Supersymmetric Dark Matter

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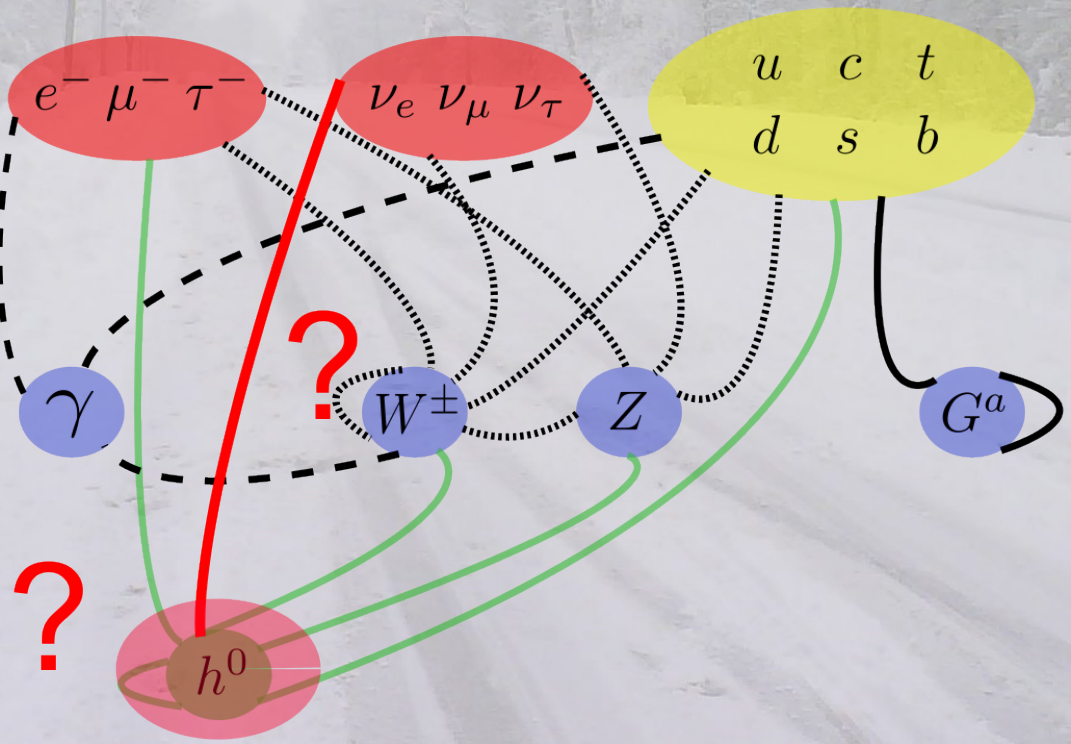
Drawbacks of the Standard Models

- **Particle Physics (SM)**
  - Hierarchy problem between EW ($\sim$ 100 GeV) and Planck ($\sim 10^{19}$ GeV) scales
    Quadratic divergences to the Higgs boson mass squared
  - Grand Unification (GUT)
  - Neutrino sector (Dirac, Majorana ? ?), ...



