Discussion session

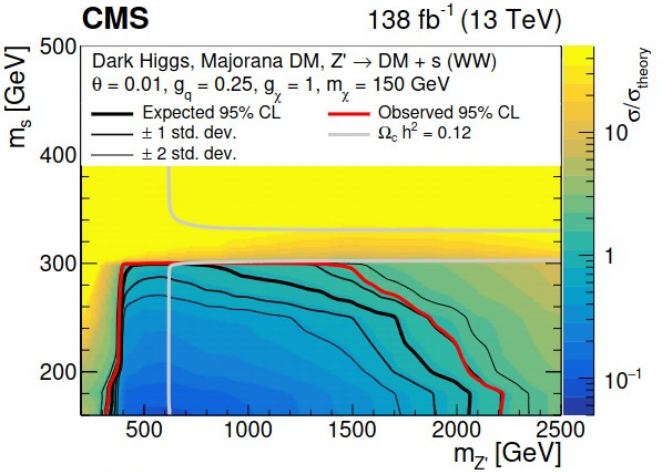
Matteo Cremonesi and Felix Kahlhoefer

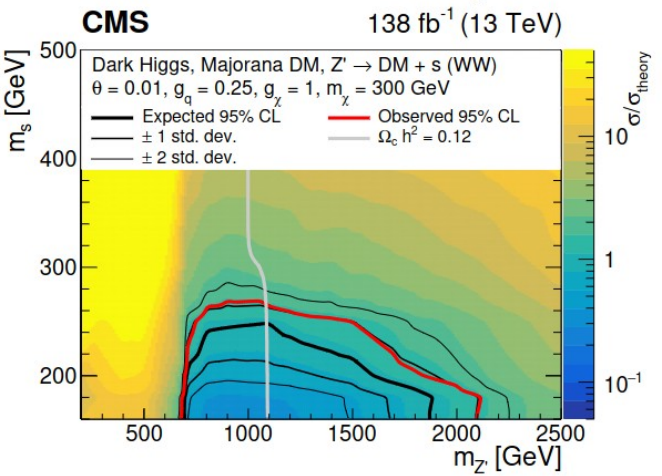
Presentation of results

- **Standard:** m_s vs. $m_{Z'}$ with fixed couplings g_q and g_χ
- Fine as long as dark Higgs decays visibly ($m_s < 2\, m_\chi$)
- For larger values of m_s search completely loses sensitivity

- Possible to draw relic density line
- Annihilation channel changes: $m_s < m_\chi : \chi\chi \rightarrow ss$

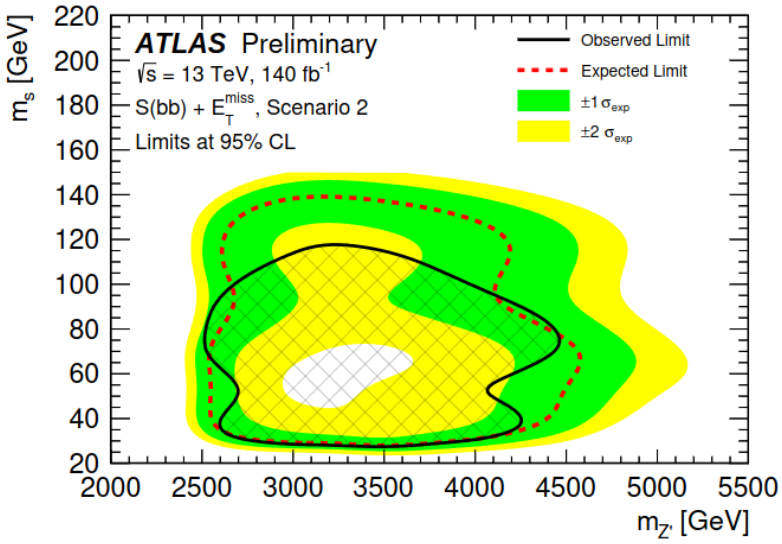
  $m_s > m_\chi : \chi\chi \rightarrow Z' \rightarrow SM$
- In both regimes relic density is basically independent of m_s
- Step change at $m_s \sim m_\chi$





