Figure 4

1. Why two LUX curves? The one where oDSP=oDM is based on a particular assumption which might not be true. Trust the orange exclusion curve a little more as it is model independent and more generic.

In general: Direct detection cannot search for low mass dark matter because you need a recoil to detect it and it can't be heavier than 200 GeV or so because otherwise this results in low dark matter density and hence less sensitivity.

Monojet search

1. Final state: 1 jet and MET. Discussed backgrounds that contribute to the search.

2. Should Higgs be considered as a monojet background if we do the search today?

   Karol: No. Because Higgs is recently discovered and we don't know the Higgs to invisible branching ratio. Higgs might be the mediator between dark sector and the Standard Model in which case it would be a signal.

   Drew Feynman diagrams for VBF and gg fusion feynman diagrams to aid the discussion.

3. Figure 5: Why such shape? Related to the $m_{\chi} < m_R/2$

Dijet search

1. Final state: 2 jets. Complementarity to monojet search is the idea that when $m_{\chi} > m_R/2$

2. How is the background estimation in a generic dijet search?

   Fit a function. But it is more complex than that because the results depend a lot on the function you choose. In the ATLAS dijet search used here, the motivation for the polynomial comes from a convolution of a PDF and what was done at LEP.

   In general, it is a trial and error process. Fit a function and calculate the log likelihood, then introduce a higher order term and calculate the log likelihood for this and consider the improvement in log likelihood based on both and then choose the function accordingly. This process is starting to breakdown.

   Discussion on trigger level analysis (TLA): Use trigger level objects for analysis. Here, the trigger rate is 100kHz (as opposed to 1kHz in general) and you reconstruct everything except detailed tracks at HLT → Bandwidth you can save to disk is super high. This results in not too bad performance and yields large statistics. With TLA, you can go to jets as low as 200 GeV as opposed to usual 500 GeV => You are sensitive to mjj>400 GeV rather than mjj>1 TeV. The problem with fitting the background in a TLA is that due to high statistics, you can fit any function you want to the data. So this arbitrary function fitting method breaks down. That's usually what people refer to as flowchart of death where they have many functions trying to fit the distribution.

   Another caveat of fitting the background is that the assumption of smooth background is not entirely true. For example, you might have kinks due to the jet calibration and it when this enters the mjj plot, it might be mistaken as a resonance or signal. So people are moving away from fitting.

   Briefly discussed the challenges of QCD MonteCarlo.

Associated dijet search

1. Final state: 2 jets+X. Refer to Feynman diagram in Fig 1e.

2. This is an alternate approach to probe the phase space where $m_{\chi} > m_R/2$ i.e. offshell decay. In this case the mediator might preferentially decay into quarks. Here, you trigger on the associated Z, ISR jet or a photon. This implies that the jets are not triggered => low energy jets are accessible. Their results are comparable to the TLA analysis.

Thanks to Karol, Cesar and Mark for a productive session!

Next week

Discuss the rest of the paper: Particularly Figure 7,8,9 and also try looking at the updated version of some of these plots. Also discuss the how ttbar cross section measurement lets us constrain the dark matter phase space.