SM interactions, at tree-level

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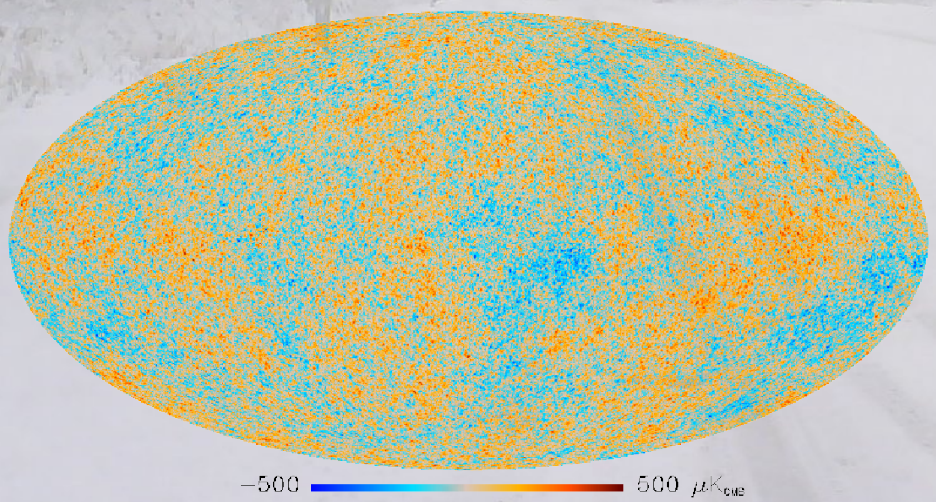
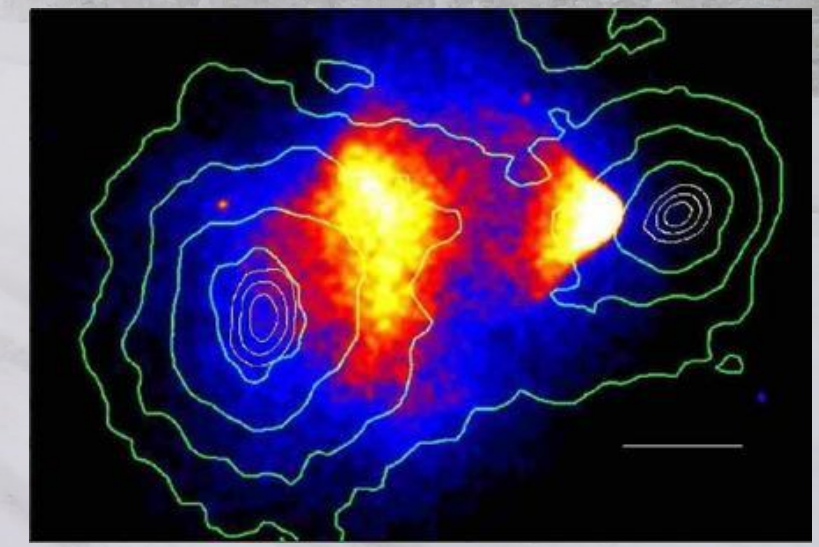
  - Simple cosmological model which fits even the most accurate measurements (Planck satellite)
  - But needs Dark Energy and Dark Matter (DM, other evidence : rotation curves of galaxies, galaxy clusters, ...)



P.A.R. Ade et al., arXiv:1303.5062



D. Clowe et al., astro-ph/0608407

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  - DM made of particles $\neq$ SM particles :
    - ✗ baryons : BBN, CMB, ...
    - ✗ charged leptons : we would have seen DM (overproduction of γ, ...)
    - ✗ neutrinos : too light $\Rightarrow$ low relic density + HDM

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$\Rightarrow$ **Example of DM candidate which gives the right abundance : Weakly Interacting Massive Particle (WIMP)**

✔ **Candidates can be found beyond the Standard Model**
Here : Supersymmetry (SUSY)

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- Unification at GUT scale
- LSP/DM (supersymmetry breaking, R-Parity)

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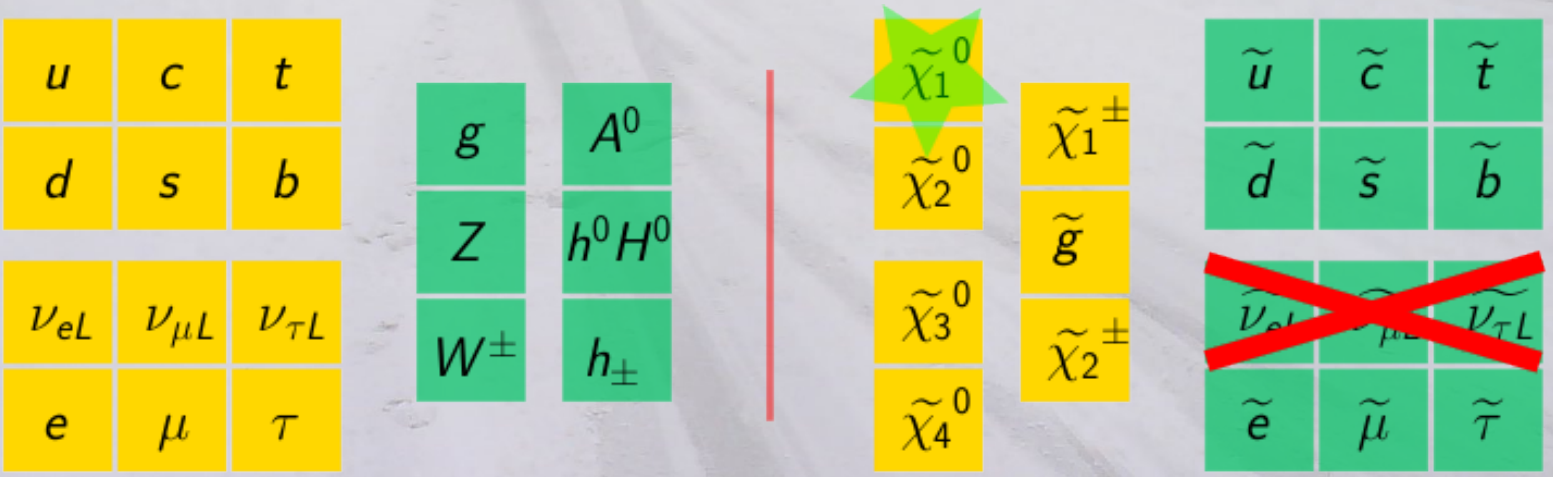
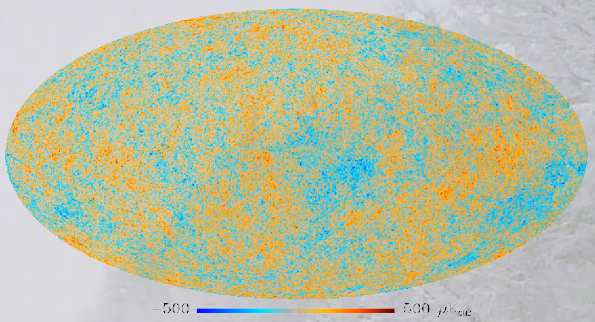
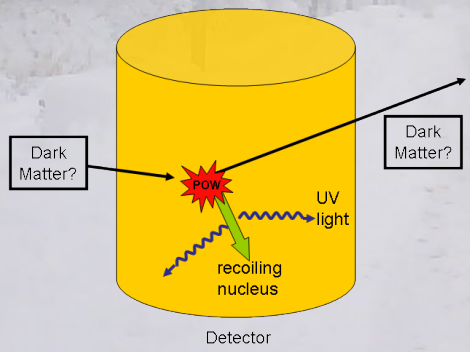
$\Rightarrow$ DM candidates in supersymmetric models

