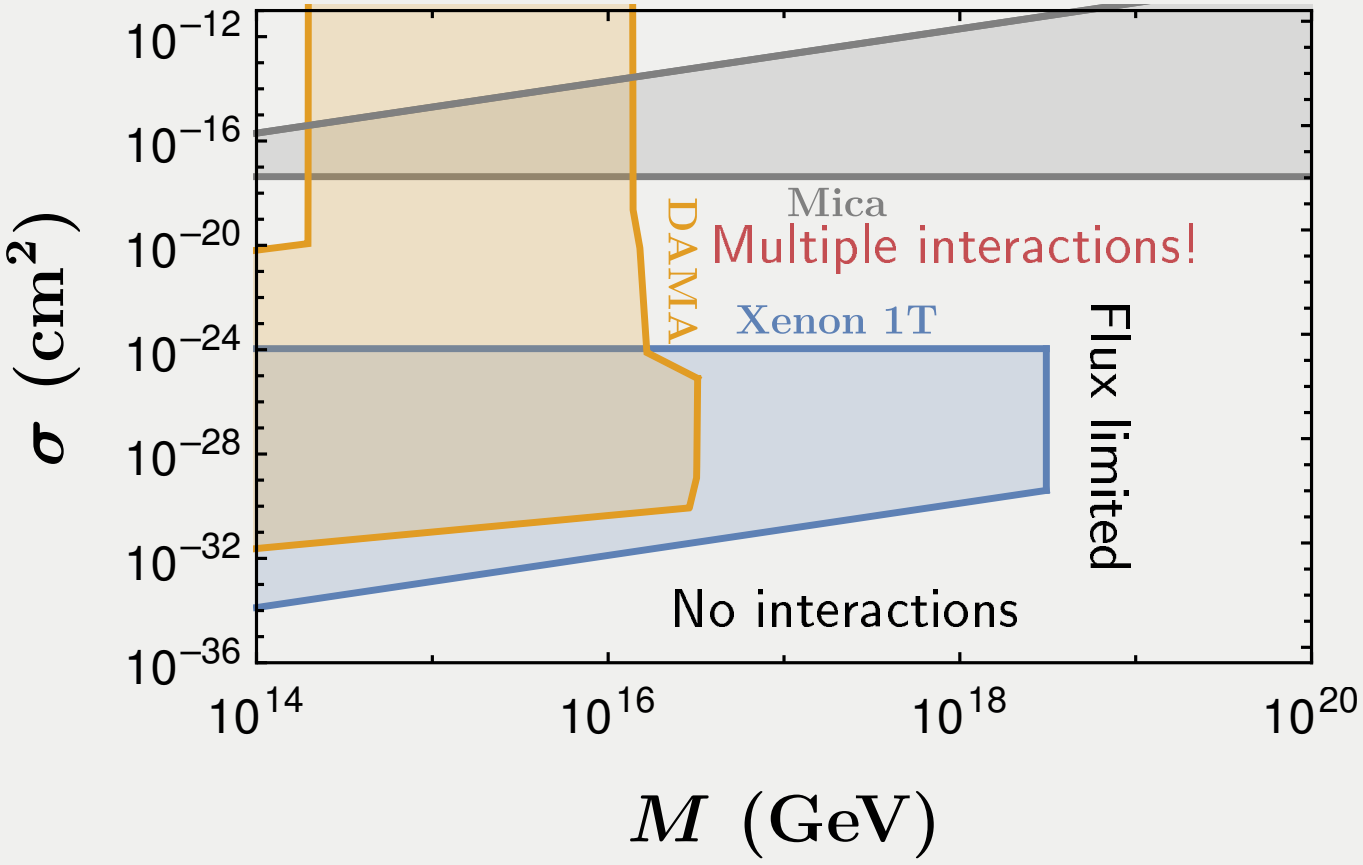
NF03 Kickoff

Direct Detection Status



Xenon1T: PRL 121, 111302 (2018)

