PROCEEDINGS OF SCIENCE DESY-13-113

Talk ? 7 pages
DESY Report
Not Linked, but ~sstor/1306.6060.ps.gz copied to ~fpp/desy/2013/desy13-113.ps.gz

DESY 13-113

arXiv:1306.6060v1 [hep-ph] 25 Jun 2013

From form factors to generalized parton distributions

Markus DIEHL*
Deutsches Elektronen-Synchroton DESY, 22603 Hamburg, Germany
E-mail: markus.diehl@desy.de

I present an extraction of generalized parton distributions from selected data on the electromagnetic nucleon form factors. The extracted distributions can in particular be used to quantify the contribution to the proton spin from the total angular momentum carried by valence quarks, as well as their transverse spatial distribution inside the proton.

XXI International Workshop on Deep-Inelastic Scattering and Related Subjects-DIS2013,
22-26 April 2013
Marseilles,France

*Speaker.

© Copyright owned by the author(s) under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike Licence.

1306.6060 hep-ph

1. Introduction

Generalized parton distributions (GPDs) contain unique information about the structure of the proton. Most prominently, they quantify the transverse spatial distributions of partons in correlation with their longitudinal momentum [1, 2]. Specific GPDs provide access to the angular momentum carried by partons, as becomes manifest from Ji's sum rule [3] and from spin-orbit correlations such as the change of the spatial parton distribution induced by transverse proton polarization [1].

Sum rules connect the GPDs for unpolarized quarks with the electromagnetic nucleon form factors according to

$$F_1^q(t) = \int_0^1 dx\, H_v^q(x,t)\,, \qquad\qquad F_2^q(t) = \int_0^1 dx\, E_v^q(x,t)\,, \tag{1.1}$$

where we introduced the valence (quark minus antiquark) combinations

$$H_v^q(x,t) = H^q(x,0,t) + H^q(-x,0,t)\,, \qquad E_v^q(x,t) = E^q(x,0,t) + E^q(-x,0,t) \tag{1.2}$$

of the conventional GPDs $H^q(x,\xi,t)$ and $E^q(x,\xi,t)$ defined in [3]. The Dirac and Pauli form factors of the proton are given by charge weighted sums $F_i^p(t) = \sum_q e_q F_i^q(t)$ with $i = 1,2$, and corresponding expressions for the neutron form factors are obtained using isospin symmetry. A Fourier transform to transverse position space turns H_v^q into the probability density for finding a quark with flavor q, longitudinal momentum fraction x and transverse position $\mathbf{b}$ in a proton, minus the corresponding probability density for antiquarks.

This contribution presents the work in ref. [4], where GPDs are determined from nucleon form factor data via the sum rules (1.1). In several ways, such a study is complementary to GPD extractions from hard exclusive processes like deeply virtual Compton scattering or meson production [5]. (i) Form factor data extend to large values of $-t$, much beyond what can ever be reached in hard exclusive processes. (ii) The integrals in (1.1) are sensitive to a wide range of x, from about 10^{-3} to 0.6 and higher in our analysis. (iii) The sum rules (1.1) can be written in terms of GPDs at zero skewness ξ, which after Fourier transform admit a probability interpretation and obey much simpler positivity bounds than their counterparts with $\xi \neq 0$. (iv) On the downside, it is impossible to uniquely reconstruct the x and t dependence of GPDs from (1.1), which leaves us with an irreducible model dependence due to the functional forms assumed for $H_v^q(x,t)$ and $E_v^q(x,t)$.

2. Form factor data

For our analysis we have made a selection from the available data on electromagnetic form factors. The magnetic proton from factor $G_M^p(t)$ offers the largest reach in t, up to $-t \simeq 31$ GeV^2. With experimental uncertainties of only a few % at small to intermediate t, quantitative control of two-photon exchange in the elastic ep cross section is essential for a reliable determination of this quantity. We use the data extracted in the global analysis of [6] and checked that it is compatible with the results of other recent work.

The scaled ratio $R^p = \mu_p G_E^p / G_M^p$ of electric and magnetic form factors can be extracted from elastic ep scattering data where either the polarization of the recoil proton is measured or the proton target is polarized. As is evident from figure 1, recoil polarization data from JLab Hall A published