Migdal effect in light of XENON1T anomaly

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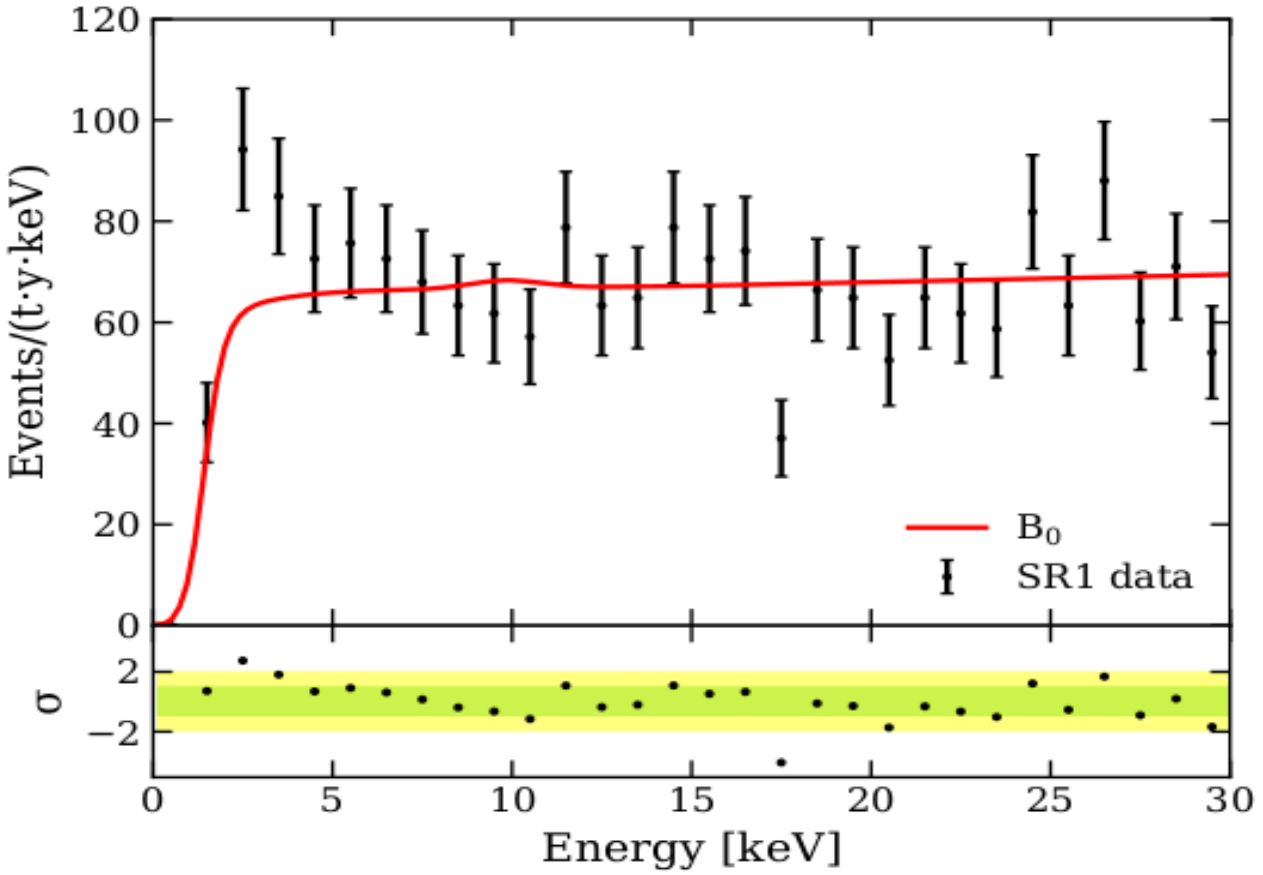
Anomalies 2020