The High Mass Frontier



Xenon1T: PRL 121, 111302 (2018)
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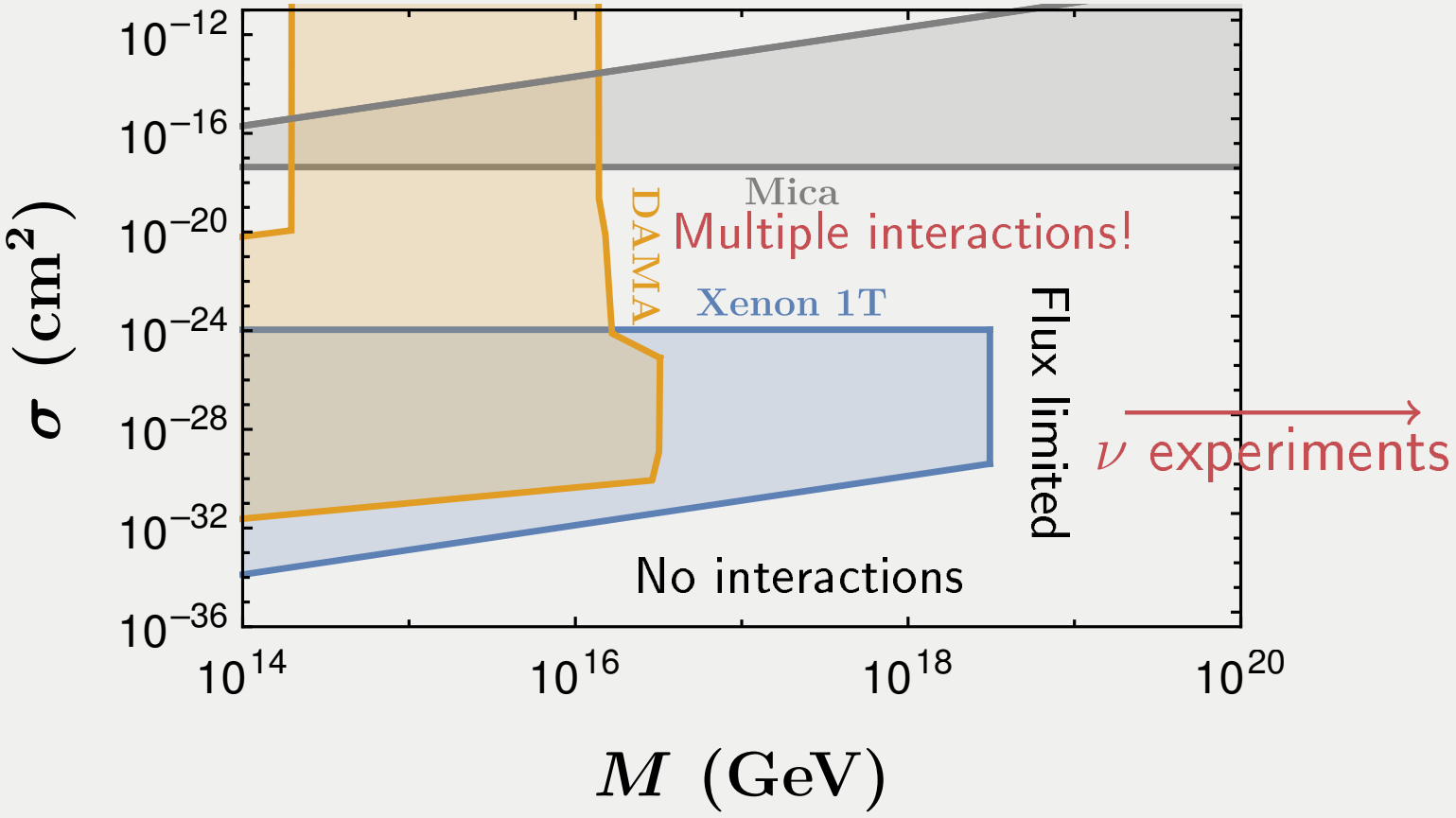
Pontón, Bai, Jain: JHEP 1909 (2019) 011

