Dark Matter-neutrino interactions: Through the lens of their cosmological implications

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Work in Collaboration with: Celine Boehm, Sergio Palomares-Ruiz and Silvia Pascoli

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Motivation

- We do not know **why** neutrinos have **mass**

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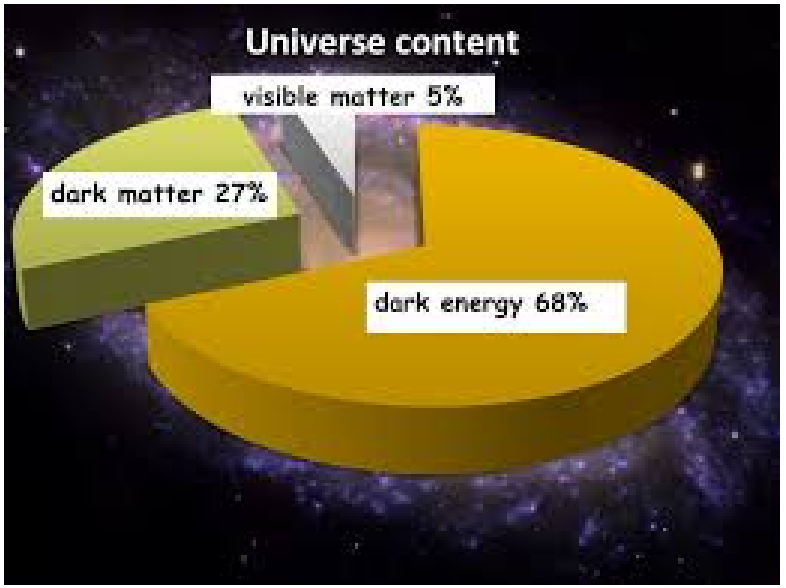
- A particle description of DM is still **missing**



Set up

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DM \ Mediator	Scalar	Fermion	Vector
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Fermion	✓	×	✓
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[C.Boehm, R.Wilkinson, 1401.7597]

Constant Cross Section

$$\sigma_{\mathrm{el}} \lesssim 10^{-36} \left(\frac{m_{\mathrm{DM}}}{\mathrm{MeV}}\right) \mathrm{cm}^2$$

T^2- dependent Cross Section

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Indirect Detection at Neutrino Detectors - We use data from the Super Kamiokande detector

Results

Majorana DM with Scalar Mediator

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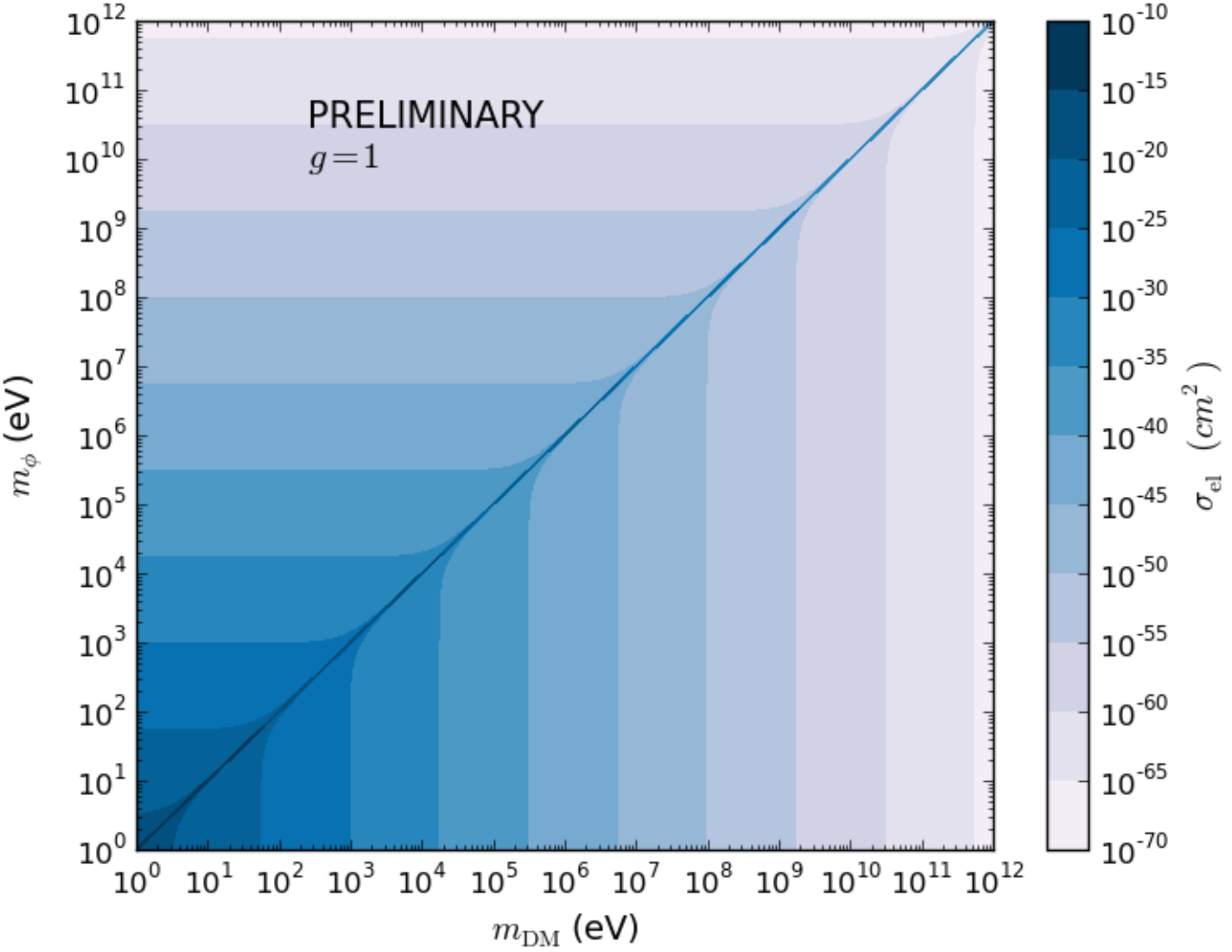
$$E_\nu \sim 2.35 \; \times \; 10^{-4} \; \text{eV} \ll \text{m}_{\rm DM}, \text{m}_{\rm N}$$

$$\sigma_{\rm el} = \frac{g^4}{8\pi} \frac{E_\nu^2}{(m_\phi^2 \; - \; m_{\rm DM}^2)^2}$$


