

Elastic form factor measurements at EIC using initial-state radiation

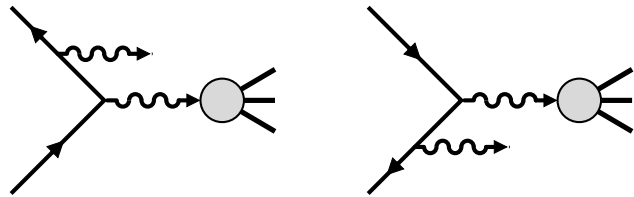
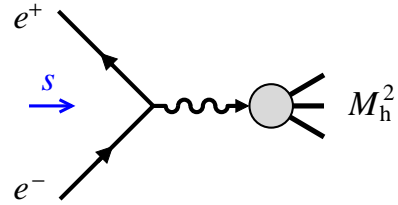
C. Weiss (JLab), EIC Yellow Report “Diffraction and Tagging” WG Meeting, 16-Apr-2020
Informal contribution, work in progress with Ch. Hyde

Idea: Use initial-state radiation (= hard photon emission by initial electron) to measure elastic ep/eA scattering at lower effective CM energies

- Used extensively in e^+e^- collisions
- Corresponds to Bethe-Heitler process accompanying DVCS
- Possible with photon detection in forward-electron direction
- Interesting applications, transition form factors

Initial-state radiation: e^+e^- annihilation

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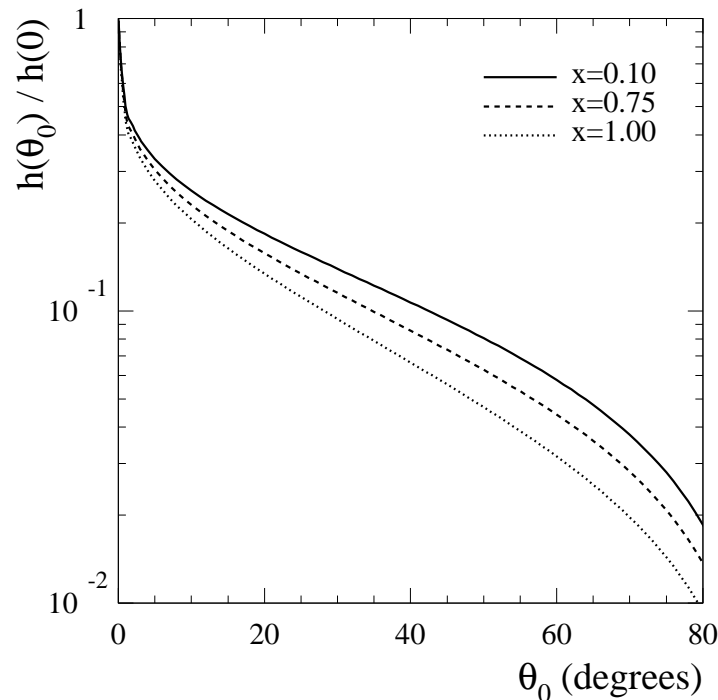
- Photon emission from e^+ or e^-

Lowers annihilation energy $M_h^2 < s$

$$x = E_\gamma / E_{e^\pm} \quad [\text{CM frame}]$$

Small-angle emission favored,
but large-angle tail present

[Baier, Khoze 1965](#); [Bonneau, Martin 1971](#)



- Used at e^+e^- facilities

PEP-II/BABAR, KEK-B/Belle, DAΦNE/KLOE

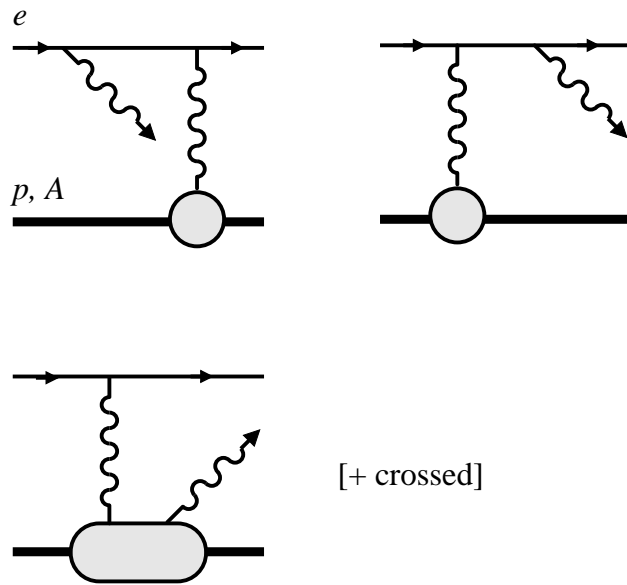
Tagged or untagged photons

Many results: Exclusive annihilation,
timelike form factors, spectroscopy

Review: [Druzhinin, Eidelman, Serednyakov, Solodov](#); [arXiv:1105.4975](#)

Initial-state radiation: ep/eA scattering

- Measurement $e + p \rightarrow e' + \gamma + p$



Bethe-Heitler and DVCS amplitudes

Select small-angle emission from initial electron, hard photons with $E_\gamma/E_e = O(1)$

Use as “elastic scattering at lower energies”?
Typical momentum transfer: Proton $\Delta_T \lesssim 1$ GeV,
light nuclei $\Delta_T \lesssim$ few 100 MeV

- Two options

Photon detection [$\gtrsim 15$ x rms angular spread of e beam]

Inclusive ISR using constrained kinematics

- Questions to be studied by simulations

Acceptance for small-angle photons?

Corrections from DVCS: Suppress by kinematics, correct by theory/models?

Event reconstruction: Exclusivity, resolution

→ common with DVCS studies

Counting rates?

→ common with DVCS studies

Initial-state radiation: ep/eA scattering

- QED processes in MC generator

Need to keep finite electron mass $m_e \neq 0$ in QED processes for small-angle emission

Implementation in progress: Ch. Hyde

- Potential applications

Elastic form factors of nucleon and light nuclei

Transition form factors $N \rightarrow N^* \rightarrow N\pi, N\pi\pi, \Lambda K$ etc.
Also needed for transition GPDs $N \rightarrow N^*$

Calibration measurement: Simple process

Complementary to DVCS: Same final state, different kinematics

Summary: For elastic ep/eA scattering at EIC we should seriously consider the initial-state radiation = Bethe-Heitler process, which is already being studied in connection with DVCS