The High Mass Frontier



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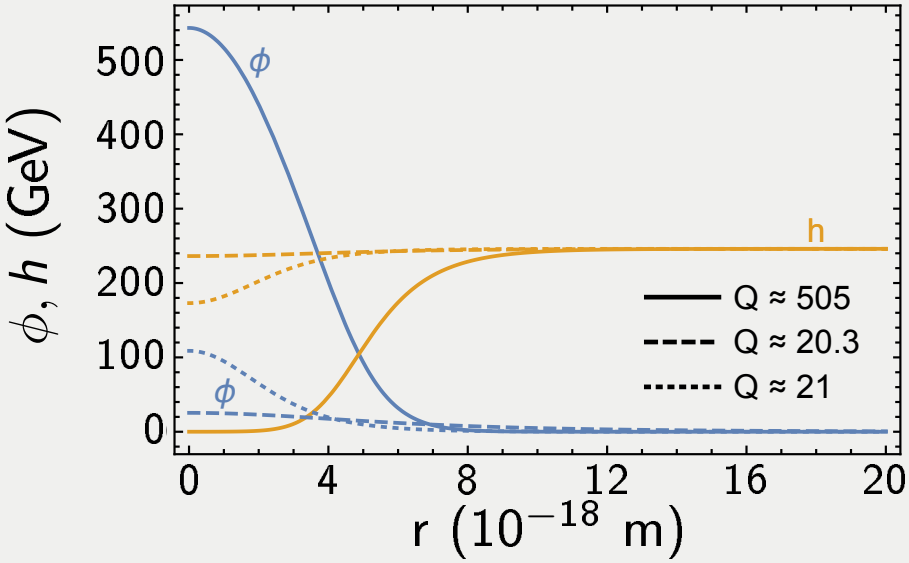
Model example

e.g: Non-topological soliton

Ingredient: scalar field ϕ

Large scalar charge $Q \rightarrow$
Stable buildup of scalar field

DM: Balls of scalar field



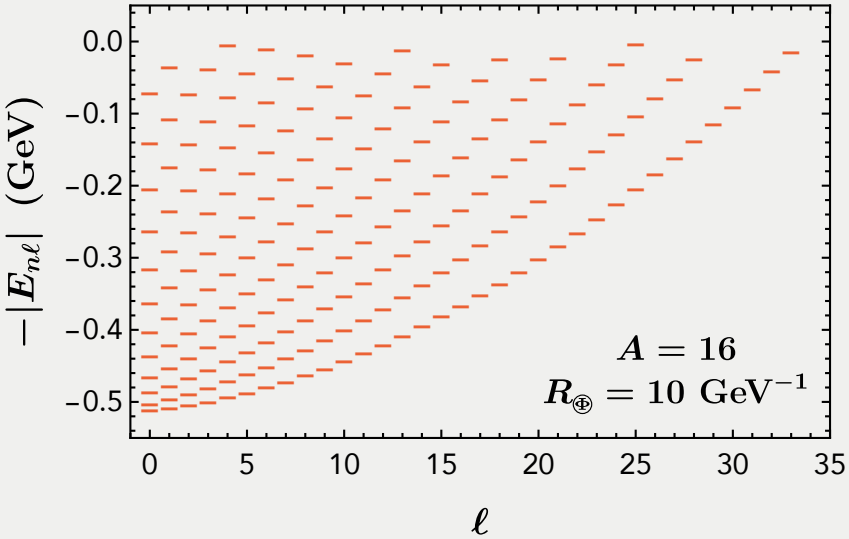
$$\phi'' + \frac{2}{r}\phi' + \left[\omega^2 - \frac{1}{2}\lambda_{\phi h}\, h^2\right]\phi = 0$$

$$h'' + \frac{2}{r}h' + \left[\frac{m_h^2}{2} - \lambda_h\, h^2 - \frac{1}{2}\lambda_{\phi h}\,\phi^2\right] h = 0$$