PRELIMINARY
$g=1$
m_ϕ (eV)
$m_{\rm DM}$ (eV)
$\sigma_{\rm el}$ (cm^2)
10^{12}
10^{11}
10^{10}
10^{9}
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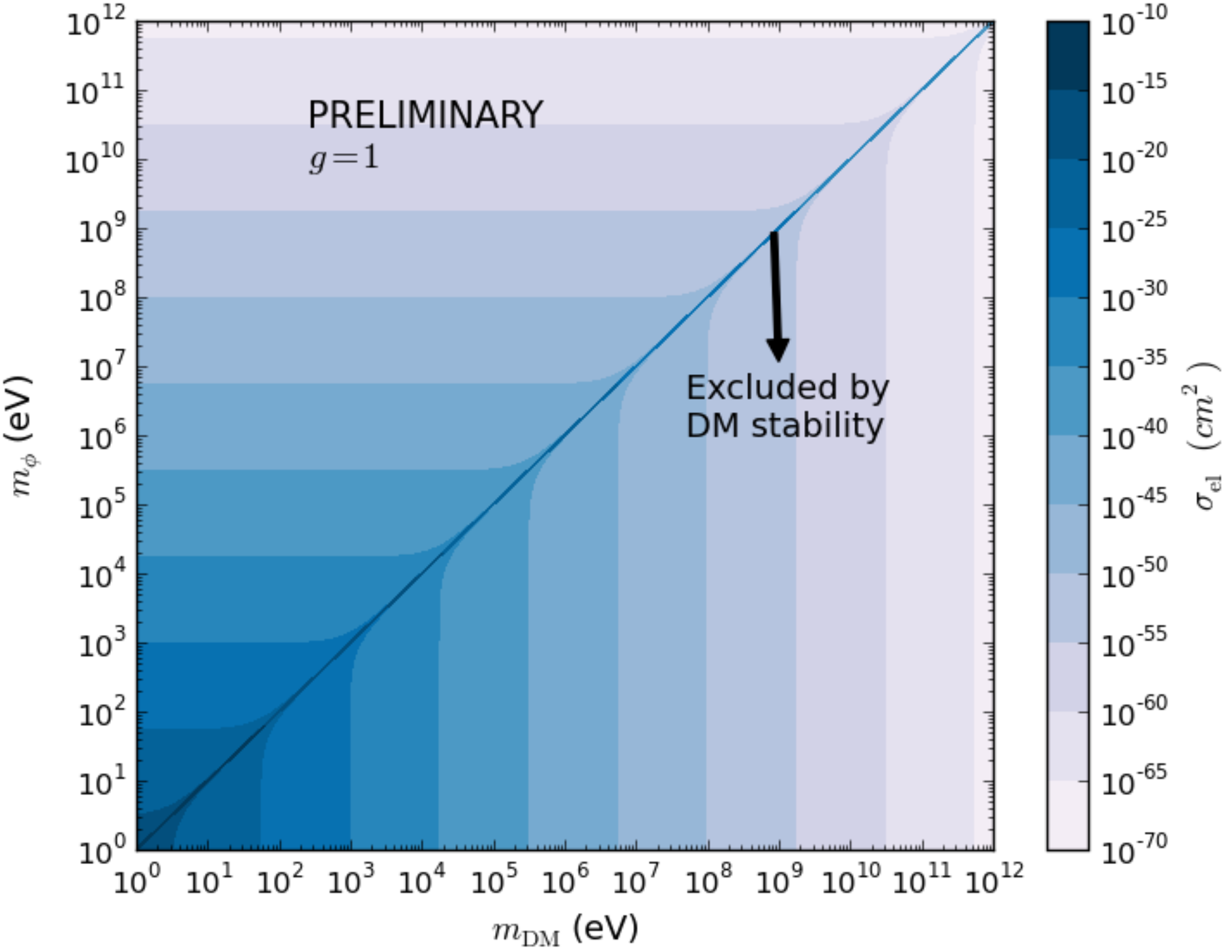
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DM stability
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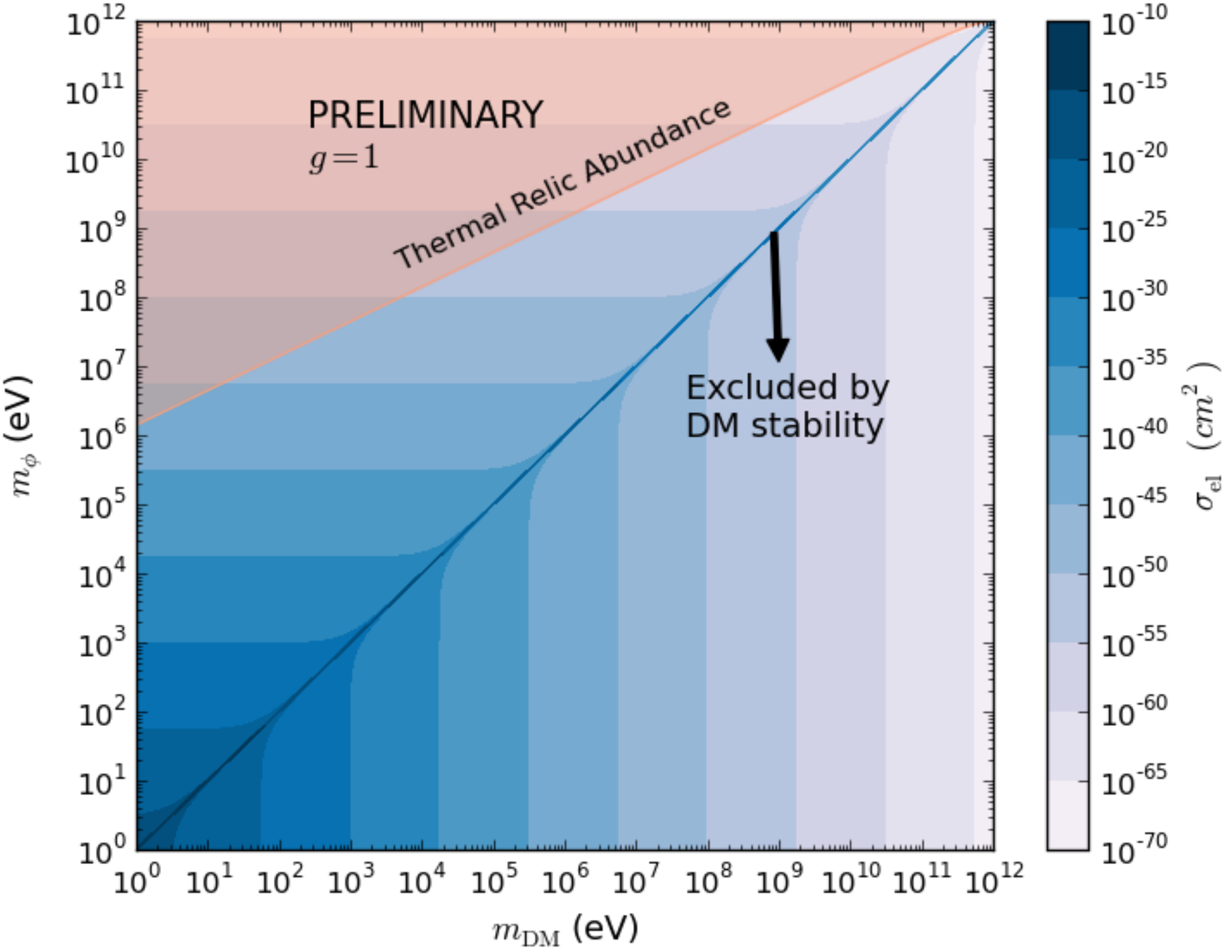
