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(on leave from SISSA, Trieste)

CERN - TH Retreat 2012

My Research Interests

- **Astro-particle physics**
  - Dark Matter
  - Baryogenesis
  - Inflation
- **BSM phenomenology**
  - Composite Higgs
  - SUSY

DM SEARCHES

DIRECT DETECTION

Xenon, CDMS, CRESST, CoGeNT, DARWIN...

COLLIDER

LHC

INDIRECT DETECTION

$e^+, \bar{p}$ **Fermi, HESS**

γ **PAMELA, ATIC, Fermi**

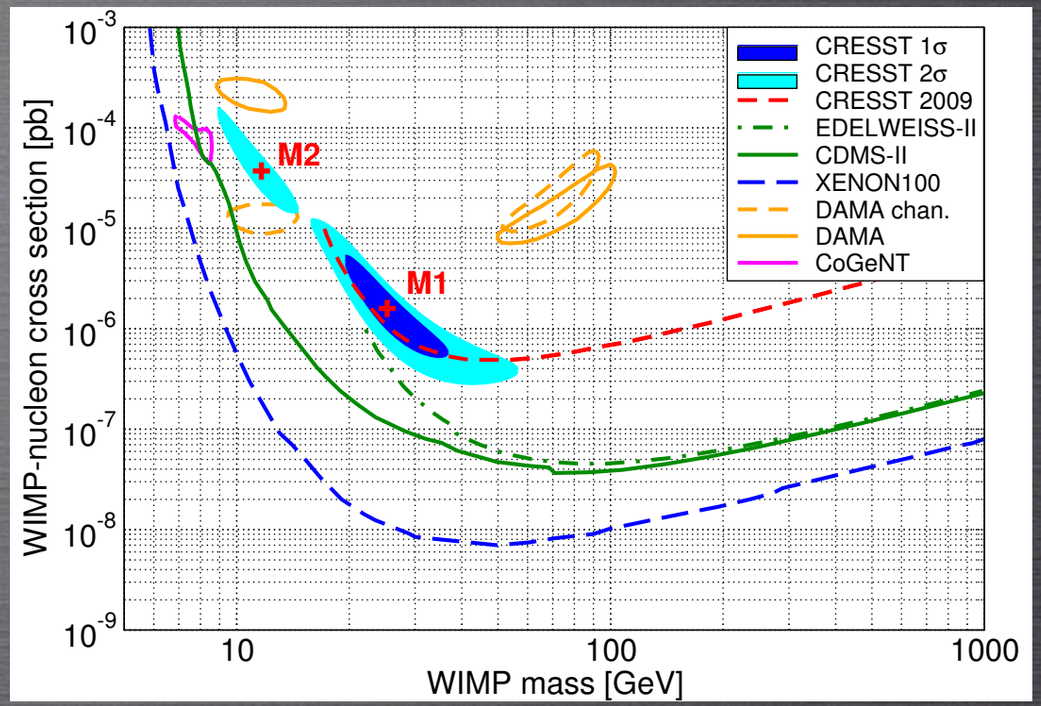
ν **IceCube, Antares, Km3Net**

$\bar{d}$ **GAPS, AMS-02**

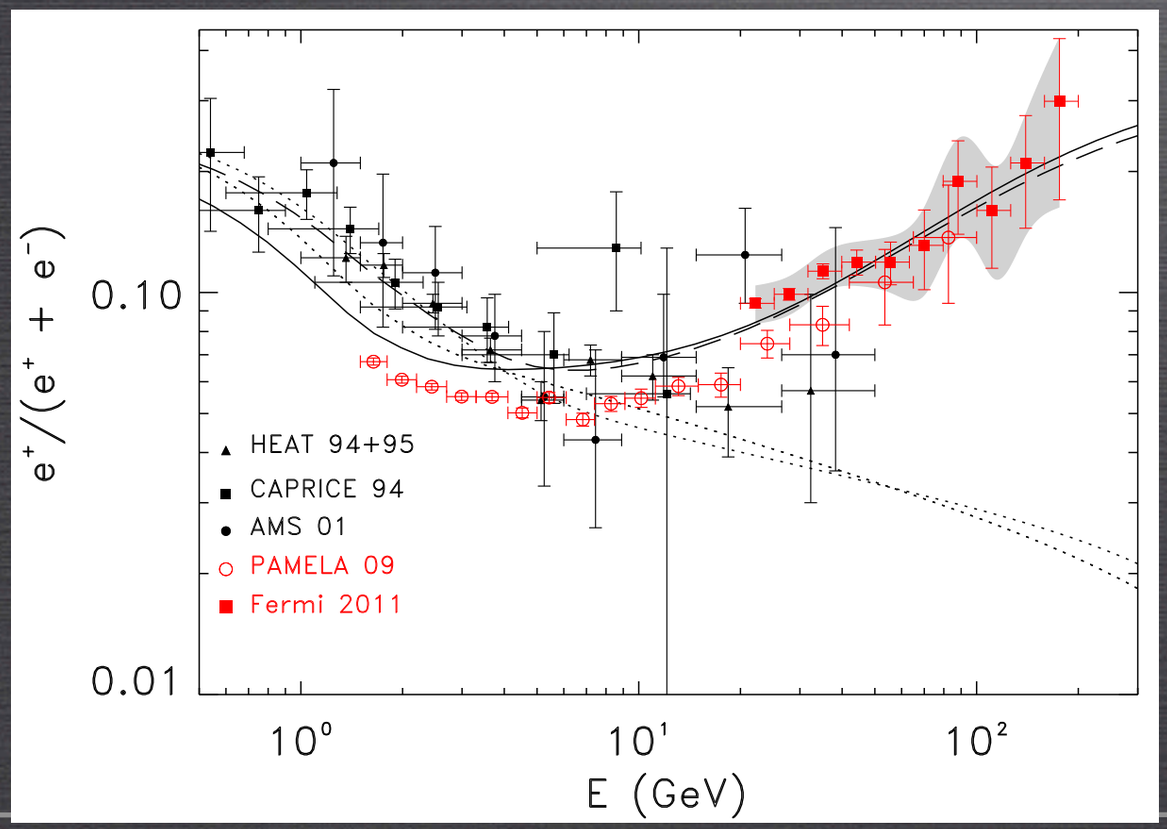
PUZZLES...

- 3 positive hints: DAMA, CoGeNT, CRESST;

- 3 null Direct detection experiments (so far): Xenon, CDMS, Edelweiss-II;



[CRESST - 1109.0702]