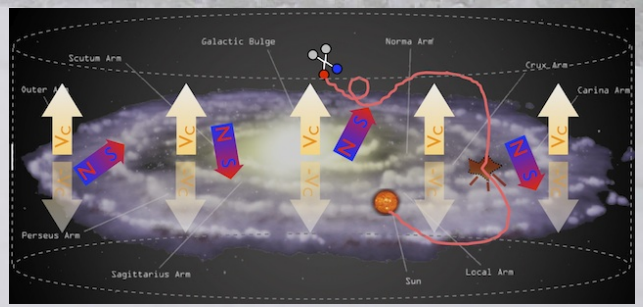
- **Examples :**

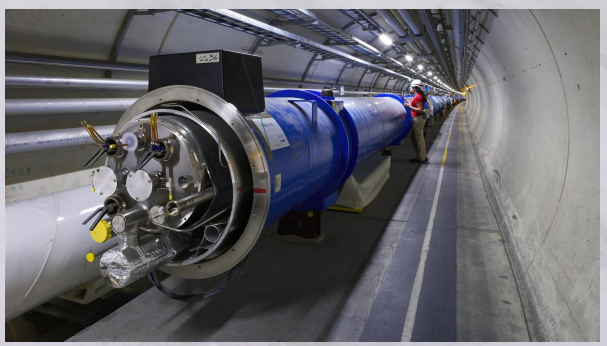


Constraints









Publications

- Work done at LAPTh Annecy-le-Vieux during my PhD under the supervision of Geneviève Bélanger :
  - G. Bélanger, JDS and A. Pukhov, JCAP 1112 (2011) 014, [arXiv:1110.2414]
    ⇒ Right-handed sneutrino viable DM in U(1) extensions of the MSSM
  - D. A. Vasquez, G. Bélanger, C. Bœhm, JDS, P. Richardson and C. Wymant, Phys. Rev. D86 (2012) 035023, [arXiv:1203.3446]
    ⇒ Collider signatures of NMSSM scenarios including cases with very light DM
  - G. Bélanger, C. Bœhm, M. Cirelli, JDS and A. Pukhov, JCAP 1211 (2012) 028, [arXiv:1208.5009]
    ⇒ The pMSSM confronting indirect detection of DM
  - C. Bœhm, JDS, A. Mazumdar and E. Pukartas, Phys. Rev. D87 (2013) 023529, [arXiv:1205.2815]
    ⇒ Supersymmetric inflaton in the NUHM2
  - G. Bélanger, JDS et al., in progress
    ⇒ Higgs sector in U(1) extensions of the MSSM
- PhD thesis online : [arXiv:1312.0257]

Projects

- **Projects with Mike Seymour linked to the `Herwig++` code :**
  - **New model of diffraction (also with Jeff Forshaw, Andrzej Siodmok, ...)**
  - **...**
- **Link with past projects :**
  - **Light DM and Leptogenesis in U(1) extensions of the MSSM with Bhupal Dev, Anupam Mazumdar (Lancaster) and Céline Bœhm (Durham)**


Merry Christmas
and
Happy New Year !!