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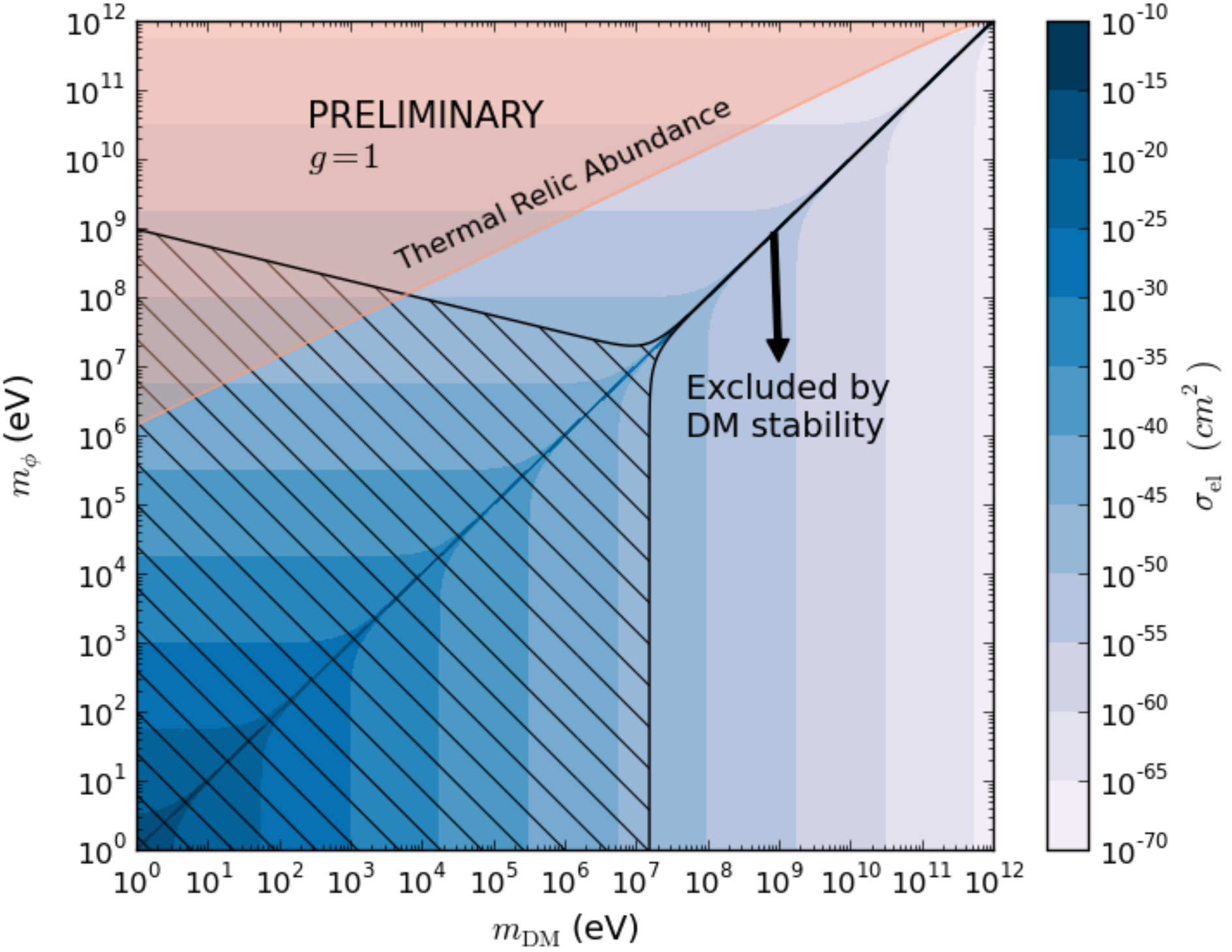
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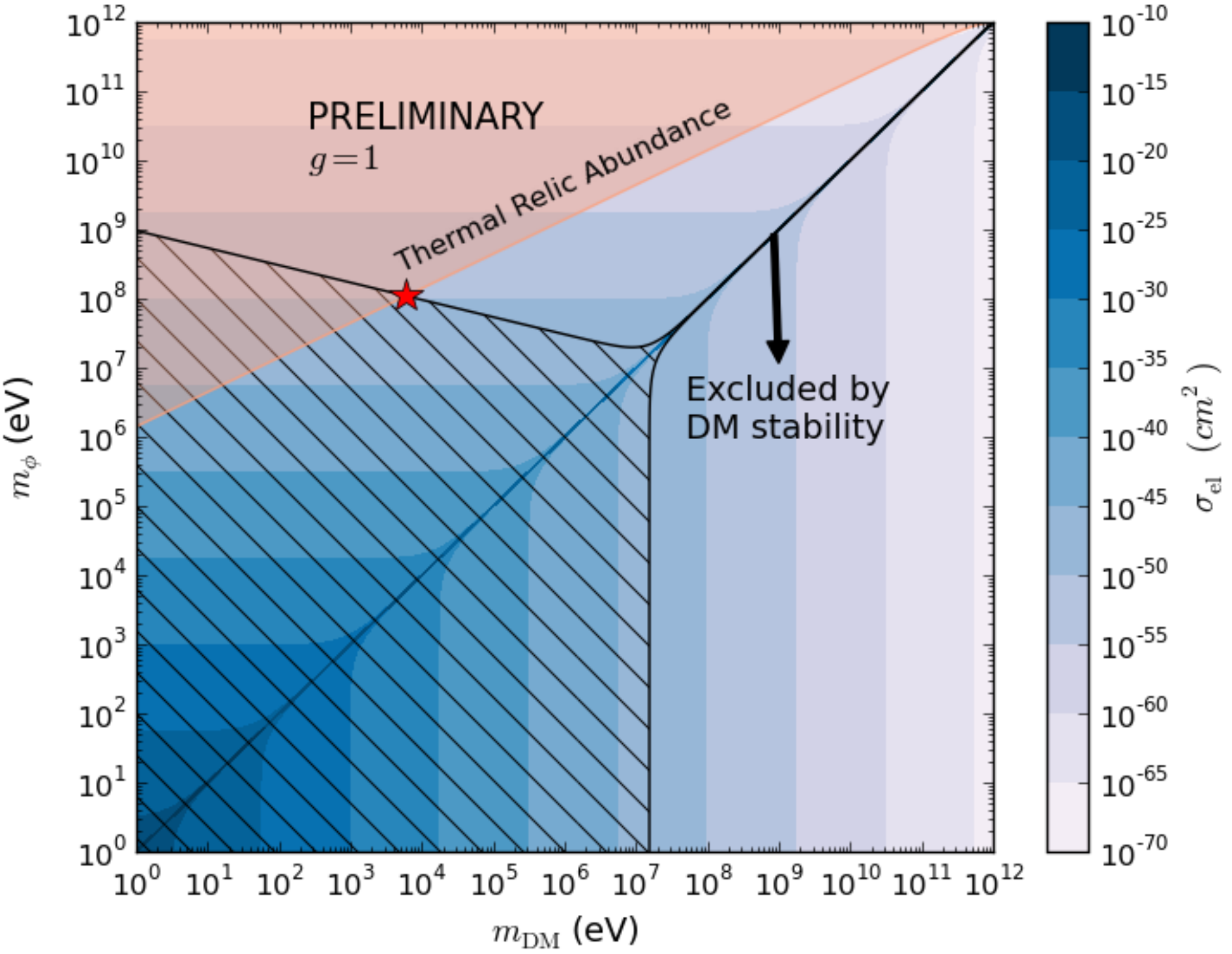
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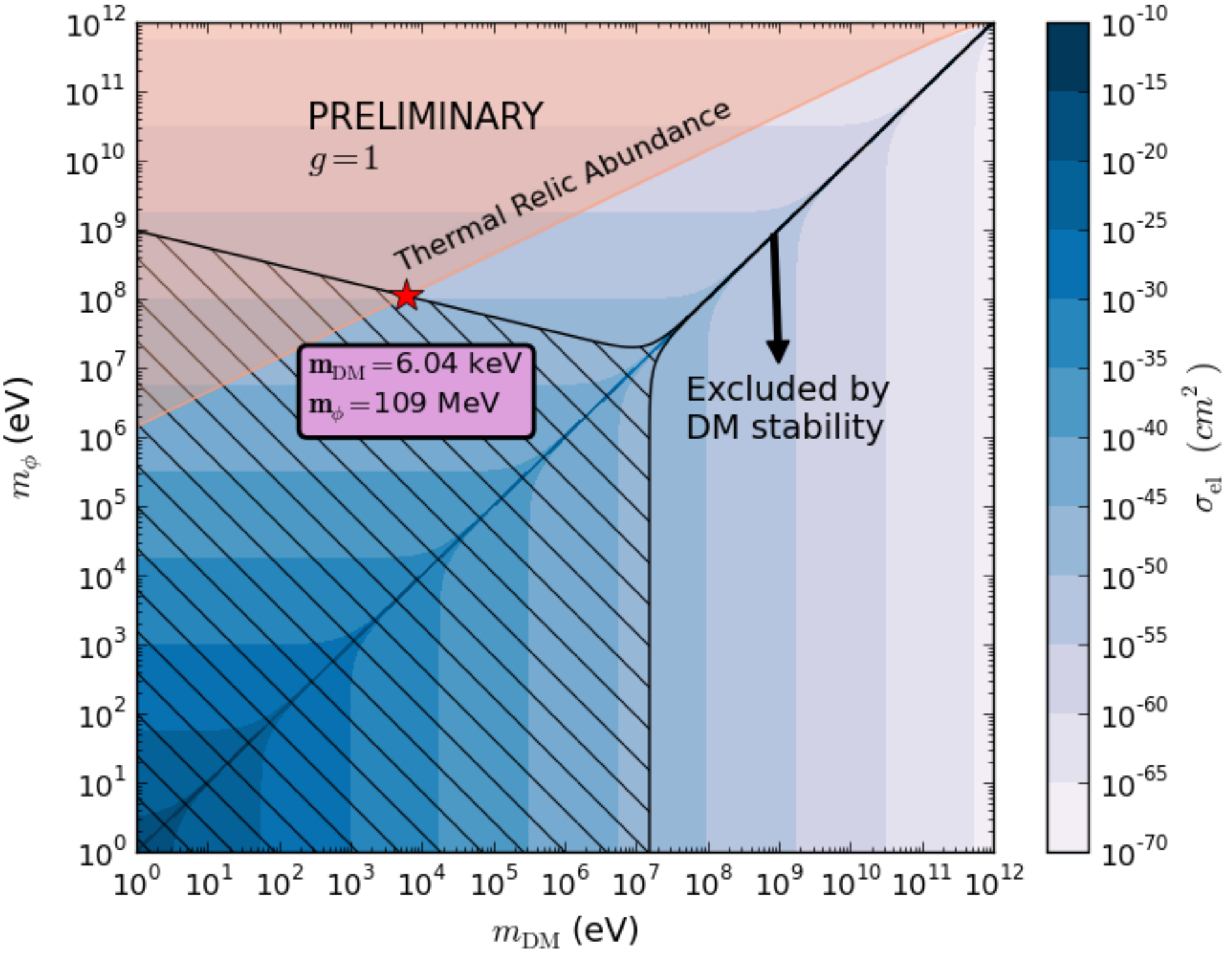