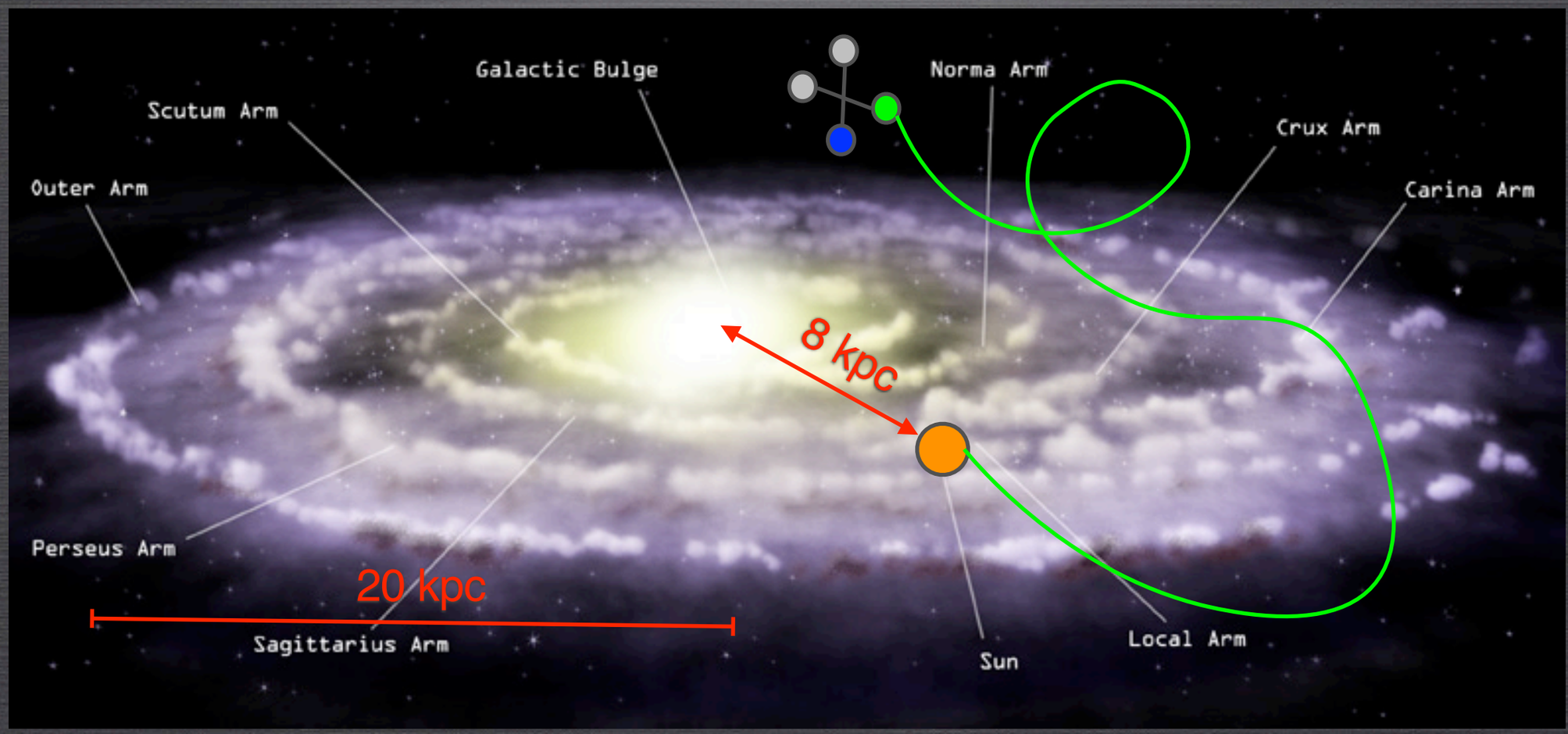


positrons

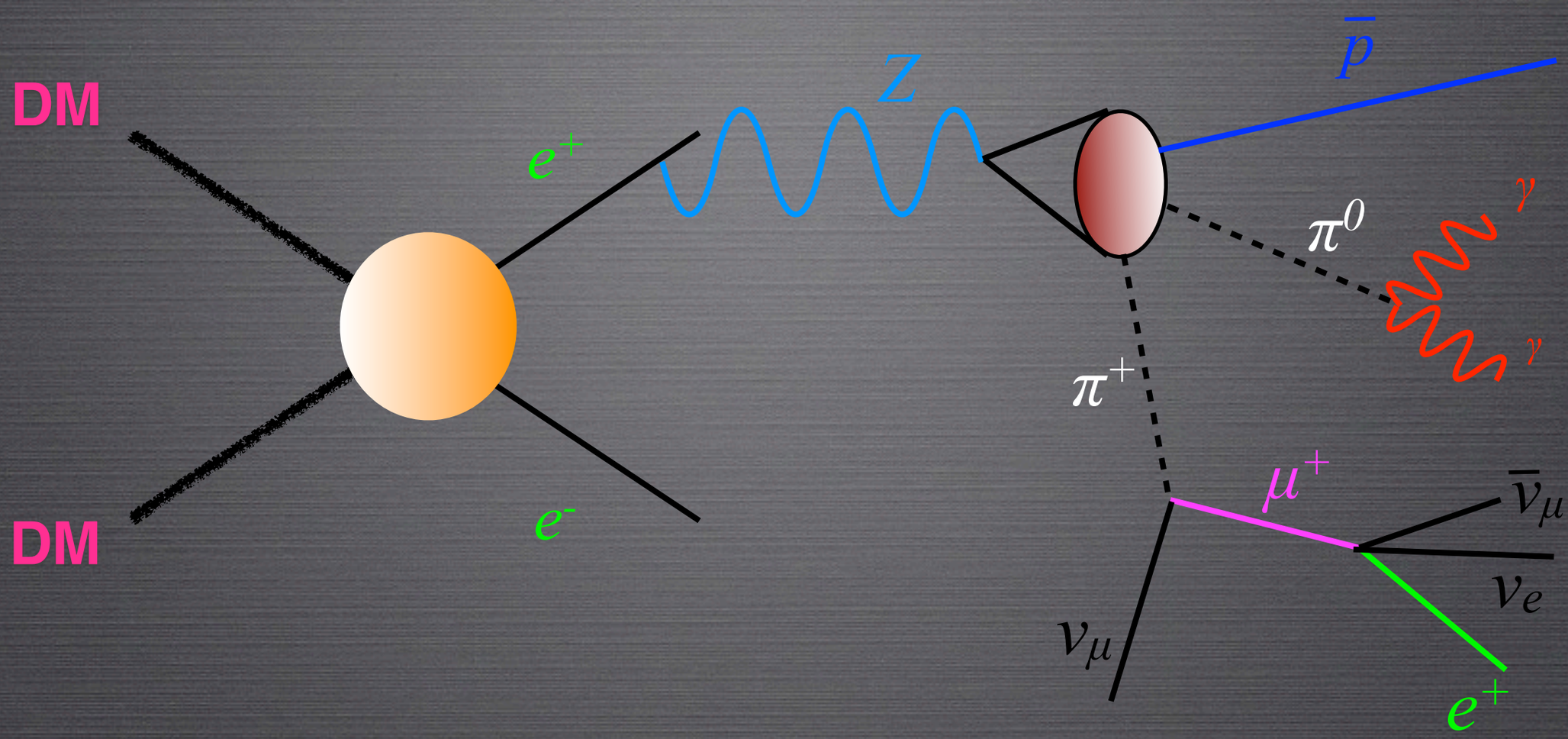
possible signal of DM?
also OK with astrophysics...

Indirect Detection

Key observable: fluxes of stable particles ($\gamma, \nu, \bar{p}, e^+$) from DM annihilations/decay in galactic halo or center



Electroweak Bremsstrahlung



- The final state of DM annihilation process can radiate γ,Z,W.
- It is a SM effect and can affect the final fluxes importantly.
- EW interactions connect all SM particles, so all species will be present in the final spectrum.

