Leading Hadronisation Corrections

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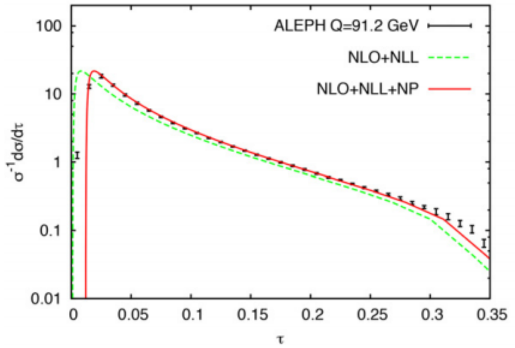
Motivation

- Hadronisation corrections are now the major source of theoretical uncertainties for strong coupling determination
- Hadronisation can be modelled as a shift of perturbative event-shape distributions:

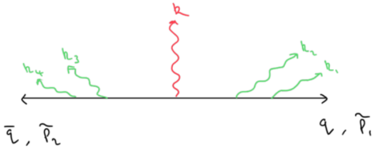


- Introduce a new method to compute leading hadronisation corrections to two-jet event shapes in e^+e^- annihilation.

Approach

$$V(\{\tilde{p}\}, k_1, ..., k_n) \geqslant 0$$

Leading hadronisation corrections due to the contribution of a very soft gluon (aka gluer)



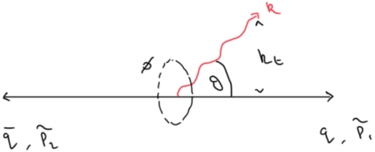
Cumulative distribution given by:
$\Sigma(v) = \Sigma_{\rm PT}(v) + \delta\Sigma_{\rm NP}(v)$

We define: $\delta V_{\rm NP} \equiv V(\{\tilde{p}\}, k, \{k_i\}) - V(\{\tilde{p}\}, \{k_i\})$

This gives us that: $\delta\Sigma_{\rm NP} \approx -\langle \delta V_{\rm NP} \rangle \frac{d\Sigma_{\rm PT}}{dv} \implies \Sigma(v) \approx \Sigma_{\rm PT}(v - \langle \delta V_{\rm NP} \rangle)$

We consider event shapes for which:
$\delta V_{\rm NP}(\{\tilde{p}\}, k, \{k_i\}) = \frac{k_t}{Q} f_V(\eta, \phi, \{k_i\})$

(with $\eta = -\ln\tan\frac{\theta}{2}$)



Results and next steps

Therefore:

$$\langle \delta V_{\rm NP}\left(\{\tilde{p}\}, k, \{k_i\}\right)\rangle = \frac{\langle k_t \rangle}{Q} c_V$$

with:

$$\boxed{c_{\rm V} = \frac{\left\langle f_{\rm V}\left(\eta, \phi, \{k_i\}\right) \delta\left(1 - \frac{V_{\rm sc}(\{\tilde{p}\},\{k_i\})}{v}\right)\right\rangle}{\left\langle \delta\left(1 - \frac{V_{\rm sc}(\{\tilde{p}\},\{k_i\})}{v}\right)\right\rangle}}$$

Observable	c_V
$\tau = 1 - T$	2
C	3π
ρ_H	1
B_W	$\frac{1}{2}\left[-2 - \psi(1) - \ln B + \eta_0 + \chi\left(\frac{R'}{2}\right) - \rho\left(\frac{R'}{2}\right) + \psi\left(1 + \frac{R'}{2}\right)\right]$
B_T	$2c_{B_W} - \psi\left(1 + \frac{R'}{2}\right) + \psi\left(1 + R'\right) + \frac{1}{R'}$
T_M	ongoing

(with $R' \equiv -v\frac{dR}{dv}$)

Additional Slides

We know that:

$$\Sigma_{\mathrm{PT}}(v) = e^{-R_{\mathrm{NLL}}(v)}\mathcal{F}_{\mathrm{NLL}}(v)$$

where:

$$\mathcal{F}_{\mathrm{NLL}}(v) = \left\langle \Theta\left(1 - \frac{V_{\mathrm{sc}}\left(\{\tilde{p}\}, k_1, ..., k_n\right)}{v}\right)\right\rangle$$

In our computation of the shift:

$$c_{\mathrm{V}} = \frac{\left\langle f_{\mathrm{V}}\left(\eta, \phi, \{k_i\}\right)\delta\left(1 - \frac{V_{\mathrm{sc}}(\{\tilde{p}\},\{k_i\})}{v}\right)\right\rangle}{\left\langle \delta\left(1 - \frac{V_{\mathrm{sc}}(\{\tilde{p}\},\{k_i\})}{v}\right)\right\rangle}$$

The denominator may be written as $R'\mathcal{F}(R')$ with:

$$R' \equiv -v\frac{dR}{dv}$$

Additional Slides

Method of computation:

- In a form suitable for evaluation numerically by a Monte Carlo procedure we can write:

$$
\begin{aligned}
&R'\mathcal{F}(R')c_{\mathrm{V}} \\
&= \int d\eta \frac{d\phi}{2\pi} R' \int_0^{2\pi} \frac{d\phi_1}{2\pi} \epsilon^{R'} \sum_{n=0}^{\infty} \frac{1}{n!} \prod_{i=2}^{n+1} R' \int_\epsilon^1 \frac{d\tilde{\zeta}_i}{\tilde{\zeta}_i} \int_0^{2\pi} \frac{d\phi_i}{2\pi} \times \\
&\times \exp\left(-R' \ln \frac{V_{\mathrm{sc}}\left(\{\tilde{p}\}, \tilde{k}_1, \ldots, \tilde{k}_{n+1}\right)}{v}\right) f_{\mathrm{V}}\left(\eta, \phi, k_1, ..., k_n\right)
\end{aligned}
$$

- Where in $f_V(\eta, \phi, k_1, \ldots, k_n)$ the k_i's are functions of $\tilde{\zeta}_i$.