Overview on EW dipoles

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Colour Reconnection Workshop – Lund, Sweden

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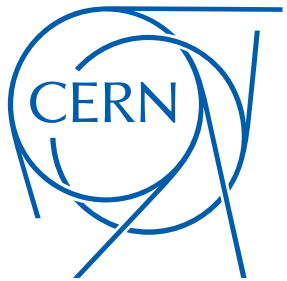

... or rather QED dipoles

Main issue: QED is U(1)

equivalent of large-N_c expansion not very meaningful

need full multipole picture for soft-photon coherence

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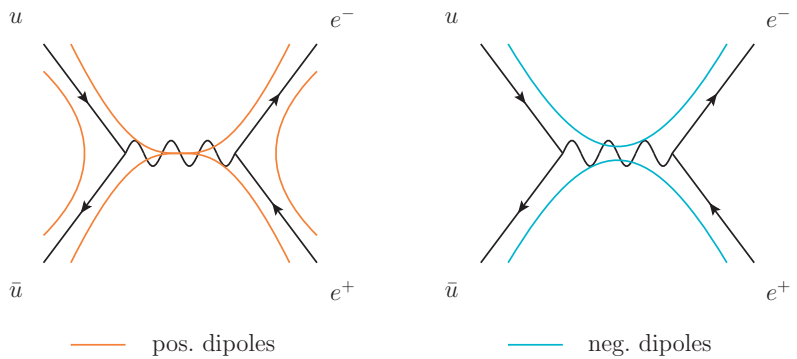

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all dipoles contribute on equal footing

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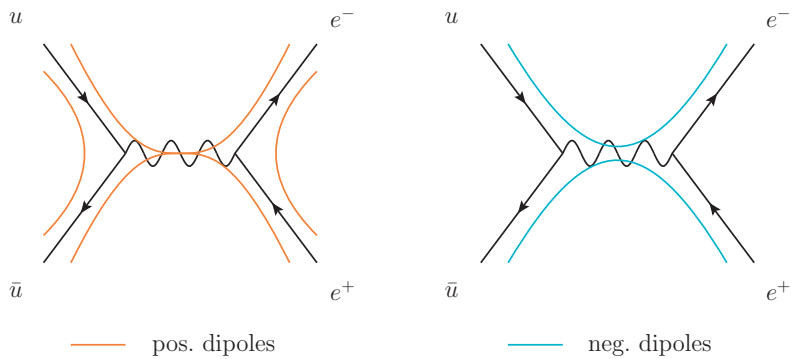

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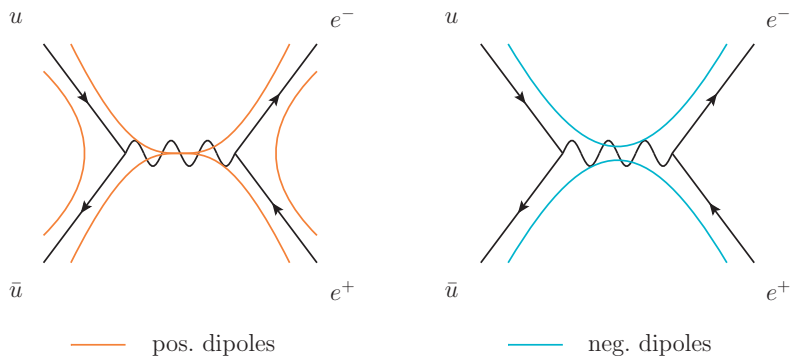

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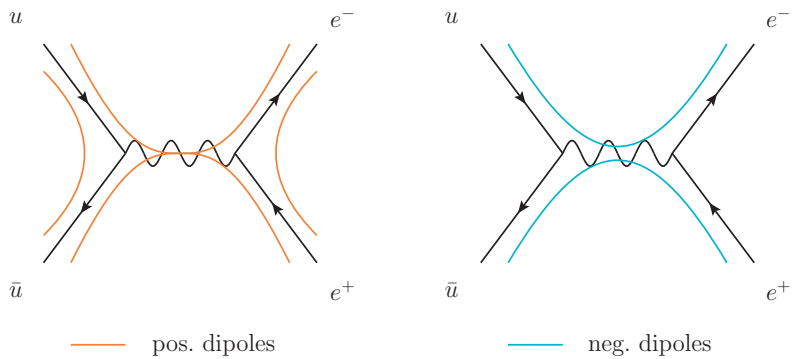