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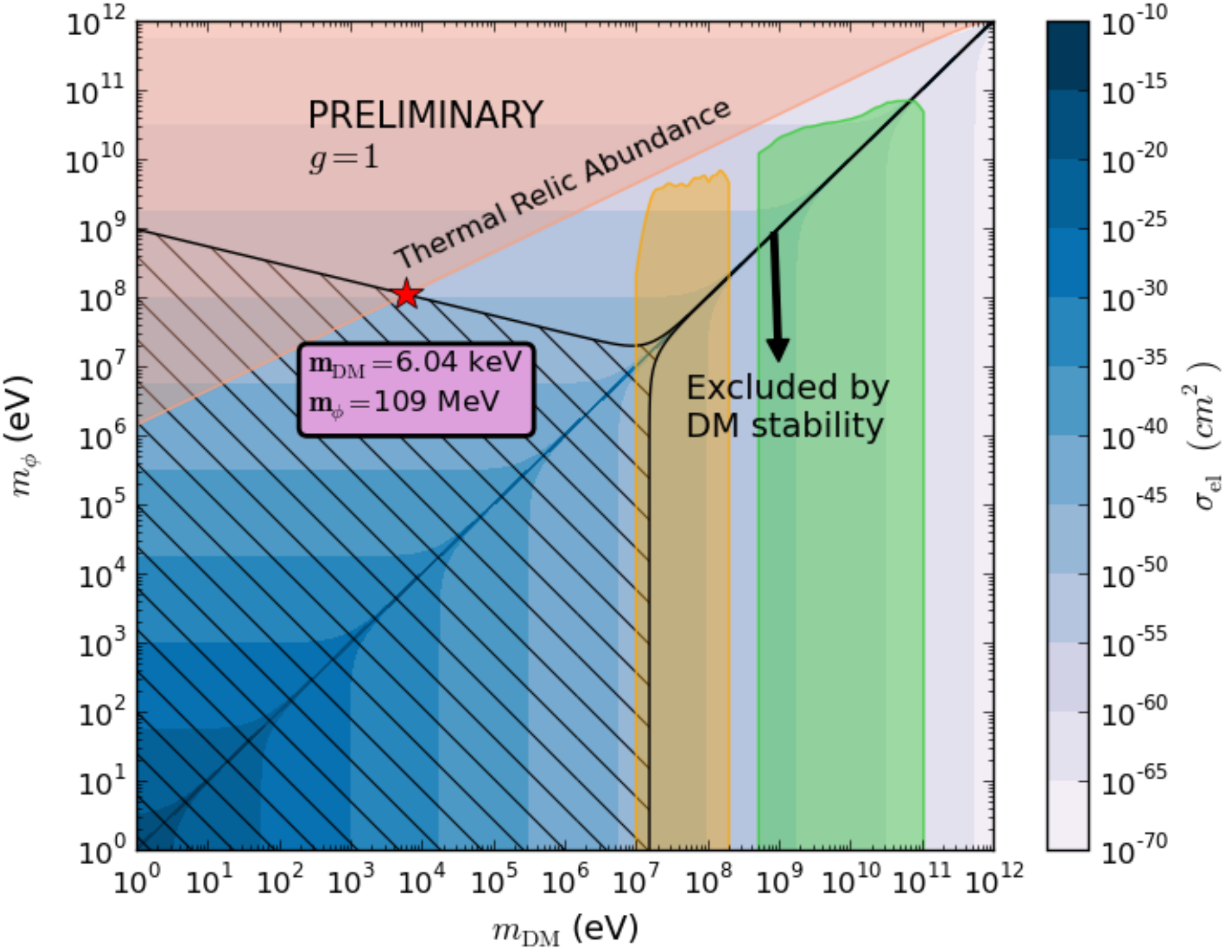
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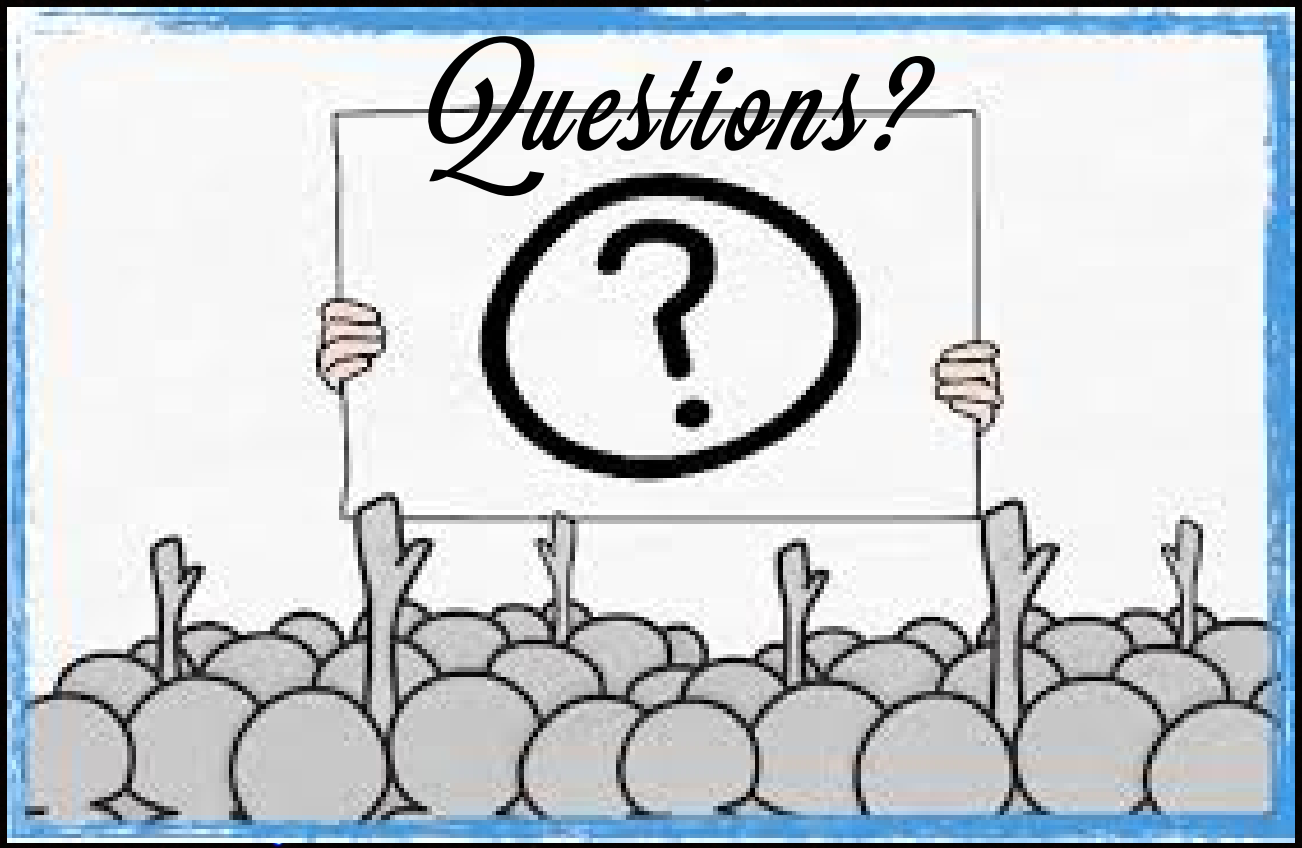
- A **large** region of the parameter space in the **strong coupling limit** (g=1) is excluded so that **weak couplings** are preferred

