

# DARK MATTER, THE ULTIMATE HIDE AND SEEK PLAYER?

- **THE STANDARD MODEL OF PARTICLE PHYSICS (SM) DESCRIBES THE FUNDAMENTAL PARTICLES AND THEIR INTERACTIONS AND HAS SO FAR BEEN HIGHLY CONSISTENT WITH EXPERIMENTAL DATA.**
- **HOWEVER THIS MODEL IS INCOMPLETE AND DOES NOT GIVE TRULY SUFFICIENT DESCRIPTION OF THE UNIVERSE.**
- **ONE ENDURING QUESTION WE HAVE LONG BEEN FACED WITH IS THE EXISTENCE OF DARK MATTER, AN OBSCURE AND HIGHLY GRAVITATIONAL SUBSTANCE.**



- **DARK MATTER DOES NOT INTERACT WITH ORDINARY MATTER, HOWEVER THE EVIDENCE FOR DARK MATTER IS UNDENIABLE, FROM THE VERY EXISTENCE OF GALAXIES TO THE OCCURRENCE OF GRAVITATIONAL LENSING.**



- **AS OF YET NO PROMISING RESULTS HAVE COME FROM ANY DARK MATTER SEARCHES AND NEW APPROACHES ARE BEING INVESTIGATED.**

**DO OR DO NOT, THERE IS NO TRY.**

# COME TO THE DARK SIDE, WE HAVE DARK MATTER.

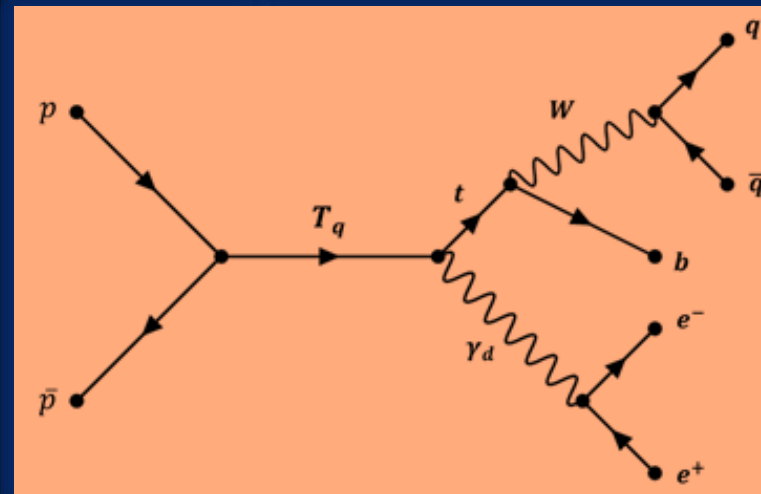
## SHINING A TORCH IN THE DARK SECTOR

- THE SEARCH FOR DARK MATTER HAS BECOME A MAJOR FOCUS AT THE LHC.
- SO FAR ATTEMPTS ARE TO FIND DARK MATTER MAY BE BY INTERACTIONS WITH SM PARTICLES OR DETECTED AS MISSING ENERGY.
- BUT NEW THEORIES HAVE COME ABOUT WITH DIFFERENT DETECTION METHODS



## DARK PHOTON MODEL

- OUR SEARCH TECHNIQUE IS FOR A HYPOTHETICAL PARTICLE CONNECTED TO DARK MATTER CALLED A DARK PHOTON.
- THE DARK PHOTON MAY BE DETECTED THROUGH ITS KINETIC MIXING WITH ORDINARY MATTER.
- IN THIS MODEL WE CONSIDER THE MAVERICK TOP QUARK, A HYPOTHETICAL HEAVY FOURTH GENERATION QUARK AND FOCUS ON HADRONIC DECAY.
- THE MAVERICK TOP QUARK WILL DECAY TO A SM TOP QUARK AND A LEPTON JET.