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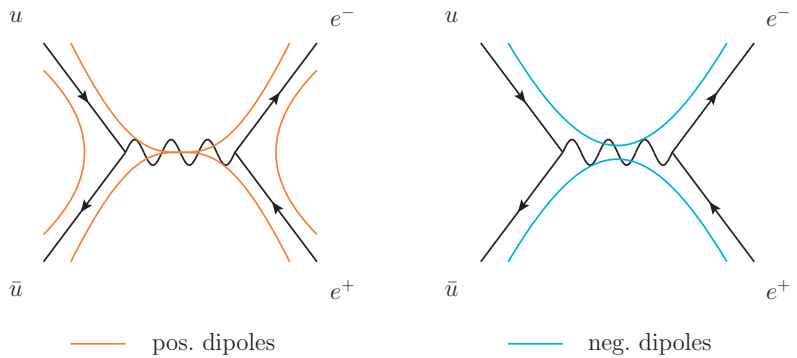

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QED dipoles for NLO EW calculations

QED dipoles for NLO EW calculations

Dittmaier hep-ph/9904440

Dittmaier, Kabelschacht, Kasprzik arXiv:0802.1405

Schönherr arXiv:1712.07975

- structurally identical to QCD subtraction
  adapt QCD subtraction (spl. fns. and colour-/spin-correlated MEs)
- replacements: $\alpha_s \to \alpha$, $C_F \to Q_f^2$, $C_A \to 0$,
  $T_R \to N_{c,f}\, Q_f^2$, $n_f\, T_R \to \sum_f N_{c,f}\, Q_f^2$,

$$\frac{\mathbf{T}_{ij}\cdot\mathbf{T}_k}{\mathbf{T}_{ij}^2} \to \frac{Q_{ij}\theta_{ij}Q_k\theta_k}{Q_{ij}^2}$$

- exception: $\gamma \to f\bar{f}$ splittings are **not dipole-like**

$$\frac{\mathbf{T}_{ij}\cdot\mathbf{T}_k}{\mathbf{T}_{ij}^2} \to \kappa_{ij,k} \text{ with } \sum_{k\neq ij} \kappa_{ij,k} = -1$$

no soft coherence, freedom to distribute recoil

QED dipoles in standard parton showers

QED dipoles in standard parton showers

- standard dipole showers neglect negative dipoles
  → naïvely wrong collinear limit **and** wrong soft limit
  → in principle, can modify prefactor to get collinear limit correct (as is done in QCD)
- technology available to include neg. dipoles

  Höche, Siegert, Schumann arXiv:0912.3501
  Höche, Krauss, Schönherr, Siegert arXiv:1111.1220

