RBRC workshop on Generalized Parton Distributions for nucleon tomography in the EIC era

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A three-day RBRC workshop titled "Generalized parton distributions for nucleon tomography in the EIC era" was held in the large seminar room of the physics department, Brookhaven National Laboratory during January 17–19, 2024. This is the first RBRC workshop on this topic related to the physics of the Electron-Ion Collider (EIC). The workshop was led by five organizers including three (S. Bhattacharya, Y. Hatta, R. Sufian) from RBRC. There were 46 participants mostly from the United States. About 10 participants were from Europe and Asia. 26 scientific talks were given including a few remote talks. The full list of participants and the agenda of the workshop can be found at `https://www.bnl.gov/gpdworkshop/index.php`.

The generalized parton distributions (GPDs) $f(x, \Delta_\perp)$ are the three-dimensional generalizations of the ordinary parton distribution functions $f(x)$ that include the dependence on the momentum transfer $\Delta_\perp$. Upon performing two-dimensional Fourier transform $\Delta_\perp \to b_\perp$, one gains access to the distribution of partons in impact parameter space $b_\perp$. Moreover, by computing the x-moments of GPDs, one recovers the electromagnetic form factors $\langle p'|J^\mu_{em}|p\rangle$ and the gravitational form factors (GFFs) $\langle p'|T^{\mu\nu}|p\rangle$ where $T^{\mu\nu}$ is the QCD energy momentum tensor. They can thus be interpreted as form factors at the partonic level. Recently there has been significant interest in the GFFs in the hadron structure community. Accordingly, the physics of GPDs has gained further momentum. Together with the transverse momentum dependent PDF $f(x, k_\perp)$, GPDs are the main objects of interest at the future EIC experiment that can unravel the multi-dimensional structure of partons inside the nucleon and nuclei.

At the workshop, many interesting recent developments in GPDs were presented. Here are selected highlights.

- Global analysis: The opening talk was given by Ji who is one of the founders of the GPD sciences. He presented a novel global analysis framework for GPD extraction based on the efficient parametrization of the conformal moments of GPDs. A practical application of this was presented by Santiago. Passek presented the extraction of GPDs from a NLO global analysis of Deeply Virtual Compton Scattering and meson production data. This is the first fully NLO extraction with the NLO GPD evolution.
- Gravitational form factors: Tanaka presented a high-precision determination of the $\bar{C}$ GFF based on perturbative QCD at four-loops. Pasquini talked about the determination of the so-called D-term, one of the GFFs of the nucleon, using the dispersion relation. Hackett presented a precise determination of the nucleon GFFs from lattice QCD. Guo presented the extraction of the gluon GFF of the nucleon from the recent experimental data on J/ψ photo-production near the threshold at Jefferson Laboratory.
- GPD from lattice QCD: Zhang discussed the LaMET framework to compute GPDs using lattice QCD. He presented the 'matching coefficients' needed to extract the GPDs in Mikowski space from Euclidean correlators calculated on the lattice. Schoenleber presented the renormalon problem in the higher order computation of the matching coefficients. Constantinou and Shi presented the actual numerical results on GPDs calculated in lattice QCD using this framework.
- New experimental observables: Yu discussed novel $2 \to 3$ exclusive processes. He has proven QCD factorization of these processes in terms of GPDs. Wagner computed the double DVCS whether the outgoing photon is timelike virtual. The cross section is small, but may be measurable at high-luminosity JLab experiments.
- Experimental talks: There were two talks given by experimentalists. Aschenauer gave an overview of the EIC from experimental perspective and prospects to measure GPDs. Jentsch gave a more focused talk on exclusive processes related to GPDs. He emphasized the possibility to use deuterons as the target.

All the talks were well attended and there were many questions asked at the end of each talk and discussions followed over coffee breaks. Overall the workshop was a successful one, adding another nice example to the list of excellent RBRC workshops in the past 25 years.

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