Based on
2006.12529
With U K Dey and T S Ray

XENON1T electron recoil anomaly



✔ Within 1-7 keV range, 53±15 more events compared to background

2006.09721

Migdal effect

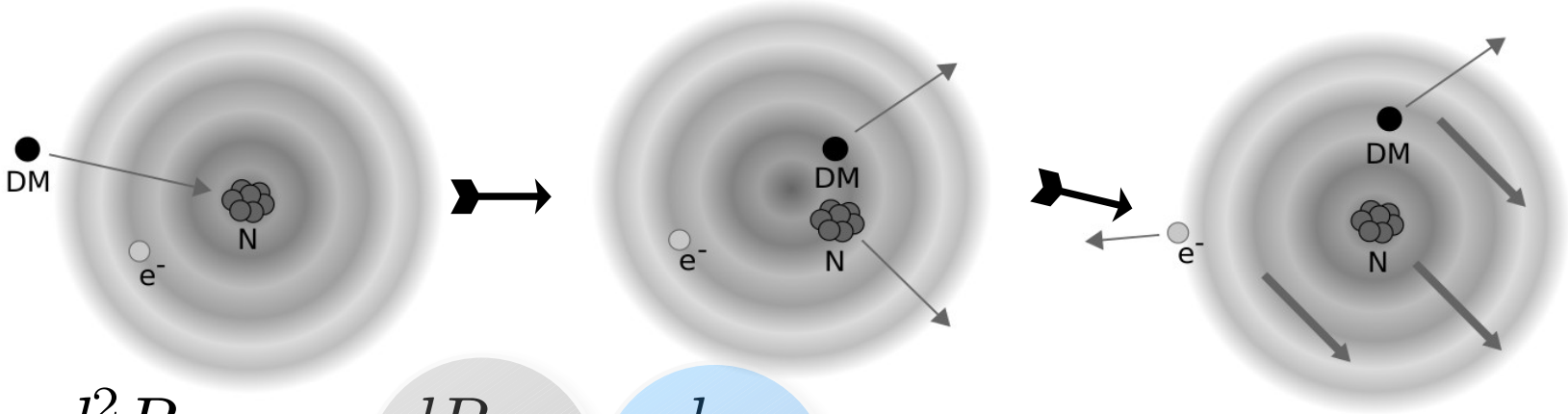


Image courtesy
1711.09906

$$\frac{d^2 R_{\rm ion}}{dE_R dE_e} \propto \frac{dR_{\chi N}}{dE_R} \frac{dp}{dE_e}$$

→ Differential electron ionization prob.

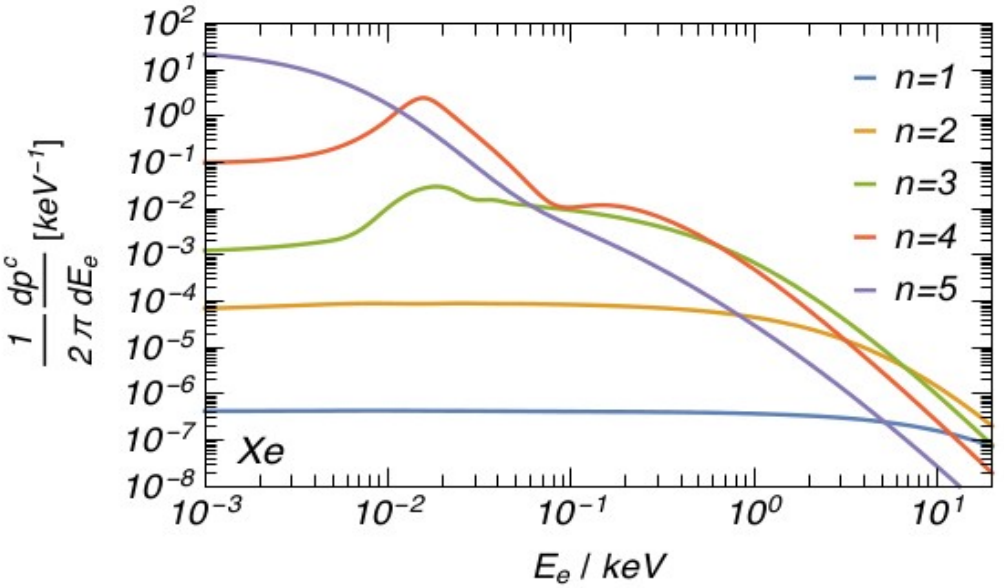
Usual nuclear recoil piece

$$E^{\rm max}_{\rm nuclear} \sim \left(\frac{m_\chi}{\rm GeV}\right)^2 \left(\frac{\rm GeV}{m_N}\right) \left(\frac{{\rm v}^2_{\rm max}}{10^{-6}}\right) {\rm keV}$$

$$E^{\rm max}_{\rm electronic} \sim \left(\frac{m_\chi}{\rm GeV}\right) \left(\frac{{\rm v}^2_{\rm max}}{10^{-6}}\right) {\rm keV}$$