- TWO ENERGETIC AND COLLIMATED LEPTONS CAN GIVE JET LIKE SIGNATURES, GIVING LEPTON JETS
- DARK PHOTONS CAN DECAY INTO SUCH LEPTON JETS.

# ANALYSIS STRATEGY

## WE CANNOT DENY THE DARK SIDE

- THE ANALYSIS STRATEGY WAS TO SEARCH FOR A HEAVY JET (THE TOP QUARK) AND LIGHT JET (THE LEPTON JET).
- IN THE MODEL THE MASS WE HAVE SIMULATED THE SAMPLE WITH, THE MAVERICK TOP QUARK HAD A MASS OF 1 TEV AND DARK PHOTON A MASS OF 100 MEV.
- THE FIRST GOAL WAS TO DETERMINE WHETHER THE TOP MAVERICK QUARK AND DARK PHOTON COULD BE RECONSTRUCTED.
- FIGURE 1 AND 2 SHOW US THAT THEY CAN INDEED BE RECONSTRUCTED

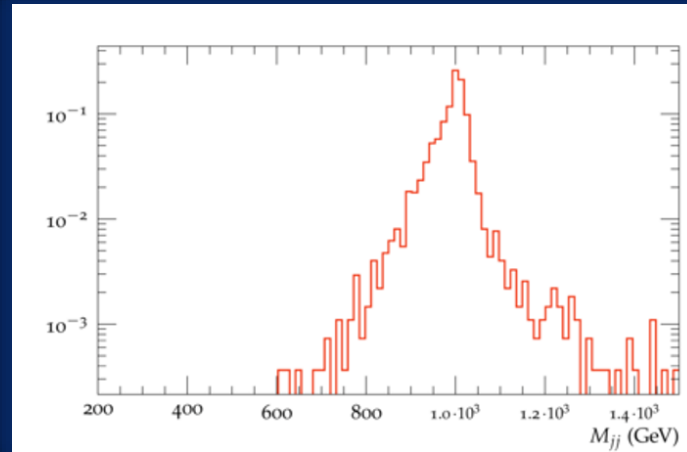


FIGURE 1: INVARIANT MASS OF LEPTON AND TOP QUARK JET.

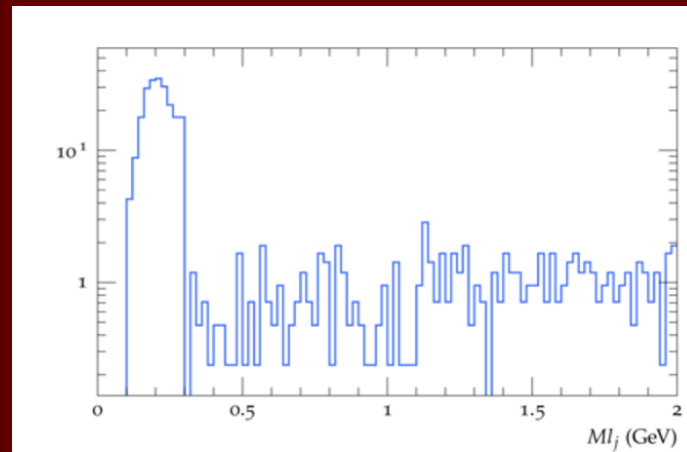


FIGURE 2: MASS OF THE LEPTON JET.

## STEPS GOING FORWARD

- FINDING A SIGNAL IN A DETECTOR IS A CHALLENGING EXERCISE ON ITS OWN, BUT FINDING A SIGNAL AMONGST A LARGE BACKGROUND IS A STRENUOUS ENDEAVOUR.
  - FOR THIS CASE THERE WILL BE BACKGROUND CONTRIBUTIONS FROM SM TTBAR AND SEMI-LEPTONIC TTBAR INTERACTIONS.
  - THE MAIN BACKGROUND CONTRIBUTIONS HOWEVER, WILL BE FROM MULTI-JET EVENTS.
- MAY THE FORCE BE WITH US...**