# LLP and DM at LHC

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Just a quick walkthrough mainly focusing on ongoing efforts within ATLAS

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## Non-gravitational DM detection

- Direct detection from astrophysical sources
  - nuclear recoil from DM interactions
- Indirect astrophysical detection
  - search for products of WIMP annihilations
- DM production at hadron collider
  - model-dependent signature typically involving missingenergy

#### Detection methods



Experiments:

- ► ATLAS
- ► CMS
- ► D0
- ► CDF



Experiments:

- ► XENON100
- ► CDMS
- ► SIMPLE
- CoGent
- ► IceCube
- Picasso



#### Experiments:

- ► Fermi-LAT
- ► PAMELA
- ► AMS-02
- ► WMAP
- ► Planck

#### mono-X searches

- Searches with large missing energy plus X
  - mono-jet, mono-photon, mono-WZ
    - WIMP escape the detector undetected and events are identified by ISR
  - mono-bjet
    - interesting because D1 operator of EFT is proportional to the initial quark mass
  - in general clean final states plus well-understood backgrounds
  - new ideas under discussion in ATLAS: assuming the capability to trigger on X, what is the minimal extra activity that can be added on the opposite side of X to increase sensitivity? (soft dileptons, displaced vertex, exotics tracks)
  - LLP can become part of the mono-X search campaign

#### other DM-related exotics searches

- extra dimensions
- searches for microscopic black holes
- dark sector searches with DM candidate

#### dark sector with dark photon



- dark photon lifetime depends on the size of the kinetic mixing
- displaced decays within the detector geometrical acceptance can easily arise

# lepton-jets from DM

- dark photon decays to bundle of tightly collimated leptons
- unique signature that can be easily missed if not searched for with dedicated strategies
- wide ATLAS lepton-jet search program
  - prompt/displaced
  - electron/muon/pion decay (tau?)
  - Higgs/SUSY intepretation

### 7 TeV result



- 8 TeV analysis in progress
- effort to include all the information needed for recasting

#### exclusion plot

- effort to present the exclusion limit in the 2D contour plot (kinetic mixing versus dark photon mass)
- easy way to combine results with regions excluded by anomalous magnetic moments, fixed-target experiment and supernovae observations



Bjorken, Essig, Schuster, Toro, 0906.0580

#### conclusions

- DM is out there but no indication of its composition
- hadron collider searches are a vital ingredient to DM searches
- less-standard search strategies are gaining traction due to missing NP in Run-I data
- LLP can offer a DM candidate
- LLP searches don't come for free dedicated efforts including specialized trigger and reconstruction algorithms
- currently preparing the ground for broadening the spectrum of searches in Run-II
- strong interest in mapping models (dark sector, WIMP, FIMP, ...) with LLP scenarios for Run-II and in the context of What Next