  → but convergence worse than in QCD since neg. dipoles more important

QED multipoles in soft-photon resummation

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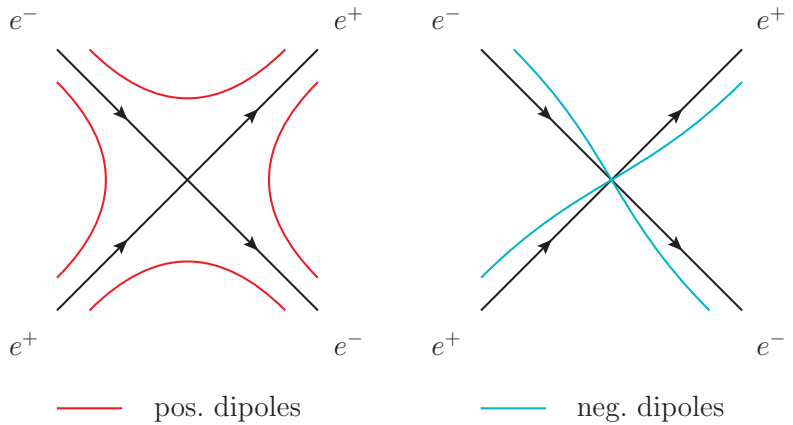
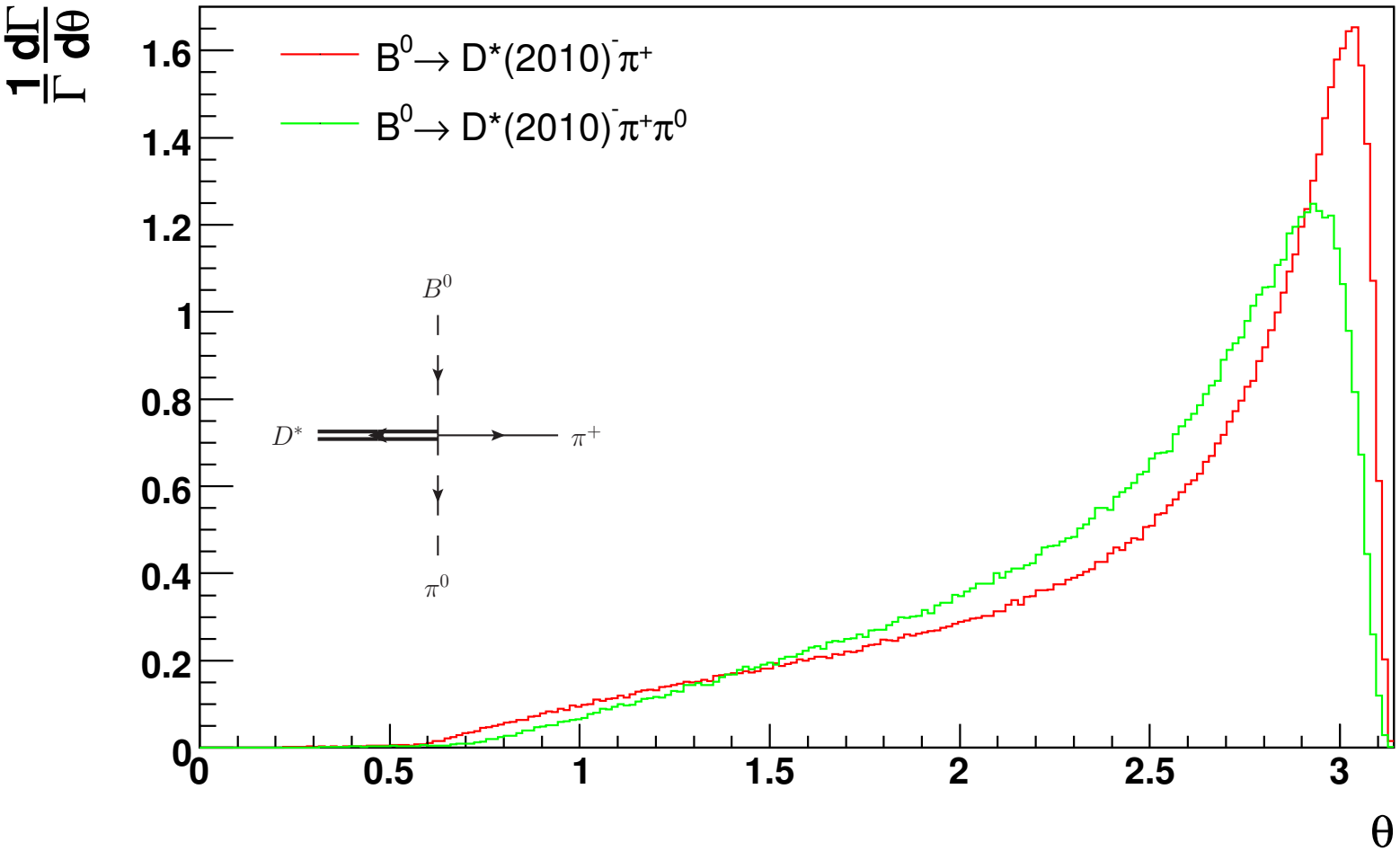
- multipole radiation calculated in multipole rest frame



- spatial distribution calculated according to multipole
  (= sum of all dipoles)
  $\rightarrow$ inherently positive definite
- generate according to sum of modulus of all dipoles to get the right probabilities to select kinematics in all dipoles
- unweight to coherent sum of signed dipoles