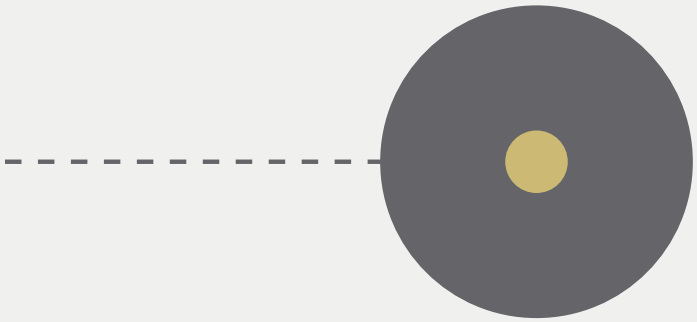
Pontón, Bai, Jain: JHEP 1909 (2019) 011

Capture process

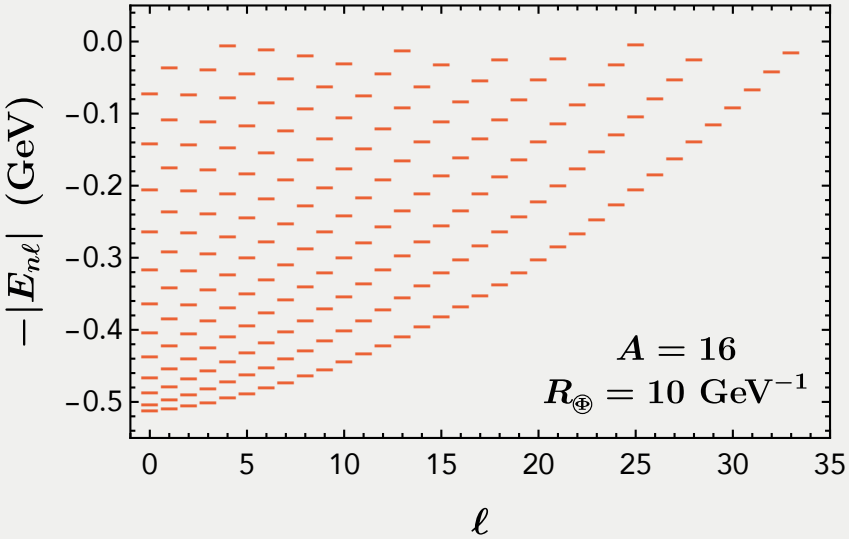
Radiative capture: analogous to neutron capture by nuclei