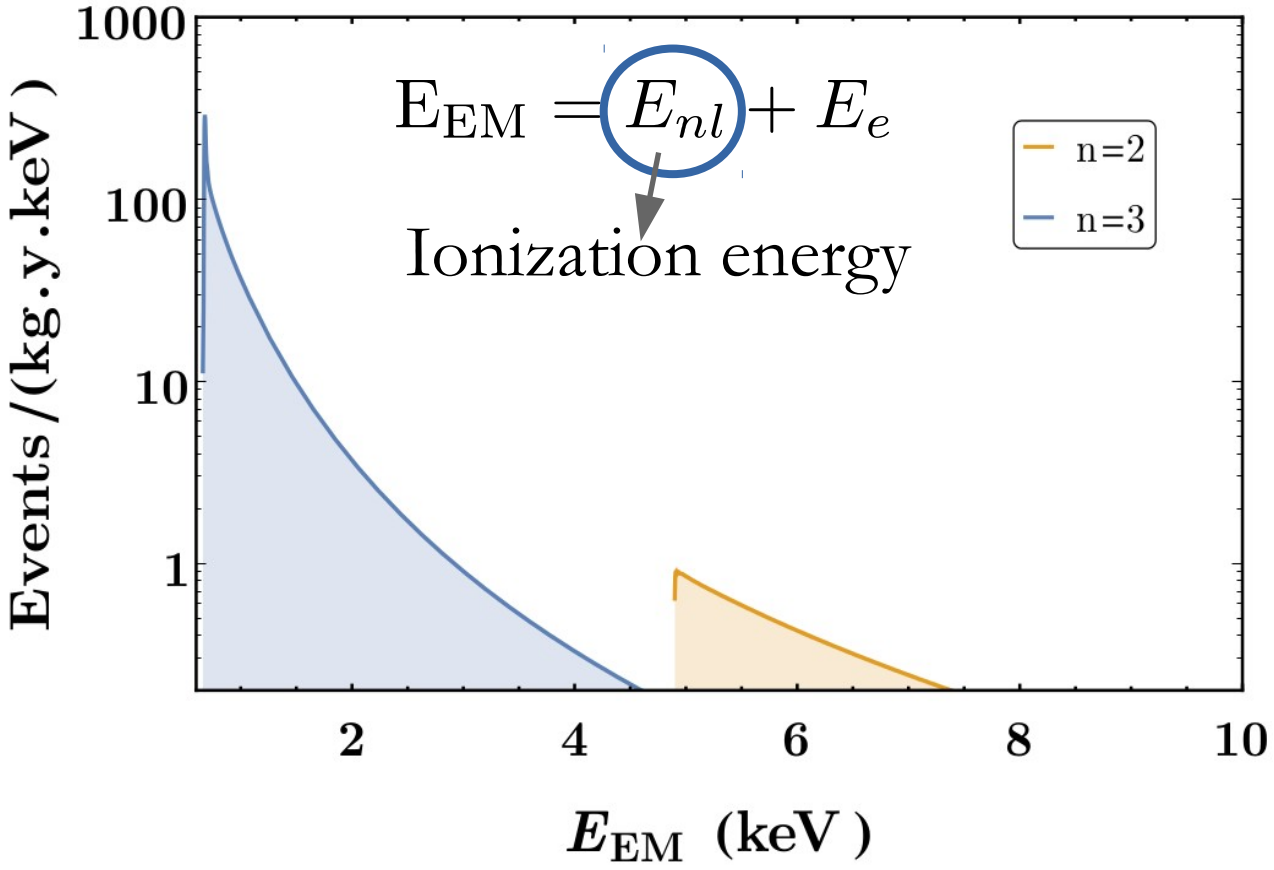
Indicates importance of Migdal effect for O(1 GeV) DM mass