QED multipoles in soft-photon resummation

photon angular distribution in multipole rest frame (φ integrated)



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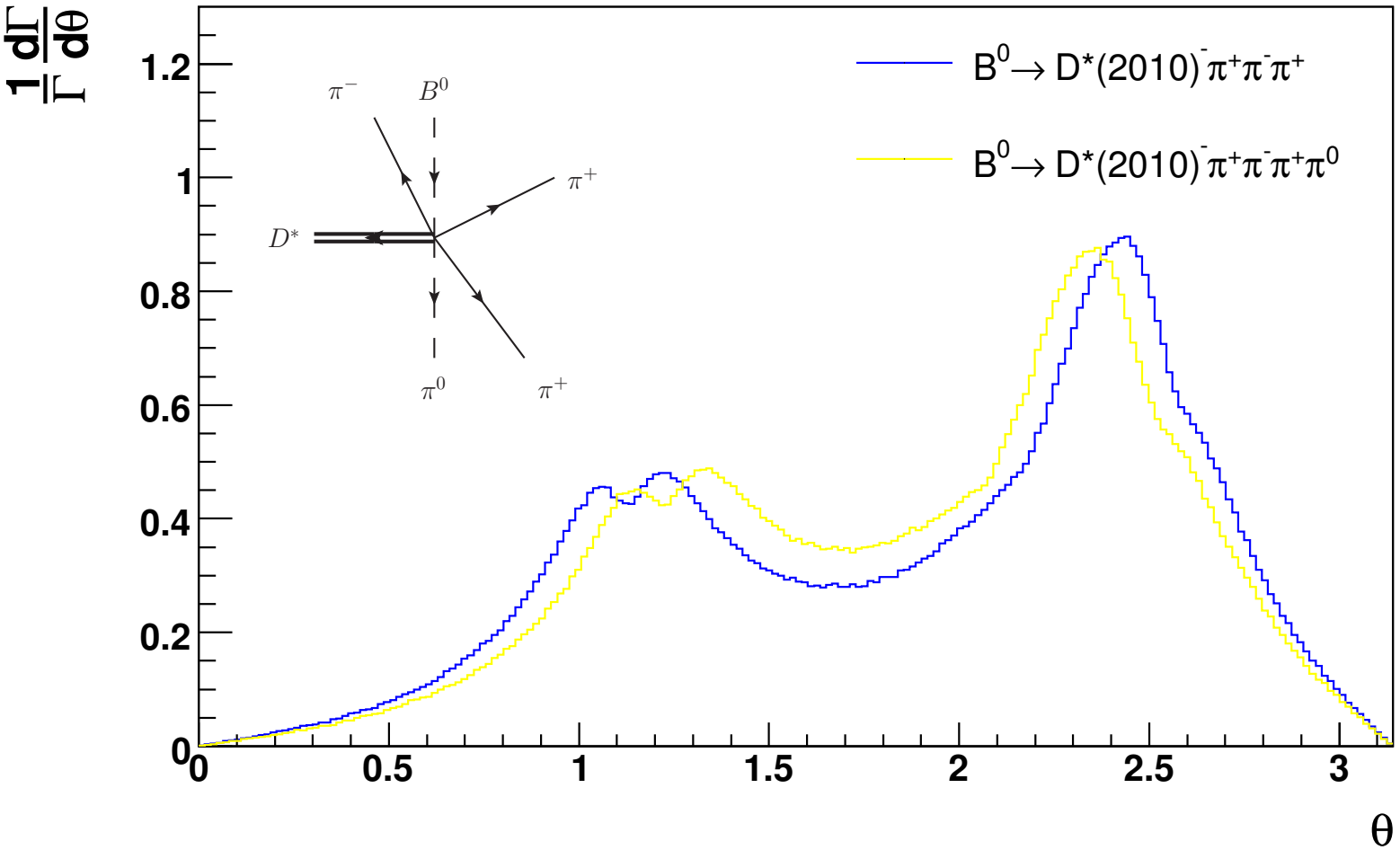