Thanks for listening

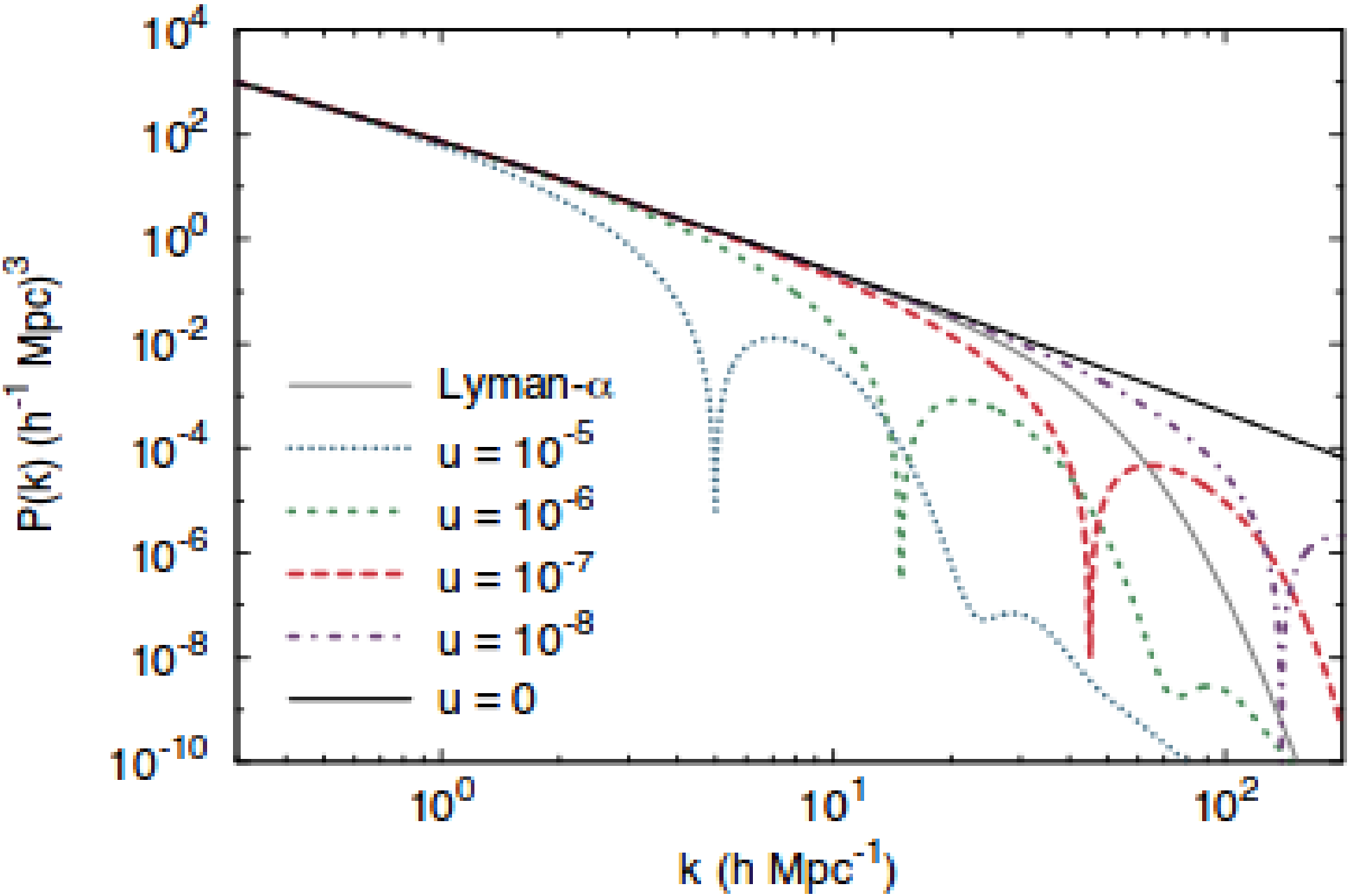


(Only one)