1905.0046



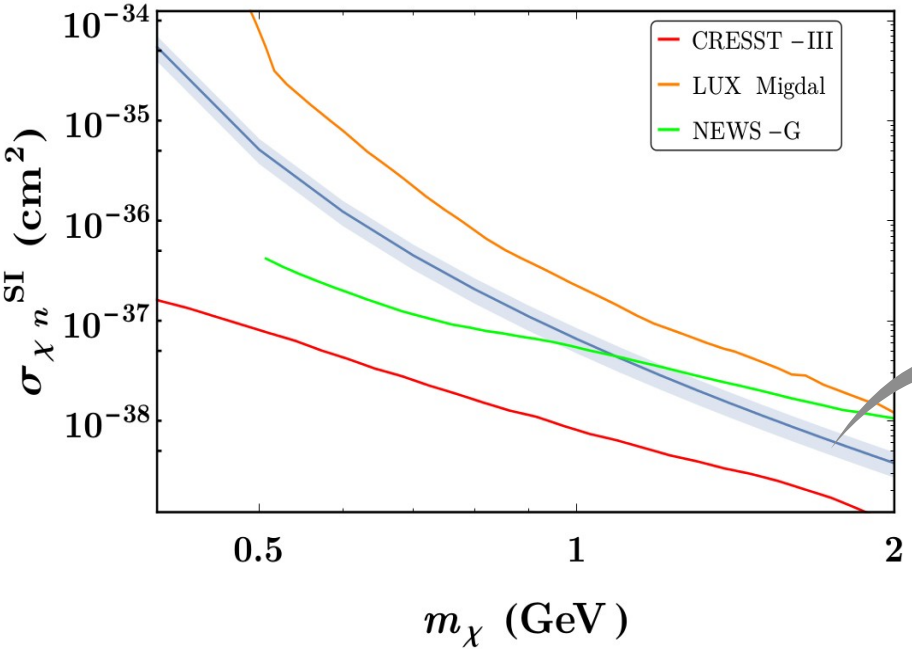
1707.07258

Migdal effect: typical spectrum



✔ The position of the peak generically matches with the energy scale of observed excess.