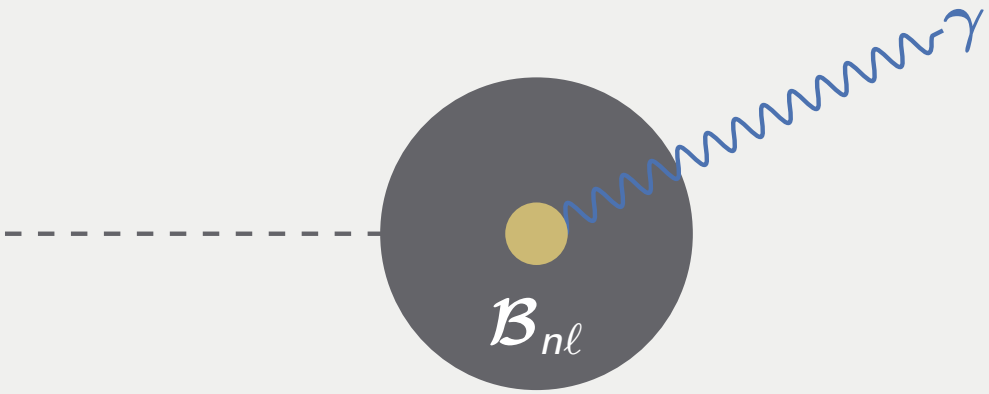
Capture process



Radiative capture: analogous to neutron capture by nuclei



Capture process



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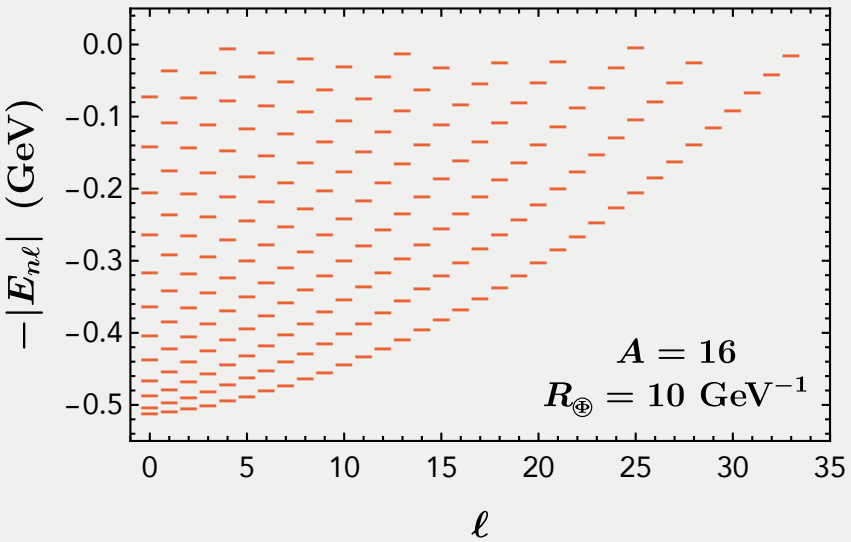
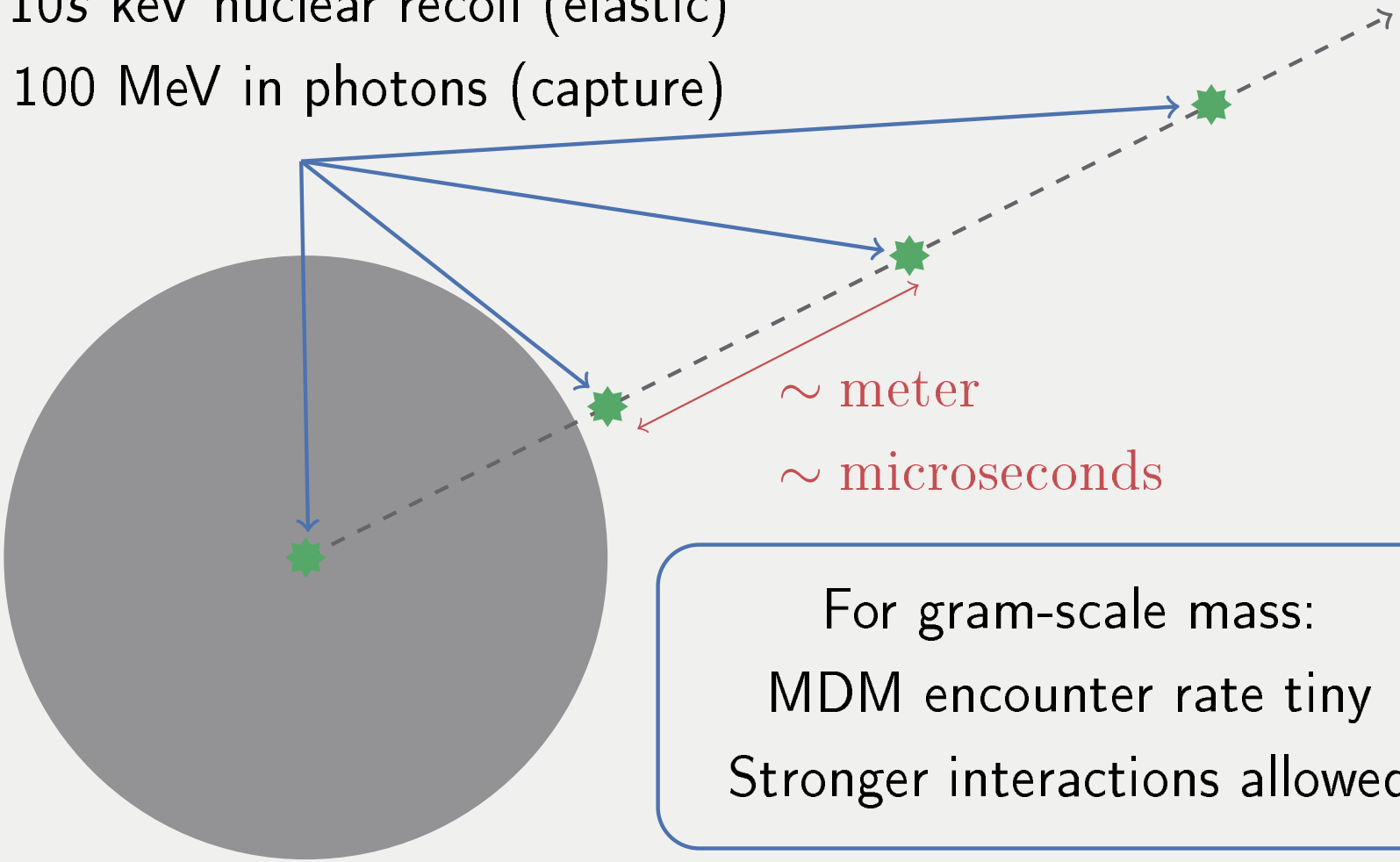


Signal

10s keV nuclear recoil (elastic)