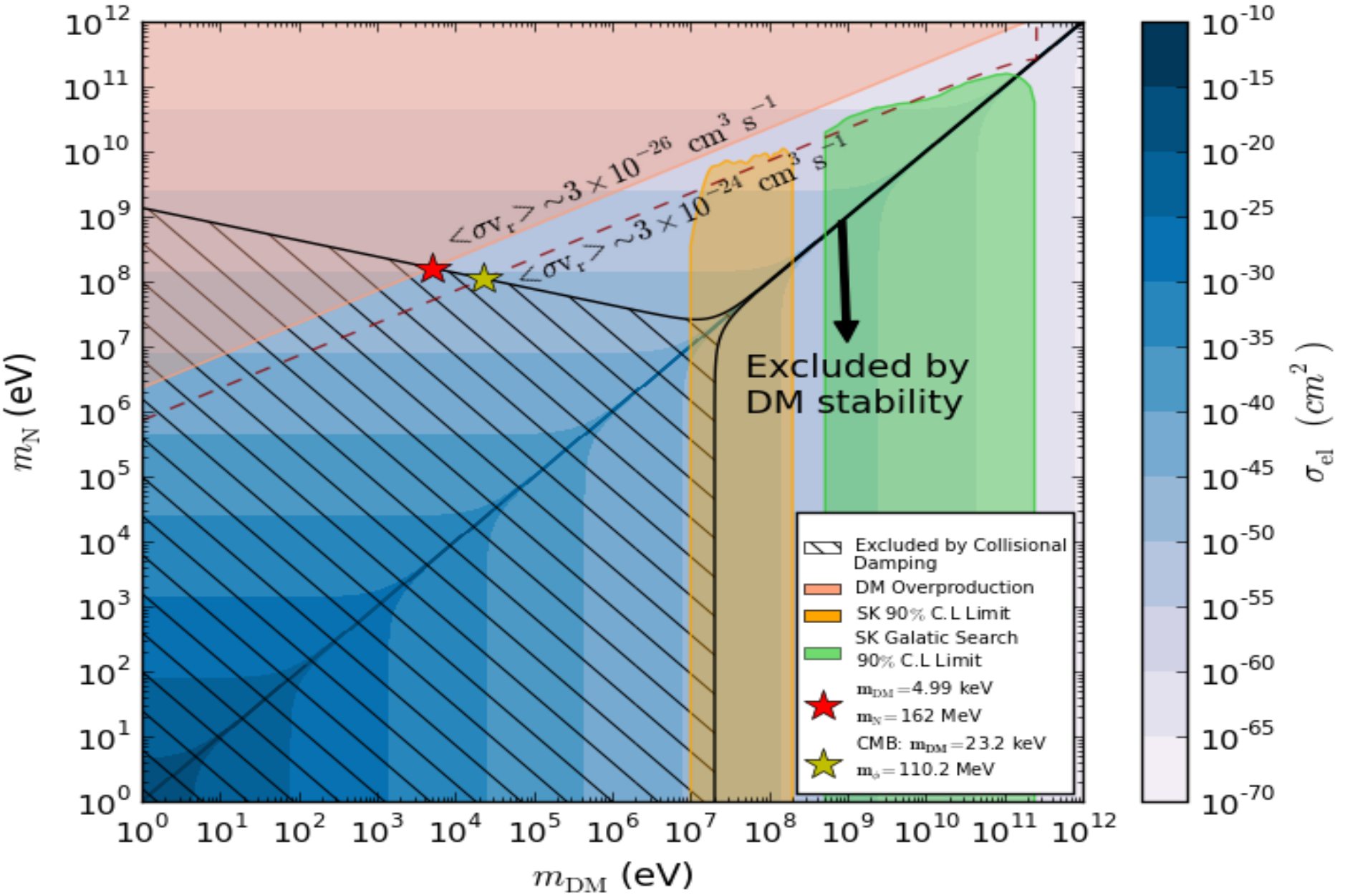
Summary of Results

DM \ Mediator	Scalar	Dirac	Majorana	Vector
Real Scalar	×	$m_{\rm DM} \gtrsim 19.3$ eV $m_{\rm N} \simeq 7.65$ keV	No lower bound	$m_{\rm DM} \gtrsim 9.64$ keV $m_{Z'} \simeq 143$ MeV
Complex Scalar	×	$m_{\rm DM} \gtrsim 9.55$ keV $m_{\rm N} \simeq 100$ MeV	No lower bound	
Dirac Fermion	$m_{\rm DM} \gtrsim 11.9$ keV $m_{\phi} \simeq 152$ MeV	×	×	$m_{\rm DM} \gtrsim 3.02$ keV $m_{Z'} \simeq 206$ MeV
Majorana Fermion	$m_{\rm DM} \gtrsim 9.55$ keV $m_{\phi} \simeq 102$ MeV	×	×	
Vector	×	$m_{\rm DM} \gtrsim 4.99$ keV $m_{\rm N} \simeq 162$ MeV	×	×