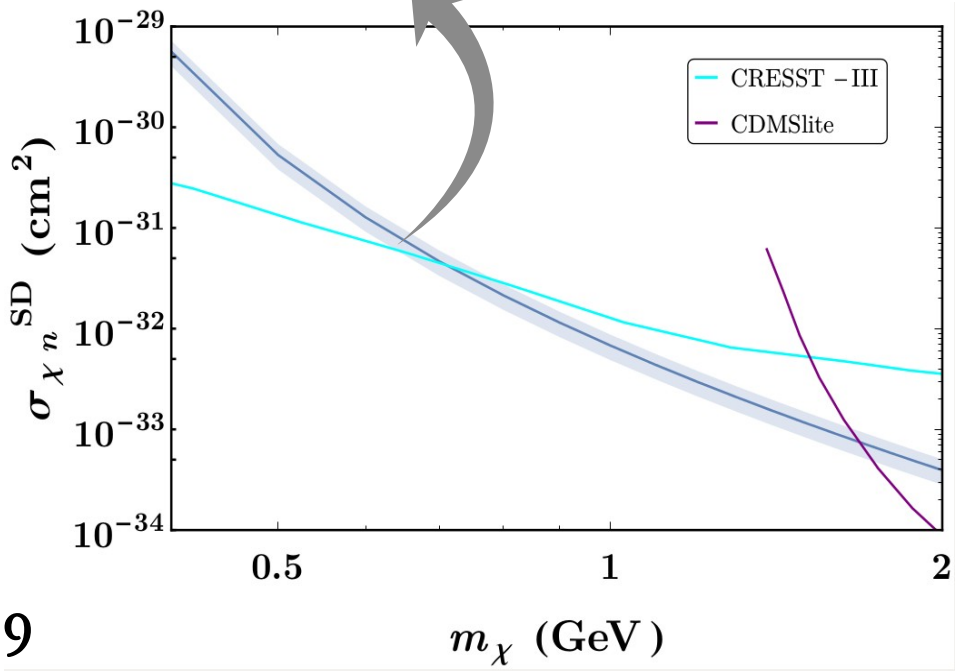
Migdal effect: Vannila DM



Spin-independent DM nucleon coupling

Produces 53 Migdal events in the 1-7 keV recoil region

Spin-dependent DM neutron coupling



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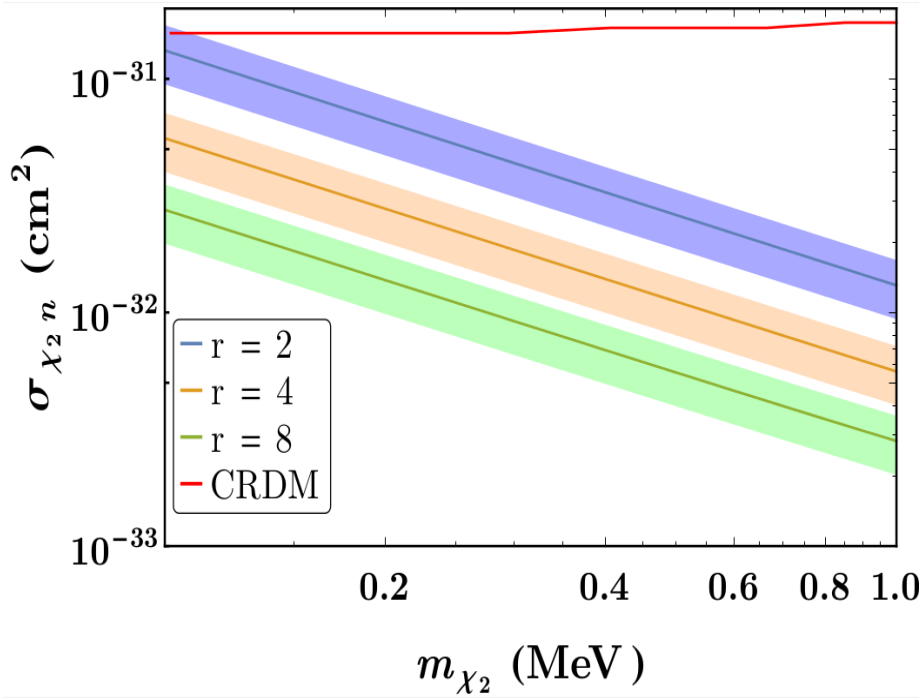
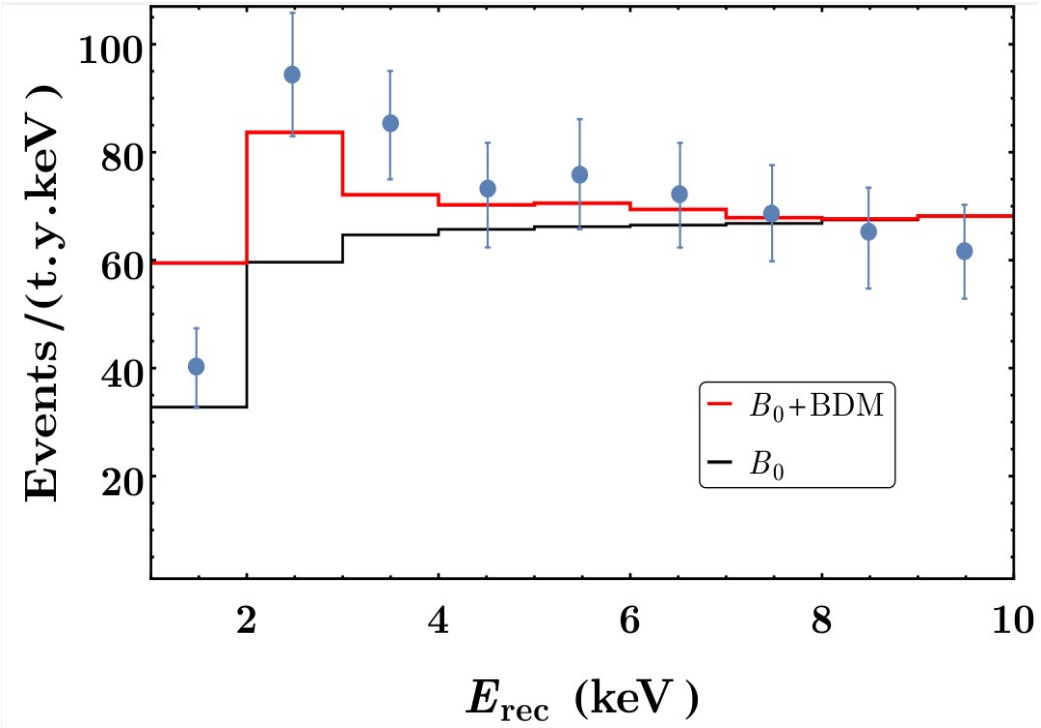
Migdal effect: Boosted DM