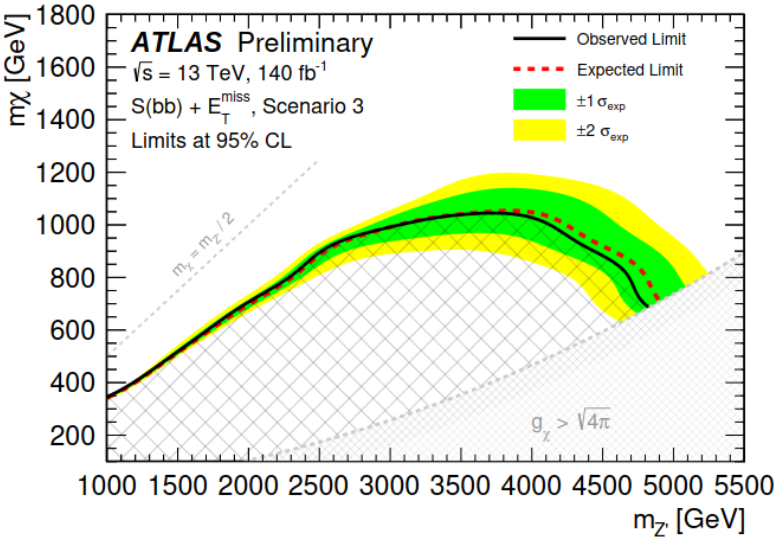
Alternative presentation: Varying g_χ

- At each point fix g_χ by relic density requirement
- Small $m_{Z'}$ corresponds to small g_χ
  - → Search loses sensitivity
- Here: m_χ fixed to 900 GeV
  - → Ensures $m_s < m_\chi < 2\, m_{Z'}$ everywhere
  - → Smaller m_χ would lead to non-perturbative couplings > $\sqrt{4\pi}$ in some parts of the plot
- Interesting to consider variations in m_χ?



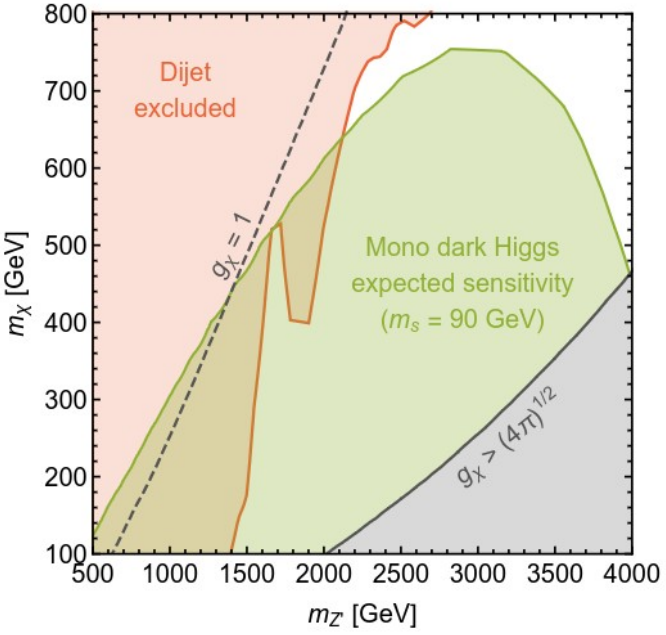
Alternative presentation: Varying m_χ

- Fix g_χ by relic density requirement
- Here: m_s fixed to 70 GeV (bb final state)
- For other searches, need larger value of m_s
  - → Expect jump in jump in g_χ when m_χ becomes smaller than m_s
  - → Should one indicate loss of sensitivity for $m_\chi < m_s/2$?
- Maybe interesting to produce these plots also for fixed $g_\chi = 1$?



Comparison plots

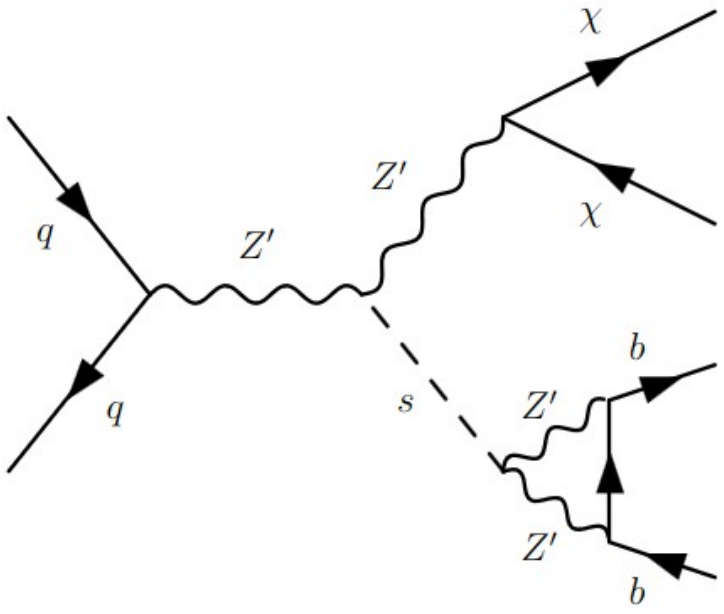
- It would be awesome to produce comparison plots with other searches
- Problems:
  - Dark Higgs model has Majorana fermion, while mono-X searches assume Dirac fermion
    - → Different Z' width and branching ratios
    - → Suppressed direct detection
  - Decay mode Z' → χχs needs to be considered
    - → (Slightly) suppresses dijet constraints
    - → Might enhance mono-X constraints



- Reinterpretation of model-independent dijet searches might be possible

Model variant 1: Long-lived dark Higgs

- Set dark Higgs mixing to zero
- Loop-induced decay into quarks
- Long lifetime → displaced decay
- Signature: Displaced vertex + MET
- Invariant mass of displaced vertex equal to dark Higgs boson mass



Model variant 2: Inelastic dark matter

- Excited DM state χ_2 decays into ground state and SM particles
- Striking signature (e.g. displaced vertex) could provide background suppression
- Make sure search is sufficiently inclusive not to veto such events