Power spectrum cut-off



Non-Thermal


$\langle\sigma v_r\rangle \sim 3\times10^{-26}$ cm^3 s^{-1}
$\langle\sigma v_r\rangle \sim 3\times10^{-24}$ cm^3 s^{-1}
Excluded by DM stability
Excluded by Collisional Damping
DM Overproduction
SK 90% C.L Limit
SK Galatic Search 90% C.L Limit
m_{DM}=4.99 keV
m_N=162 MeV
CMB: m_{DM}=23.2 keV
m_ϕ=110.2 MeV
m_N (eV)
m_{DM} (eV)
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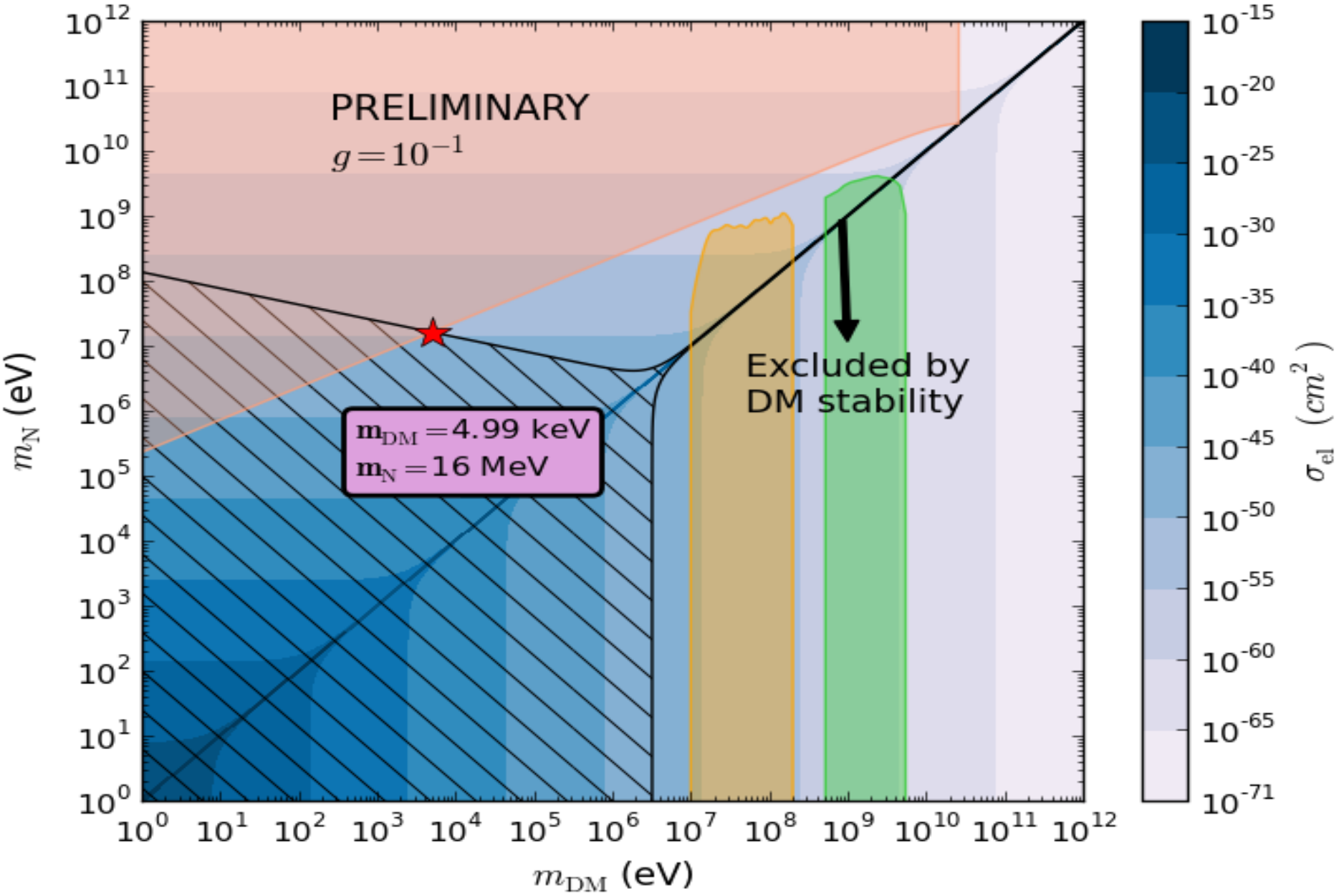
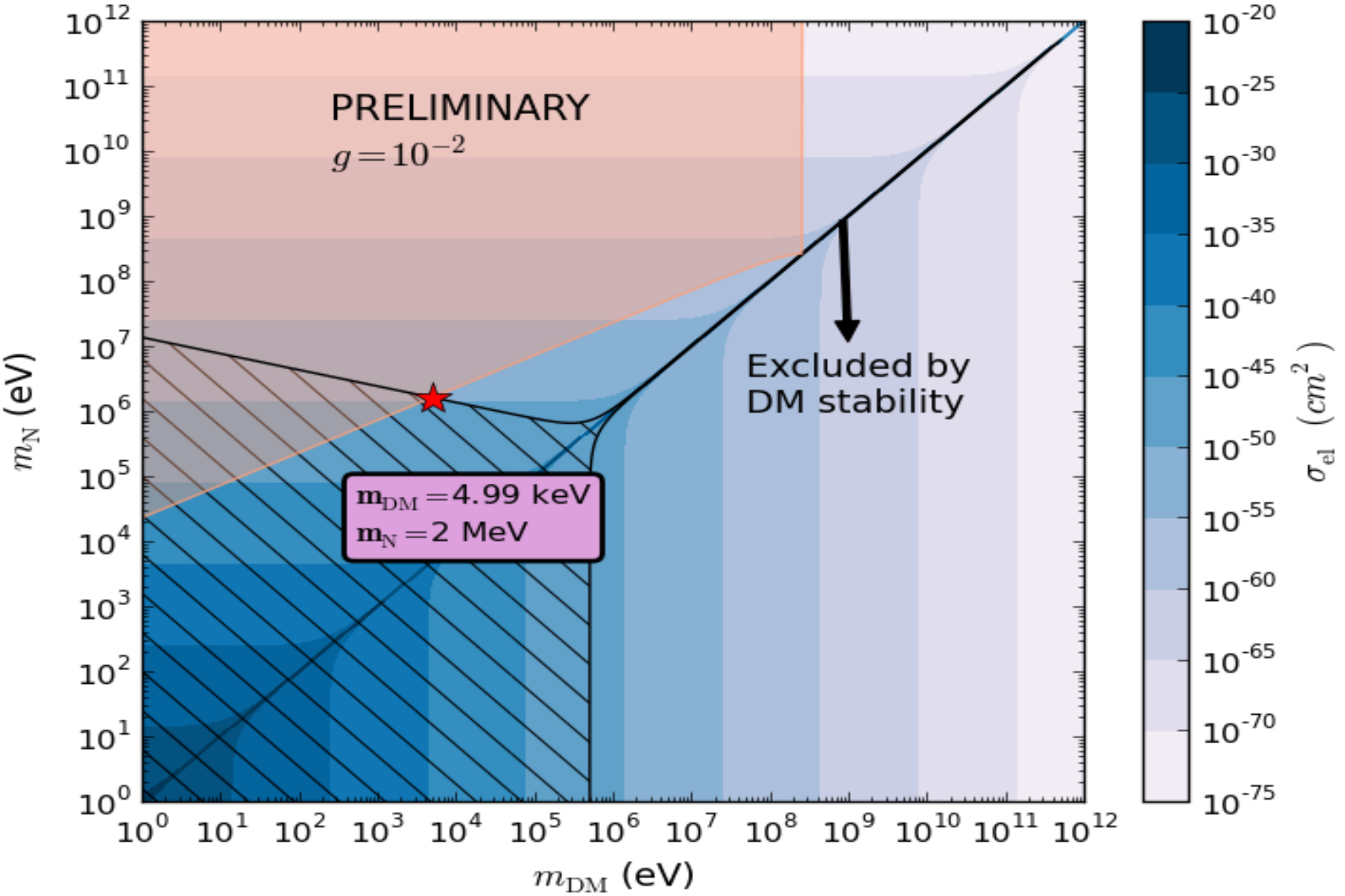
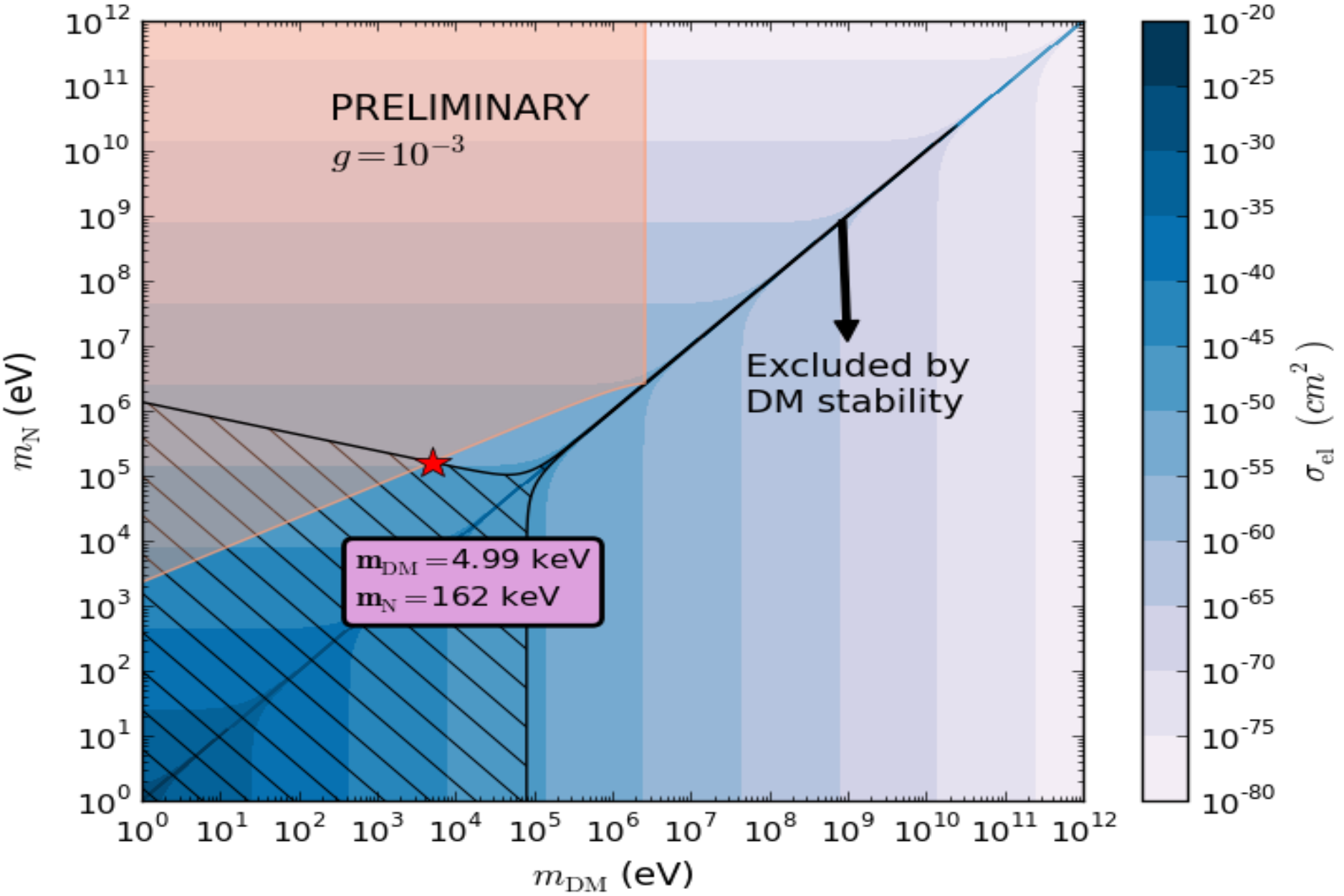
Small coupling (I)



