# Heavy Quarks in PDF's fits for pedestrians (myself included)

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First of all, an assumption:

**We all agree on the partons**

i.e. purely massless MSbar, evolved through the heavy quark thresholds with variable flavour number

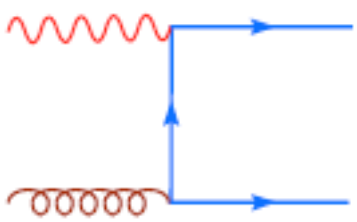
If we do (do we?), then the issue is
how to calculate the cross sections

[Normally a user issue, but the fitters also have to deal with it]

# Possible approaches for $F_2$

## FFN

$$F_2^h \sim \sum_{\text{light partons}} f_i(\mu) \otimes C_i^{\overline{MS}}(Q, m, \mu)$$



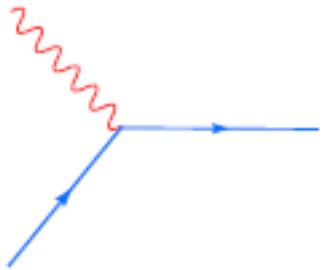
Proper m/Q mass terms

Unresummed log(Q/m) term

Fails in Q >> m limit

## ZM (resummed)

$$F_2^h \sim \sum_{\text{all partons}} f_i(\mu) \otimes C_i^{\overline{MS}}(Q, \mu)$$



Resummed log(Q/m) terms

Missing m/Q terms

Fails in Q ~ m threshold region

# Matching

An obvious solution would seem to be

$$F_2 = FFN + ZM - subtraction$$

where

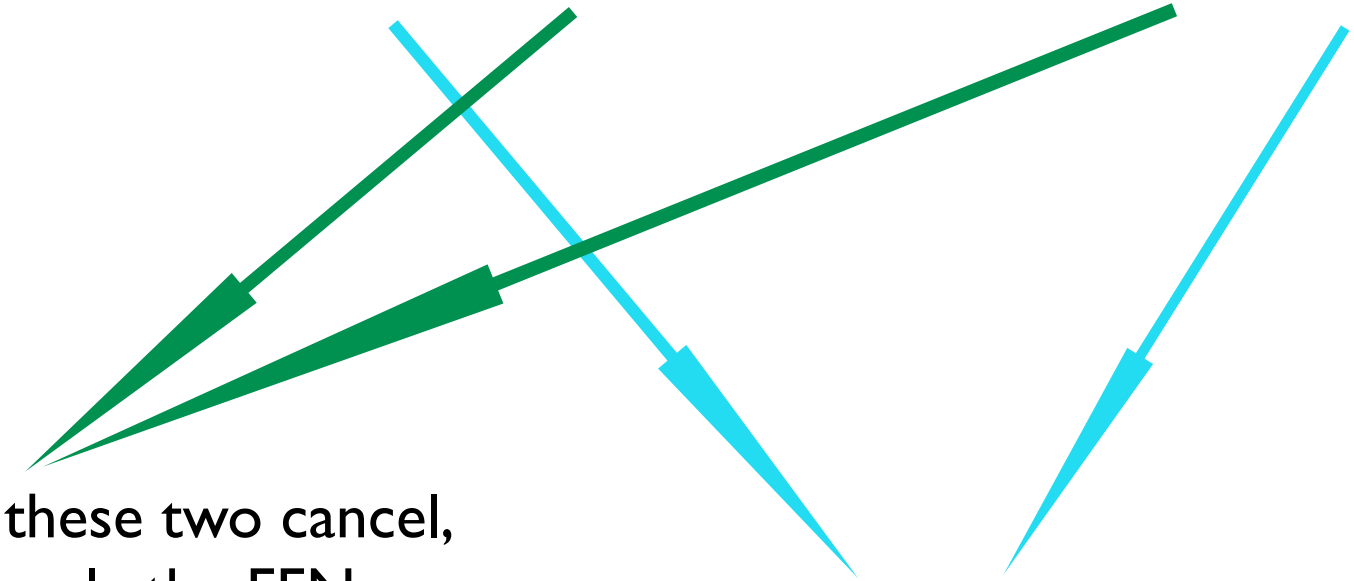
$$subtraction = \begin{cases} O(\alpha_s^n) \text{ limit of ZM} \\ \text{quasi-collinear limit of FFN} \end{cases}$$

Everybody does something like this

# Matching

In an ideal world the matching would be smooth

$$F_2 = \text{FFN} + \text{ZM} - \text{subtraction}$$



At Q ~ m these two cancel, leaving only the FFN

At large Q these two terms cancel, leaving the resummed ZM one

However, the devil lies in the details

# The devil

$$F_2 = \text{FFN} + \text{ZM} - \text{subtraction}$$

This terms starts one order higher than FFN.
A priori, it **does not** contain the correct mass effects

Its naive behaviour is usually unphysical: need a prescription

(Doing nothing if formally qualitatively equivalent to choosing a prescription, but it can make an important quantitative difference)

How to include such mass effects, which are **not known** from an explicit calculation, is precisely the source of the ambiguity between different approaches

# Some food for thought

Cross section predictions are intrinsically **ambiguous** in the threshold region

- Can we agree on a prescription?
- Should we actually agree on one?
  Won't the artificial agreement hide the uncertainty?
- Can we quantify the size of the ambiguity?
  Does it actually matter given the size of the experimental errors?
  Will it matter in the future?

# Some food for thought

Assuming that the ambiguity does matter numerically then

- Should we fit in the threshold regions, knowing that the resulting partons will be prescription-dependent?
- Does it make sense to skip these regions altogether? Would we be throwing away too many data points?

Answers (hopefully) from the following talks and the discussion