B-decays in Sherpa, first steps

LHC-D Workshop 2006 Flavour Physics

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For energies $\ll m_{\mathrm{W}}$ $\longrightarrow$ Factorisation into two currents

$$\mathcal{M}(B \to D\bar{l}\nu_l) = -\mathrm{i}\frac{G_F}{\sqrt{2}} V_{cb}\; L_\mu\; H^\mu$$

Leptonic Current via helicity amplitudes

$$L_\mu = \overline{u}_\nu\; \gamma_\mu\; (1-\gamma_5)\; v_{\bar{l}}$$

Hadronic Current via form factors

$$\begin{aligned} H^\mu &= \langle D(p_D)\,|\bar{c}\,\gamma^\mu\,(1-\gamma_5)\,b|\,B(p_B)\rangle \\ &= f_+\,(q^2)\,\left((p_B+p_D)^\mu - \frac{m_B^2-m_D^2}{q^2}(p_B-p_D)^\mu\right) \\ &\quad + f_0(q^2)\,\frac{m_B^2-m_D^2}{q^2}\,(p_B-p_D)^\mu \end{aligned}$$

HQET (Heavy Quark Effective Theory)

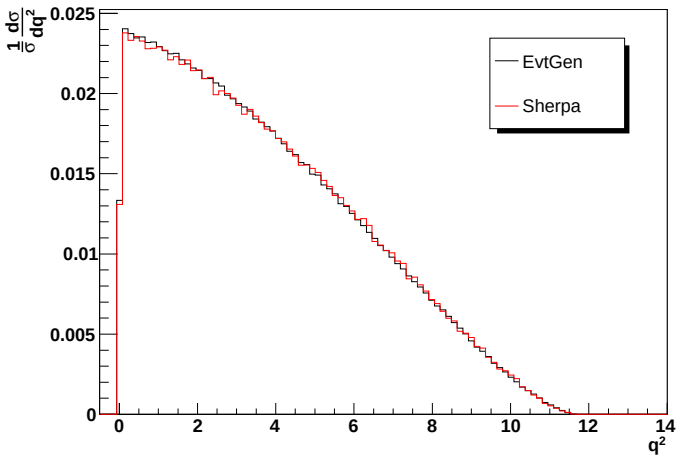
$$
\begin{aligned}
f_+ &= 1 - \rho^2 (v_B \cdot v_D - 1) + c(v_B \cdot v_D - 1)^2 \\
f_0 &= 0 \\
&\text{with: } \rho^2 \approx 0.7,\ c = 0 \text{ Inputparameters}
\end{aligned}
$$

ISGW (Isgur, Scora, Grinstein, Wise)

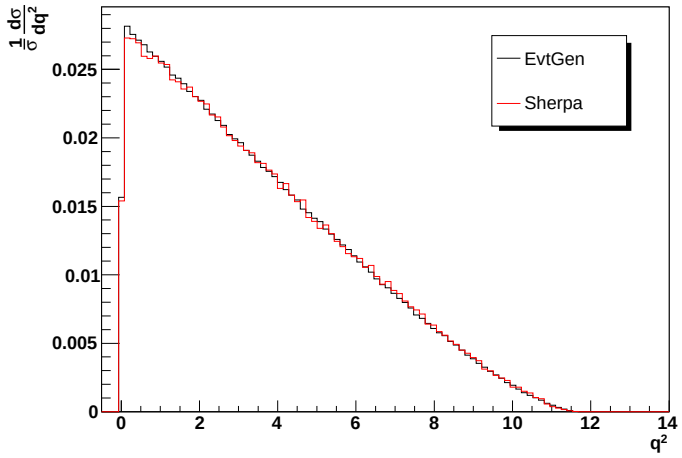
$\rightsquigarrow$ *Isgur, Scora, Grinstein, Wise* - Semileptonic B and D decays in the quark model

ISGW2 and HQET2

- especially necessary for decays to τ leptons
- just implemented by Jan Stieglitz