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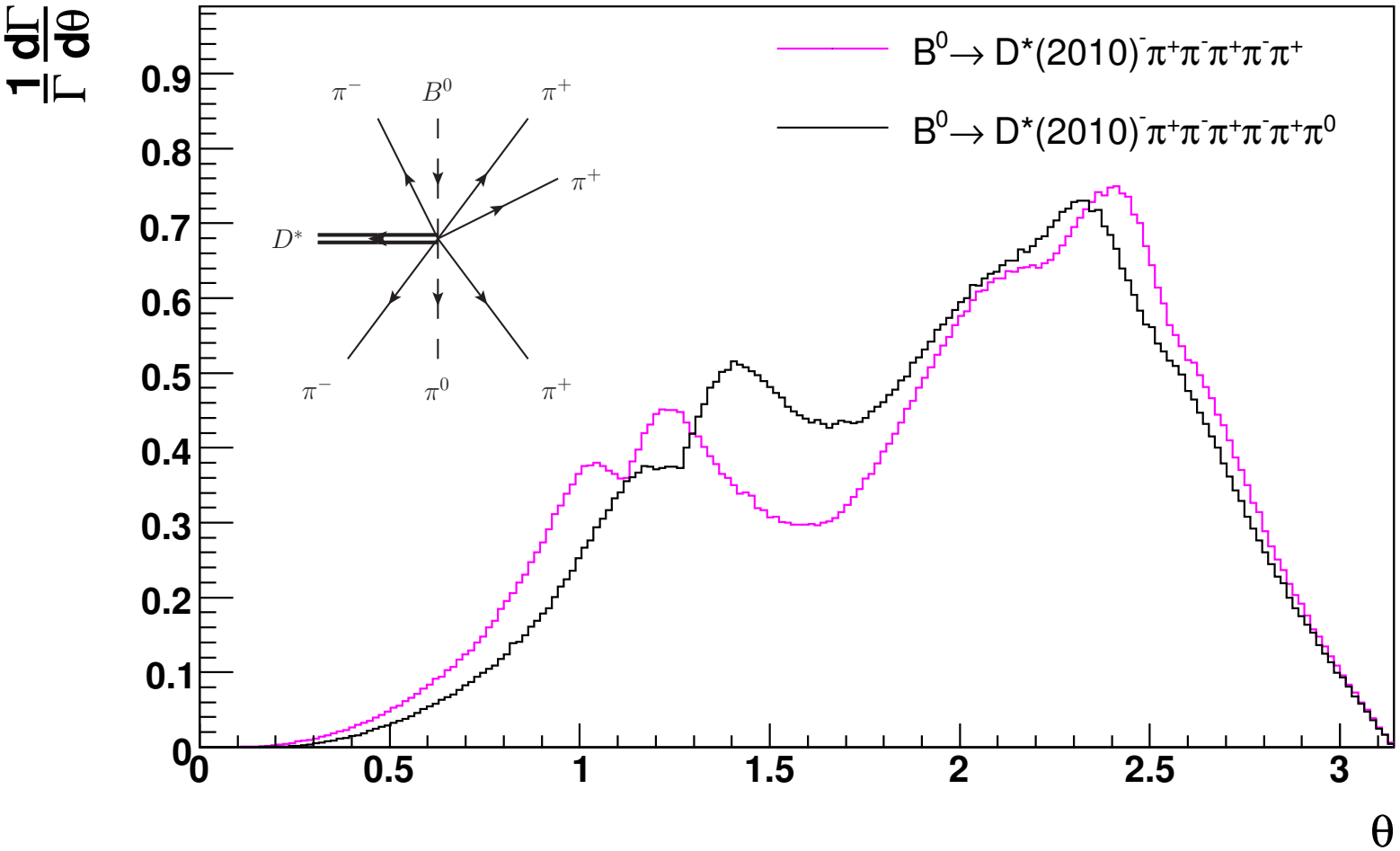

Conclusions

- QED dipole subtraction derived from QCD dipole subtraction
- QED dipole showers suffer from large number of "subleading" dipoles with negative sign
  $\rightarrow$ needed to get correct soft-photon coherence
- QED multipole radiation inherently positive definite (because physical pattern)

Thank you for your attention!