Sub-GeV DM

Model details

- Model: Fermionic (or scalar) DM candidate coupled to U(1)' gauge boson (dark photon) with kinetic mixing

- Conceptually very similar to simplified DM model with spin-1 mediator, but in principle UV-complete (no gauge anomalies, no unitarity violation)

- Four basic parameters: 2 masses, 2 couplings
  - Plan to impose $m\_DM < 1$ GeV and $m\_DM < m\_A' / 2$ to reduce number of relevant likelihoods

- Fifth parameter: Particle-antiparticle asymmetry

Physics interest

- Dirac fermion DM very strongly constrained in sub-GeV range

- Constraints evaded in special regions of parameter space and/or for large asymmetry

- Identification of viable parameter regions interesting as target for LDMX

Theory calculations (cosmo)

- Relic density calculation for asymmetric DM (DarkSUSY)

- Photon and positron spectra from DM annihilations into hadronic final states (Hazma) multiplied with branching ratios (DarkSUSY) and convoluted with efficiency functions (DarkAges) to get CMB constraint (plc)

- Combination of BBN and CMB constraint on Neff with consistent evolution of Neff during BBN

Theory calculations (laboratory)

- DM-electron scattering and Migdal effect

- Dark photon production and decay in beam dump experiments

- X-ray signals from DM annihilation into electrons

- Bullet Cluster constraint on DM self-interactions

Likelihoods

- DM-nucleon scattering (done, might add DarkSide)

- DM-electron scattering (done, might add DAMIC)

- BBN constraints (done, might add photodisintegration)

- CMB constraints (done, some bug testing needed)

- Invisible dark photon decays

    - B factories (done)

    - Beam dumps (need GAMBIT implementation → Taylor)

- X-ray constraints (need GAMBIT implementation → Chris)

Current limitations/restrictions

- Likelihoods for visible dark photon decays would require substantial amount of work

- Assume for the moment that invisible decays completely dominate in allowed regions of parameter space

- Check assumption explicitly at each (viable) point in parameter space

Plan

- First scans of full parameter space imminent (Where? Who?)

- 5 dimensions, 10-20 seconds per point

- Could reduce dimensions or skip expensive likelihoods for first scans

- Implement missing likelihoods over the next couple of weeks and run full scans

- Push paper out before beginning of winter term (mid-October)