DM Annihilations

$$v\sigma_{\rm ann} = a + b\,v^2 + \mathcal{O}(v^4)$$

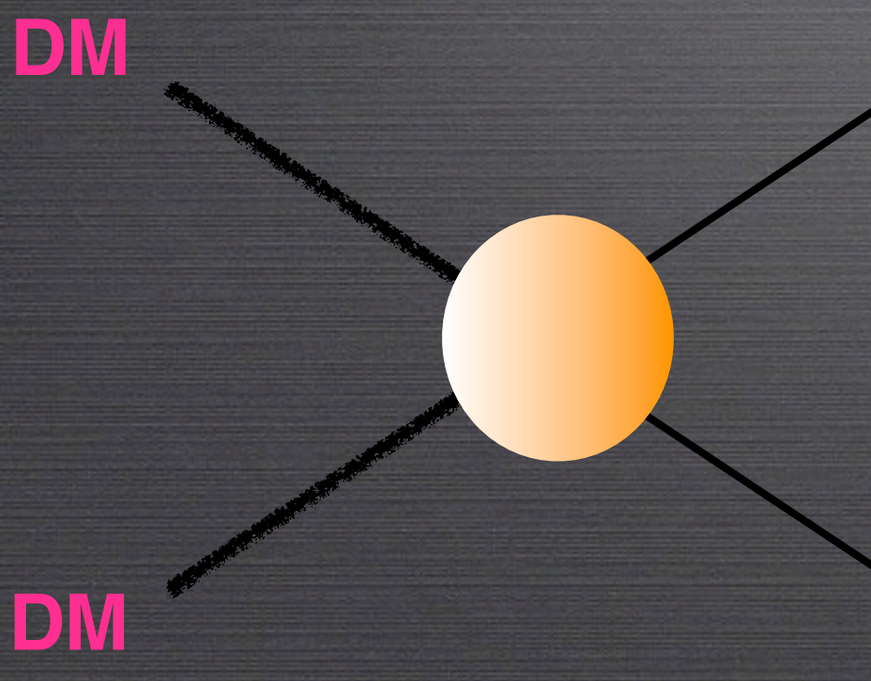
s-wave

p-wave

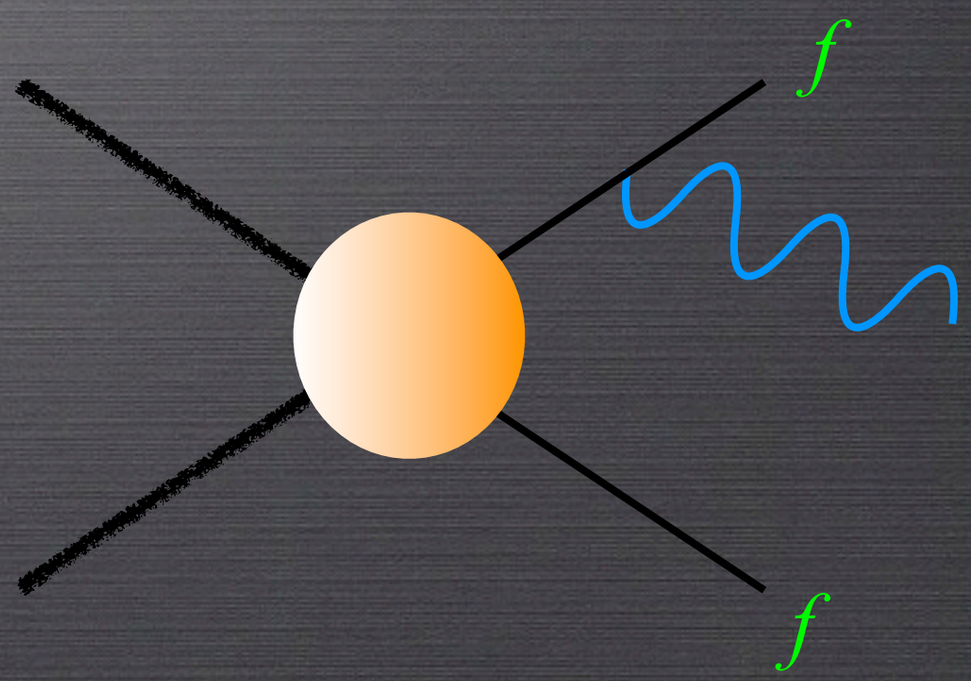
$v \sim 10^{-3} c$

today

For a Majorana fermion/real scalar and SM singlet



helicity suppression → only p-wave ($m_f \ll M_\chi$)



Adding radiation, there is an s-wave

Some Work in Progress...

EFT

For Majorana/real scalar DM, the lowest-dim operator gives a p-wave annihilation.
$\mathcal{O}_8$ can be more important than $\mathcal{O}_6$ despite larger dimensionality.

- Carrying out a general operator expansion in v and $1/\Lambda$.

Corelations

- Exploit that EW connects all particles and adopt multi-messenger search approach.