$\frac{1}{\sigma}\frac{d\sigma}{dq^2}$
EvtGen
Sherpa
q^2

HQET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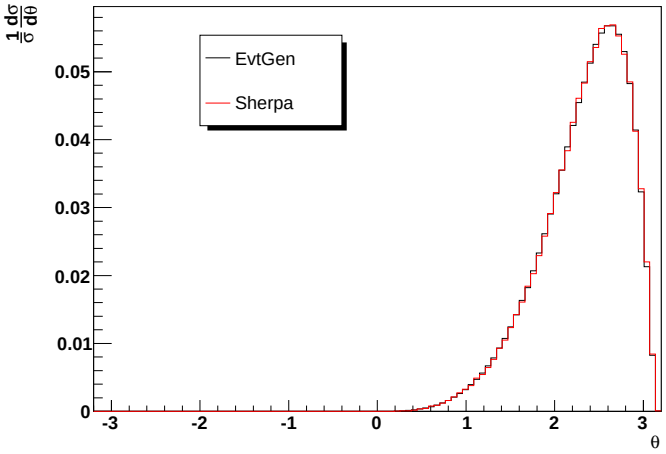
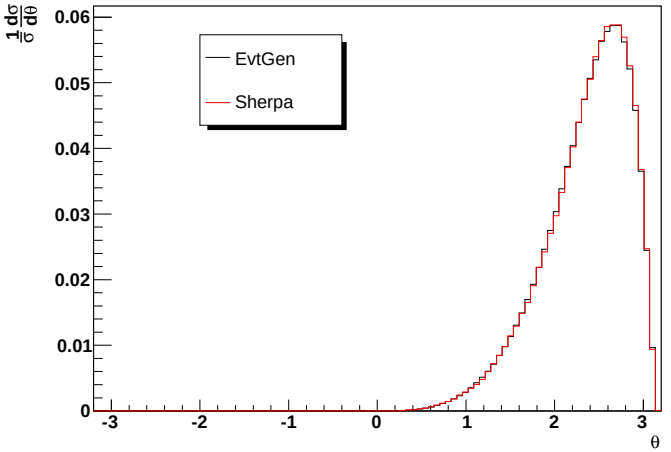

$\frac{1}{\sigma}\frac{d\sigma}{d\theta}$
EvtGen
Sherpa
θ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Leptonic Current via helicity amplitudes

$$L_\mu = \overline{u}_\nu\, \gamma_\mu\, (1 - \gamma_5)\, v_{\bar{l}}$$

Hadronic Current via form factors

$$\begin{aligned}
H^\mu &= \langle D^*(p_D, \varepsilon) \,|\bar{c}\, \gamma^\mu\, (1 - \gamma_5)\, b|\, B(p_B)\rangle \\
&= V\left(q^2\right) \frac{2\,\mathrm{i}}{m_B + m_D}\, \epsilon^{\mu\nu\alpha\beta}\, \varepsilon^*_\nu\, p_{D\alpha}\, p_{B\beta} \\
&\quad - A_1\left(q^2\right)\, (m_B + m_D)\, \varepsilon^{*\mu} \\
&\quad + A_2\left(q^2\right)\, \varepsilon^* \cdot q \frac{1}{m_B + m_D}\, (p_B + p_D)^\mu \\
&\quad + \left[A_3\left(q^2\right) - A_0\left(q^2\right)\right]\, 2\, m_D \frac{\varepsilon^* \cdot q}{q^2}\, q^\mu
\end{aligned}$$

HQET (Heavy Quark Effective Theory)

$$
\begin{aligned}
A_1 &= \left(1 - \frac{q^2}{m_B + m_D}\right) \frac{\xi}{R^*} \\
A_2 &= \frac{R_2}{R^*} \cdot \xi \\
V &= \frac{R_1}{R^*} \cdot \xi
\end{aligned}
$$

with: $\xi = 1 - \rho^2(v_B \cdot v_D - 1)$, $R^* = \frac{2\sqrt{m_B * m_D}}{m_B + m_D}$

