IDENTIFICATION OF OPTIMAL PRODUCTION CHANNELS FOR DARK PHOTON SEARCHES

By: Gautham Anne, Dean Barrow, George Bayliss, Surya Bhamidi, Dean Cianciolo, Peter Dong, Jesus Fileto, Kevin Huang, Rohan Jain, Caroline Kowal, Jack Morby, James Pan, Dheeran Wiggins, Kevin Zhang,
Illinois Mathematics and Science Academy

Paul Karchin, Wayne State University

Lenny Spiegel, Fermilab

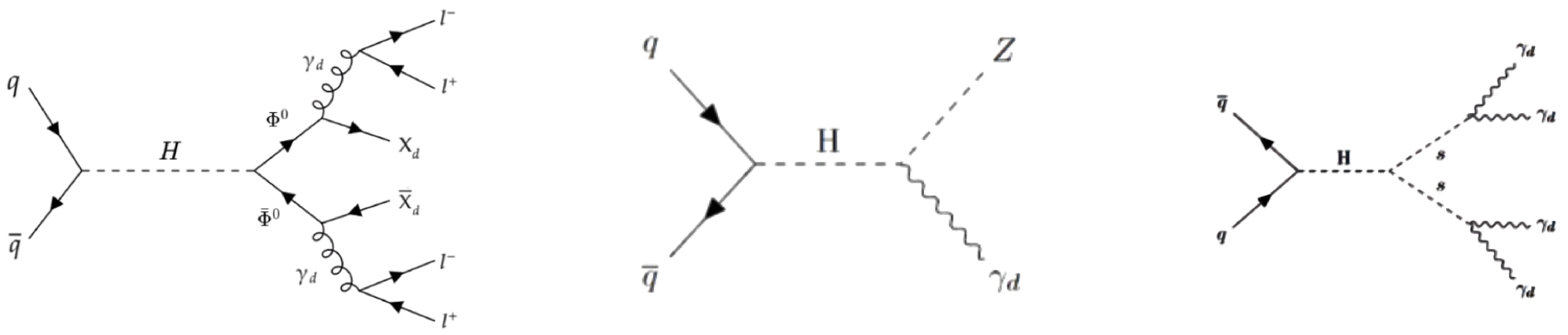
Introduction

- Dark matter may be explained by a whole undiscovered dark sector beyond the Standard Model
- A U'(1) gauge theory in the dark sector could produce massive dark photons
- If dark photons are the lightest stable dark particle, they can decay into Standard Model particles

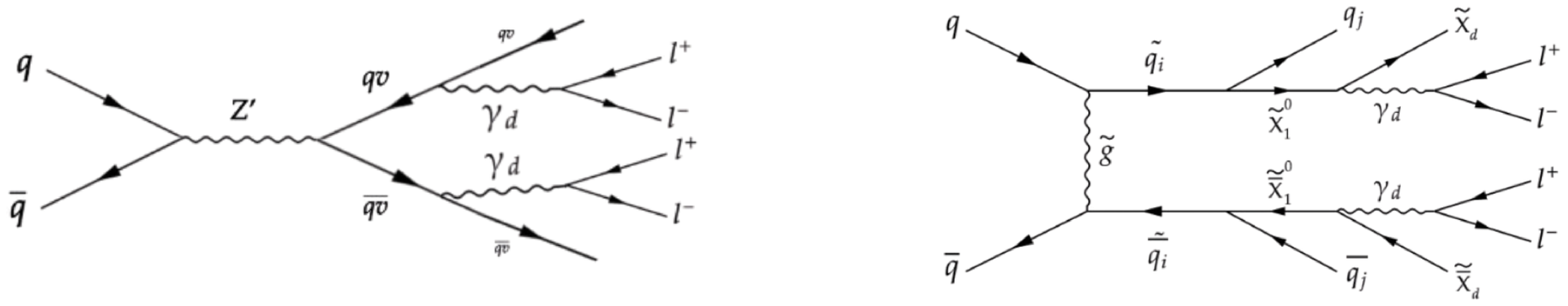
Lepton Jet Signature

- If there exists some particle that couples to both U(1) and U'(1) sectors, kinetic mixing allows dark photon decay to SM particles
- Since dark photons form from the decay of high-mass particles, the final leptons are highly collimated
- Results in distinctive "lepton jets", pairs of leptons separated by small ΔR
- Kinematic origins should make lepton jet signature largely independent of production mechanism

