University of Illinois at Urbana-Champaign

Degree of Doctor of Physics

Drell-Yan at COMPASS rocks it!

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To whom it may concern

Abstract

Dear Barbara Badelek, hereafter my abstract

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Chapter 1

Measurement of the Left Right Asymmetry in the Drell-Yan Process

Introduction about L/R asym. In this Chapter.... Define AN

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1.2.1 Geometric Mean

The number of physics counts, N, detected from any particular target with any polarization can be written as

$$\mathrm{N} = \mathrm{L} * \sigma * \mathrm{a}, \tag{1.1}$$

where L is the luminosity, σ is the cross-section to produce such an event and a is the acceptance. In simple words, the number of counts detected is the number of chances for an event to occur times the probability for an event to occur and that the event will be detected. To get spin-dependent counts for the left, right asymmetry, the target, polarization and left or right direction relative to the spin should be included in the counts formula. Generically this can be written

$$\mathrm{N}^{\uparrow(\downarrow)}_{\mathrm{target,Left(Right)}} = \mathrm{a}^{\uparrow(\downarrow)}_{\mathrm{target,spectrometer\ direction}} * \mathrm{L}^{\uparrow(\downarrow)}_{\mathrm{target}} * \sigma_{\mathrm{Left(Right)}}, \tag{1.2}$$

where $^{\uparrow(\downarrow)}$ denotes the target polarization, $_{\mathrm{target}}$ is either the upstream or downstream target $_{\mathrm{Left(Right)}}$ is left or right of the spin direction and $_{\mathrm{spectrometer\ direction}}$ denotes which side of the spectrometer the event was detected on.

The previous definitions of the detected counts all depend on the spectrometer acceptance. This is a problem because the spectrometer acceptance can change with time and space and therefore can be dependent on the physical kinematics which produced the event. Such dependences can cause unphysical false asymmetries in the measurement of $\mathrm{A_N}$ and must therefore be removed or must included as systematic effects.

The geometric mean asymmetry method is a way to determine the left, right asymmetry without acceptance effects from the spectrometer. It is defined as

$$\frac{1}{\mathrm{P}}\frac{\sqrt{N^{\uparrow}_{\text{target,Left}}N^{\downarrow}_{\text{target,Left}}}-\sqrt{N^{\uparrow}_{\text{target,Right}}N^{\downarrow}_{\text{target,Right}}}}{\sqrt{N^{\uparrow}_{\text{target,Left}}N^{\downarrow}_{\text{target,Left}}}+\sqrt{N^{\uparrow}_{\text{target,Right}}N^{\downarrow}_{\text{target,Right}}}}, \tag{1.3}$$

where P represents the fraction of polarized partons. Using Eq. 1.2 for the definition of counts, the geometric mean asymmetry is

$$\frac{1}{\mathrm{P}}\frac{\kappa\sqrt{\sigma_{Left}\sigma_{Left}}-\sqrt{\sigma_{Right}\sigma_{Right}}}{\kappa\sqrt{\sigma_{Left}\sigma_{Left}}+\sqrt{\sigma_{Right}\sigma_{Right}}}, \tag{1.4}$$

where κ is a ratio of acceptances defined as

$$\frac{\sqrt{\mathrm{a}^{\uparrow}_{\text{target,Jura}}\mathrm{a}^{\downarrow}_{\text{target,Saleve}}}}{\sqrt{\mathrm{a}^{\uparrow}_{\text{target,Saleve}}\mathrm{a}^{\downarrow}_{\text{target,Jura}}}}. \tag{1.5}$$

Here the detection side of spectrometer is specified by looking down the beam line as either Jura to mean left or Saleve to mean right. These relations of Jura is left and Saleve is right are only strictly true if in the target frame the polarization is pointing straight up or straight down. In particular if the beam particle and the target polarization do not make a right angle in the laboratory frame this relation will no longer be strictly true but is an approximation for ease of notation.

Relation 1.5 is equal to $\mathrm{A_N}$ if κ is equal to one. However time effects can vary κ from unity. These effects are estimated through false asymmetry analysis and included in the systematics. Equation 1.3 is therefore to a good approximation an acceptance free method to determine A_N. It is also defined for the upstream and downstream targets independently and therefore can used as a consistency check between the two targets.

1.3 Systematic Studies

1.4 Results

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Chapter 2

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