R_1, R_2, ρ Inputparameters

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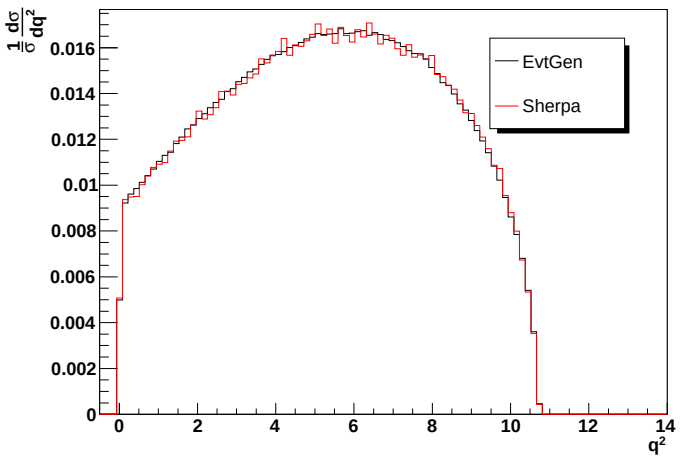
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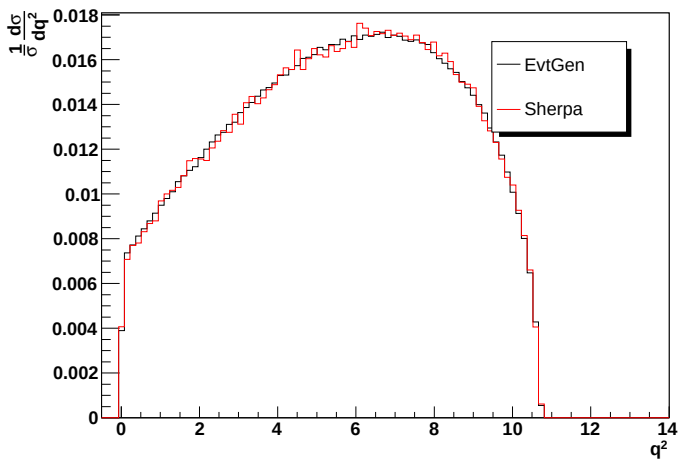
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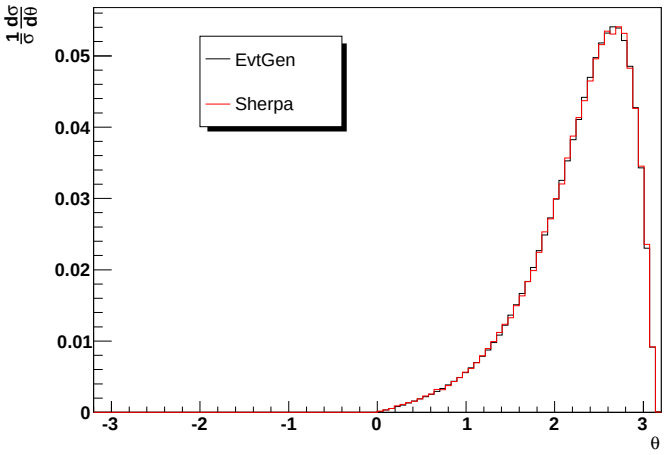
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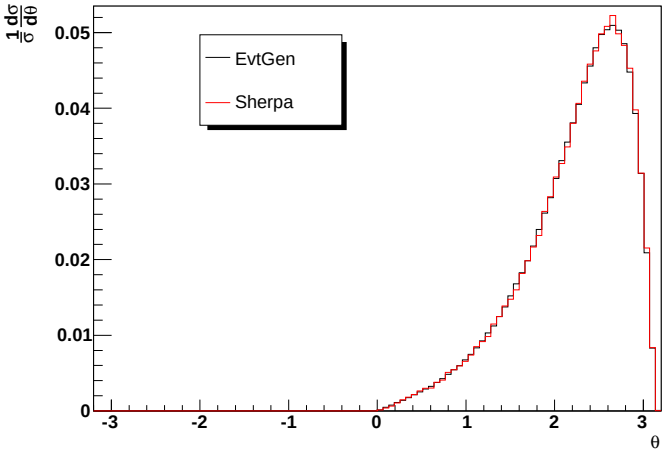
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The next steps are

- Hadronic B-decays like $B \to D^{(*)} + N\pi + NK$
  $\to$ utilize and extend currents from τ decays
- Semileptonic D-decays
- Complete decay table (branching fractions) of B mesons
- ...