Production Portals



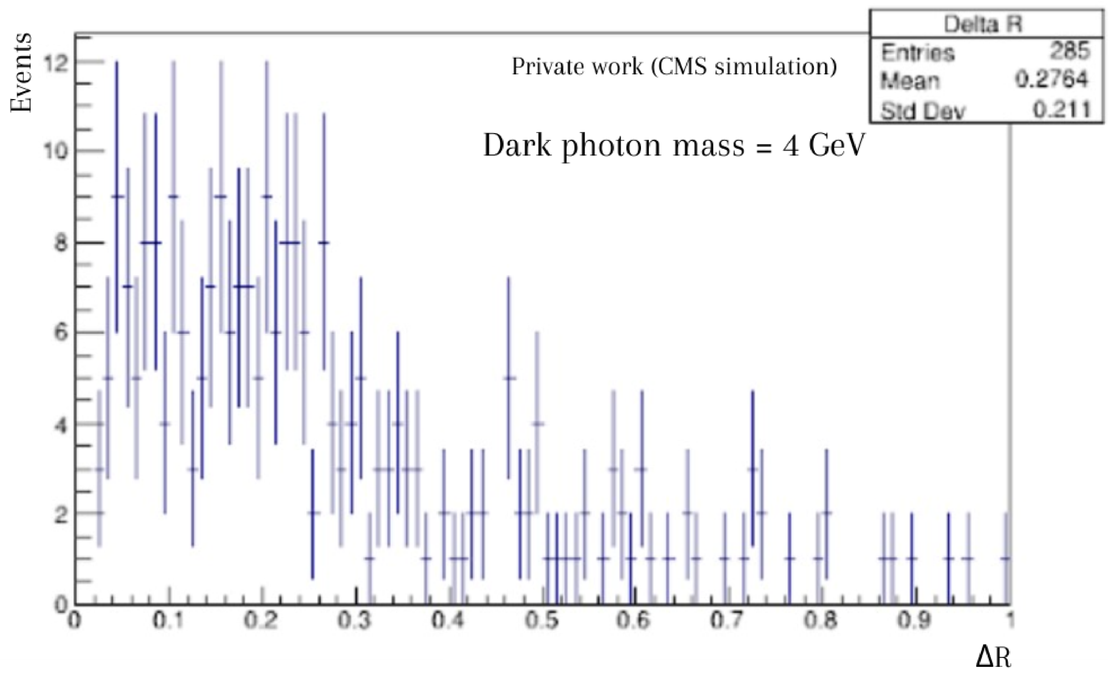
Figures 1-3: Dark photon channels relying on exotic Higgs-like particles, spin 0 particles different from the Standard Model Higgs. Dark photons decay into opposite-sign lepton pairs.

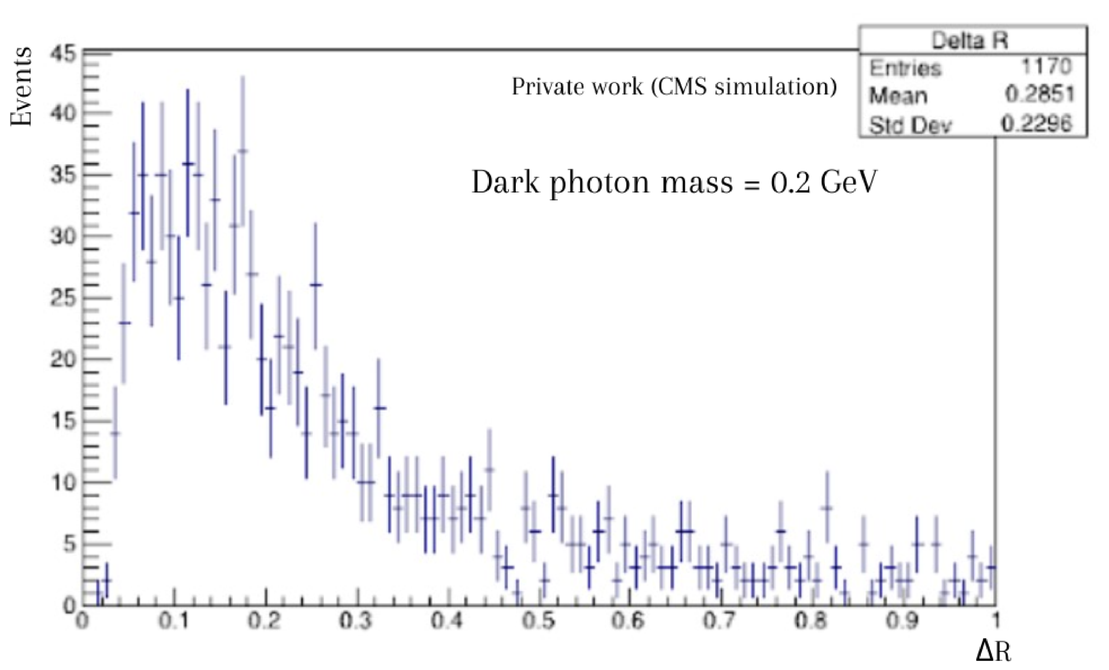


Figures 4-5: Dark photon channels relying on other mechanisms: a heavy Z' particle (left) and supersymmetric particles (right)

ΔR Distribution Relative to Mass

- ΔR distribution was examined for different mass points, ranging from 0.1 to 4.0 GeV
- No significant deviation between the mean and standard deviation of the different delta distributions
- No dependence on mass for kinematics, but an impact on branching ratios.
- ΔR was found to be similar for all production portals





Conclusions

- Analyze different production portals to confirm that we can search for dark photons without assuming a production mechanism
- For Higgs portals, delta R decreases as the Higgs mass increases
- Other Higgs production mechanisms given kinematically similar results
- The supersymmetric portal with squark masses around 500 GeV and neutralino mass of 90 GeV is kinematically similar to a Higgs portal with a mass of 300 GeV
- The Z' portal is characterized by high pT and low ΔR - For a mass of 1000 GeV, ΔR is much smaller than the Higgs portal at the same mass
- We chose a 1000-GeV Higgs production as a primary production mechanism for the search