100 MeV in photons (capture)

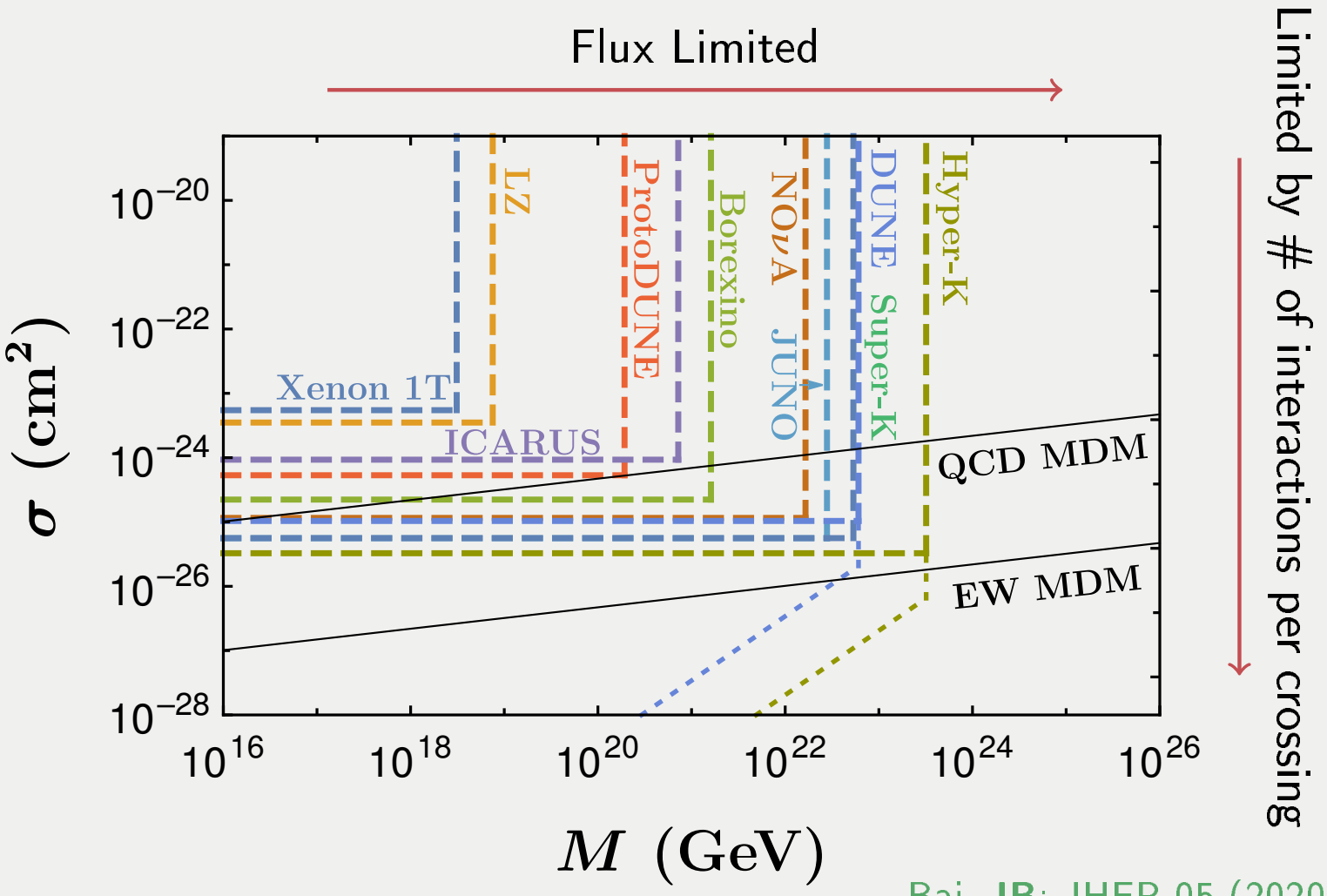


For gram-scale mass:

MDM encounter rate tiny

Stronger interactions allowed

Projected sensitivity



Bai, **JB**: JHEP 05 (2020) 160

Next Steps

- Backgrounds

  Assumed to be background free

  Cosmics may impede reconstruction (surface detectors)

- Trigger

  Events arrive off-beam at random times

- Thresholds

  Soft nuclear recoil for elastic scattering

  Low energy γs possible for capture

- Reconstruction

  "Line of hits/captures" structure (great for LArTPCs!)