Dark sector: χ_1 and χ_2, $m_{\chi_1}/m_{\chi_2} = r$

✔ Energetic χ_2 through the annihilation of χ_1 can ionize n=2 levels electrons





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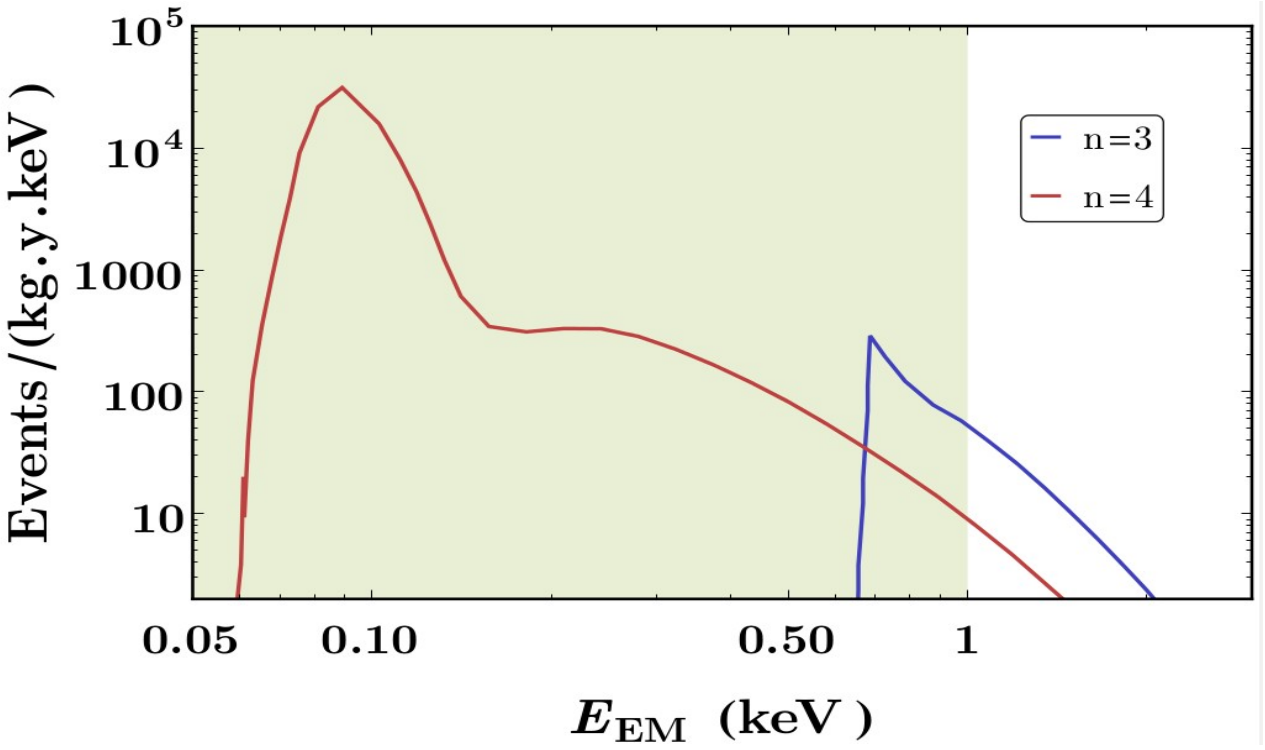
Outlook

✔ We have investigated the prospect of Migdal effect in the explanation XENON1T electron recoil excess.

✔ This frameworks may be readily explored by lowering the detector threshold.



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Thank
You