Studying QCD modeling uncertainties on particle spectra from dark matter annihilation into jets

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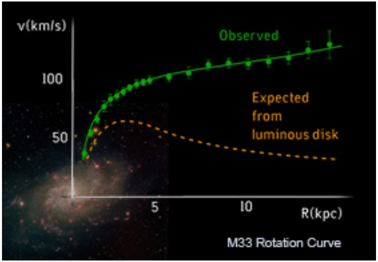
13 August 2013

Plan de la présentation

Introduction



- Other observations lead to the hypothesis of a new type of matter : Dark Matter.
- The Dark Matter particles have to be : neutral, Non Baryonic, Non-relativistic, Stable.
- No Standard Model particle can be a candidate of Dark matter.

Dark Matter $\Longrightarrow$ Physics Beyond the Standard Model.

DARK MATTER

$J = \;?$

Mass $m = \;?$
Mean life $\tau = ?$

DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
?	?	?	?

Introduction

There exist three different methods to detect Dark matter :

- Direct detection : $\text{DM} + N \to \text{DM} + N'$
- Indirect detection : $\text{DM} + \text{DM} \to SM + SM$ or $\text{DM} \to SM + SM$
- Collider searches : e.g. $pp \to 2\,\text{DM} + X$

Dark matter can be annihilated, for example, into :

- ZZ which can subsequently decay into $q\bar{q}$
- Or to $q\bar{q}$

Our Aim : Study and Model the uncertainties on spectra of particles coming from $Z \to q\bar{q}$ at $E_{cm} = 1$ TeV and $E_{cm} = 91.2$ GeV

Altarelli-Parisi equations

- Charged Particles radiate : quarks radiate gluons.
- After multiple emissions of gluons and also of quarks, the initial parton *a* is evolved.
- The evolution of a parton *a* is given by the set of Coupled integro-differential equations :

$$\frac{d}{dlogQ^2} f_g(x,Q) = \frac{\alpha_s(Q)}{\pi} \int_0^1 \frac{dz}{z} \Big(P_{q\to g}(z) \sum_q \left(f_q(x/z,Q) + f_{\bar{q}}(x/z,Q) \right) + P_{g\to g}(z) f_g(x/z,Q) \Big)$$

And

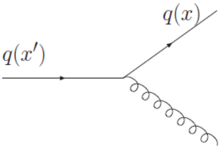
$$\frac{d}{dlogQ^2} f_q(x,Q) = \frac{\alpha_s(Q)}{\pi} \int_0^1 \frac{dz}{z} P_{q\to q}(z) f_q(x/z,Q) + P_{g\to q}(z) f_g(x/z,Q))$$

$$\frac{d}{dlogQ^2} f_{\bar{q}}(x,Q) = \frac{\alpha_s(Q)}{\pi} \int_0^1 \frac{dz}{z} P_{q\to q}(z) f_{\bar{q}}(x/z,Q) + P_{g\to q}(z) f_g(x/z,Q))$$

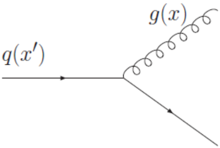
These are the Altarelli-Parisi equations

Altarelli-Parisi Equations

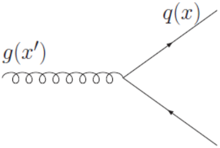
Where $P_{i \to j}$ are the splitting functions and $f_i(x/z, Q)$ are the distribution functions of a parton i carrying the momentum fraction x/z.
The splitting functions are given by :



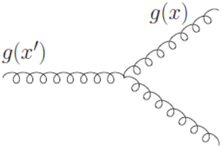
$$\mathcal{P}_{qq}(z) = C_F \frac{1+z^2}{1-z}$$



$$\mathcal{P}_{gq}(z) = C_F \frac{1+(1-z)^2}{z}$$

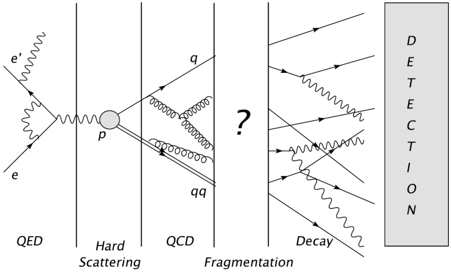


$$\mathcal{P}_{qg}(z) = \frac{1}{2}\left[z^2 + (1-z)^2\right]$$



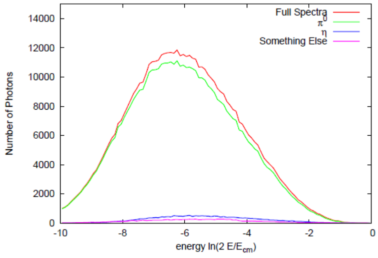
$$\mathcal{P}_{gg}(z) = 2C_A\left[\frac{1-z}{z} + \frac{z}{1-z} + z(1-z)\right]$$

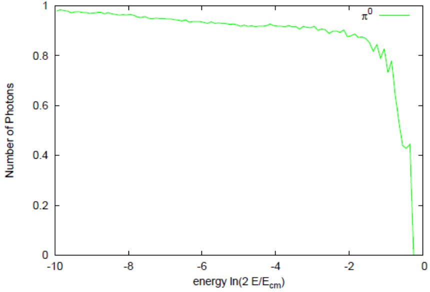
Hadronization Process



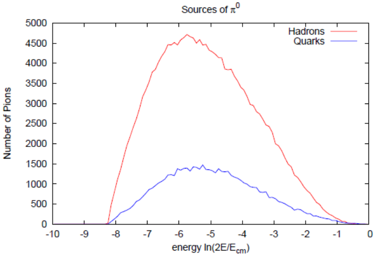
- Quarks, after showering, collect with each other to give hadrons.
- PYTHIA event generator is based on the string hadronization model.

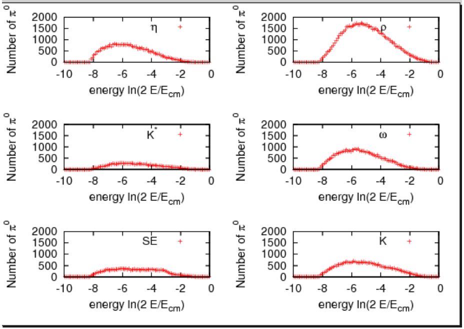
Results and Discussion





Results and Discussion





Summary and Conclusions

- There exist some interesting regions in the spectra of photons which can be subject to further studies for dark matter purposes.
- There exist some uncertainties on particle spectra obtained by various event generators.
- We will be interesting on the LEP data concerning the spectra of γ, π^0 and $\pi^\pm$ and search how we can vary the parameters within the range allowed by LEP results, in order to estimate the uncertainties on the dark matter spectra.