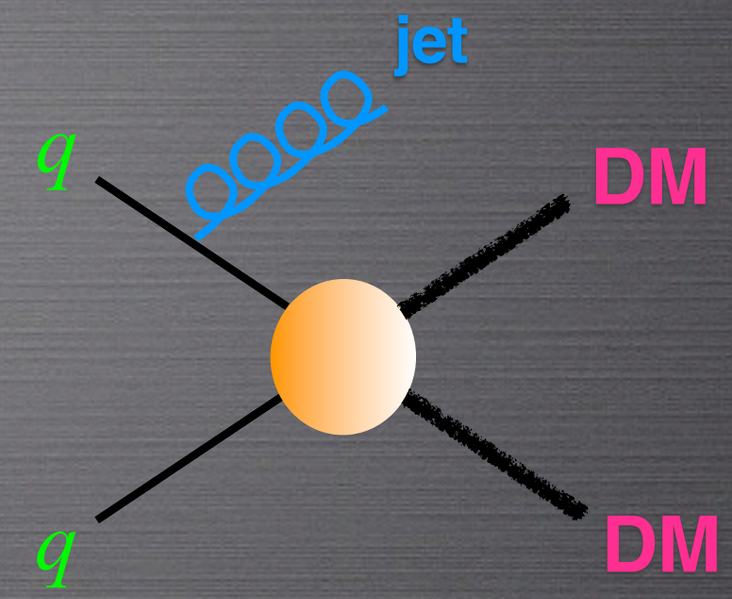
Neutrino signals

- Work out fluxes of neutrinos from DM annihilations inthe Sun/Earth, to be searched by IceCube.

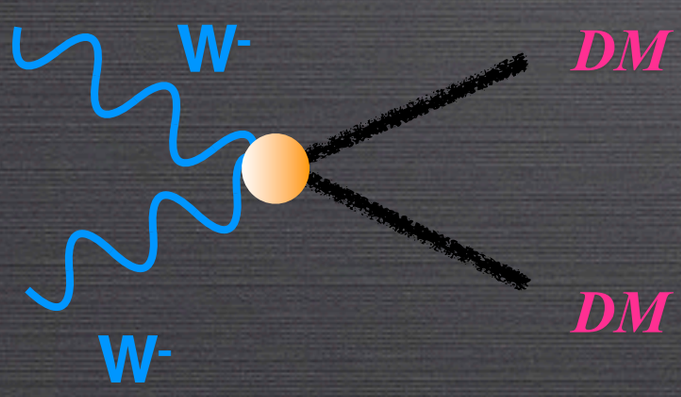
Collider Searches

In LHC we trust...

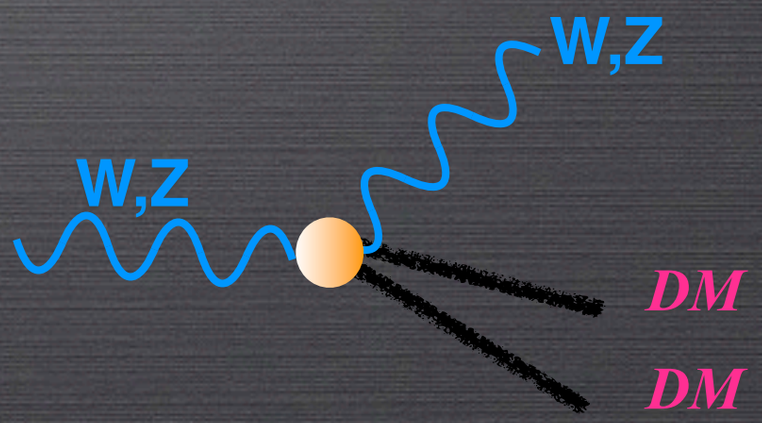
- DM pair production is invisible at LHC (need to correlate MET with other handles)



VBF



Associated Prod



BKG can be greatly reduced

Cosmological Perturbations from the SM Higgs

We considered a possibility that inflaton drives inflation and Higgs provides cosmologial perturbation.

Light scalar fields are excited during inflation, producing super-horizon fluctuations then converted into curvature perturbations.

Correlations $\{m_h, m_t, \alpha_s\} \longleftrightarrow \{H, f_{NL}\}$

make possible to make predictions (PLANCK) and falsify the scenario.

(e.g for central value of mt, fNL detection would imply H~10^(11) GeV (undetectable tensor modes))

TO HEAR MORE.... COME TO MY TALK ON WED 28TH NOV!