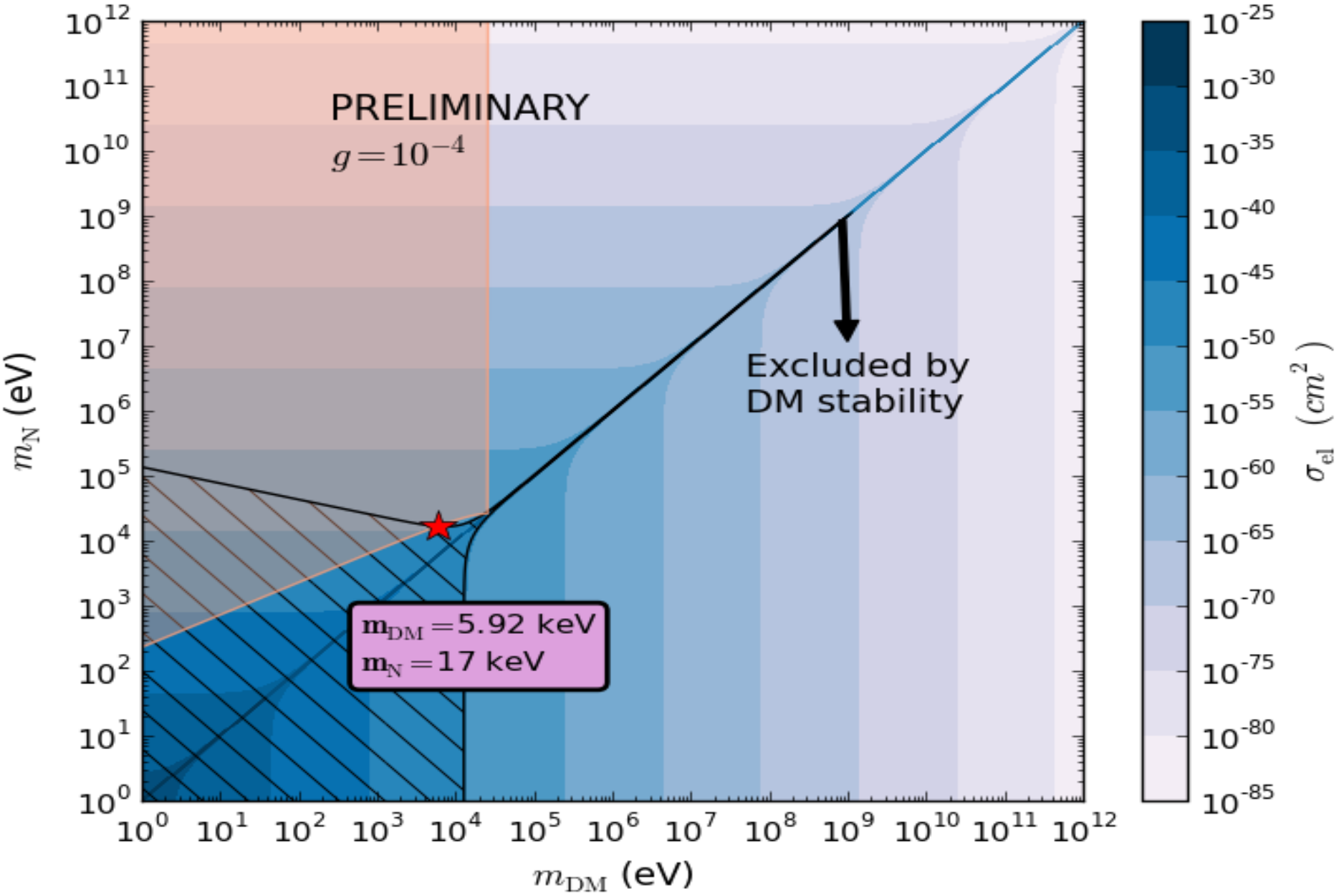
Small coupling (II)



Small coupling (III)



Small coupling (IV)



SK Updated Plots