

Wigner 121

Scientific Symposium

Wigner Research Centre for Physics
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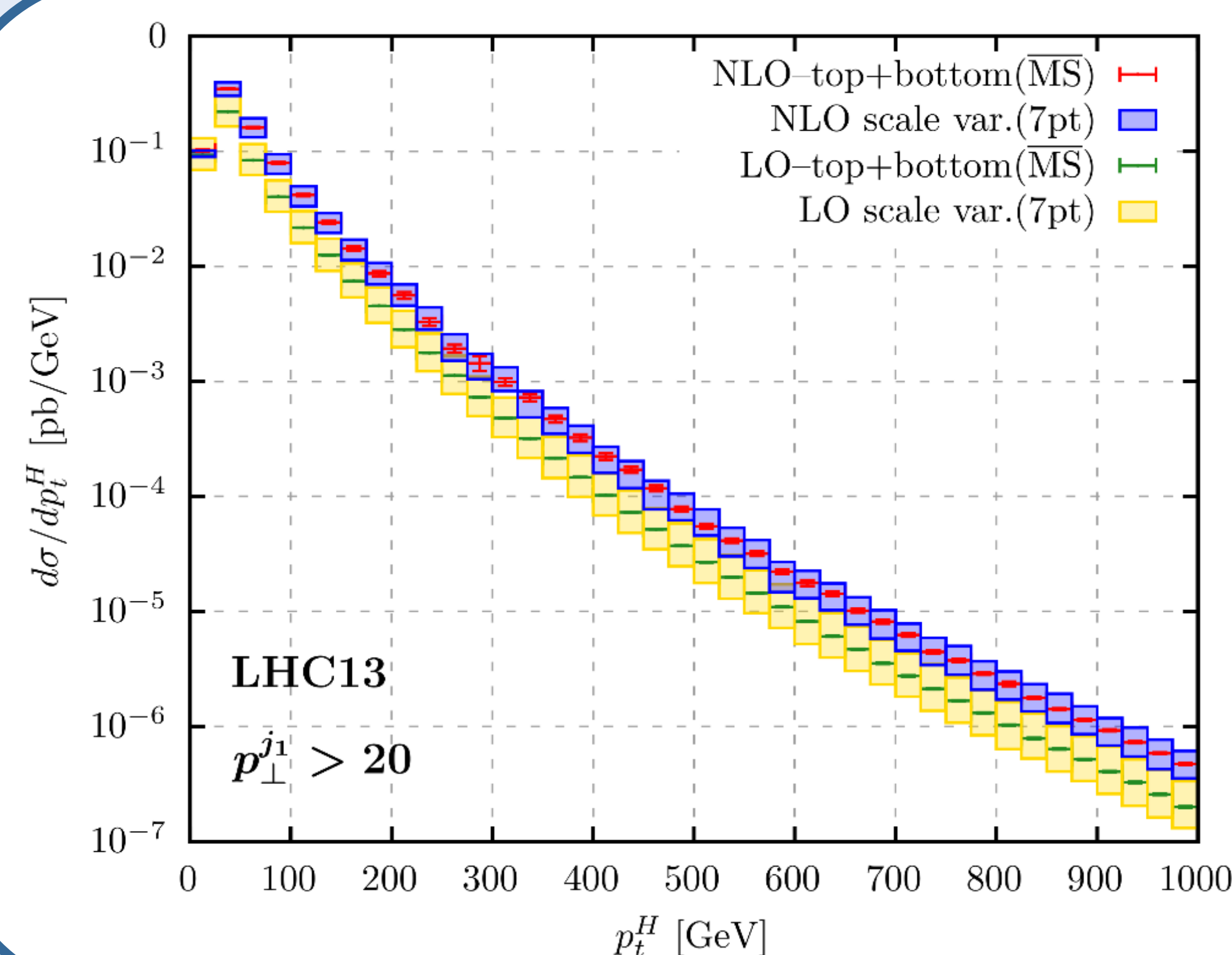
The geometry of 3-space from quantum mechanics

In [1], a simple, elementary proof of Penrose's Spin Geometry Theorem was given, viz. that the conformal structure of the Euclidean 3-space is determined by SU(2)-invariant elementary quantum mechanical systems. In [2], this result was extended to E(3)-invariant system: the metric (and not only the conformal) structure is also determined by such elementary quantum mechanical systems. In [3], a new quantum mechanical phenomenon was found: the 'most classical' states of the SU(2)-invariant systems must be 'double valued' on the classical parameter space, i.e. the genuine parameter space of these states is the Riemann surface which is a double cover of the classical one. In [4], it was clarified how the analogous states of E(3)-invariant system are related to the well known coherent states of the Heisenberg systems.

Bi-Hamiltonian structures of integrable many-body models

Integrable dynamical systems often admit alternative formulations, where two different Hamiltonians generate the same dynamics via two compatible Poisson brackets. We discovered the bi-Hamiltonian structure of an integrable model describing an arbitrary number of mass points moving on the circle, in which the coupling parameters depend on two spin variables interacting with each other and with the particles. To do this, the model was derived by symmetry reduction of a free particle moving on the complex general linear group GL(n,C) [5]. Our method also led to a new group theoretic interpretation of the bi-Hamiltonian structure of the Toda molecule [6]. More recently, we explored a general class of Hamiltonian reductions of master integrable systems on doubles of compact Lie groups [7].

NLO QCD Corrections to Higgs + Jet Production at the LHC



The transverse momentum (pT) distribution of Higgs bosons created in proton-proton collisions is a flagship observable of the LHC physics program. Hence, its accurate theoretical description is of paramount importance. In [8], we have computed the next-to-leading-order (NLO) QCD corrections to the Higgs pT distribution in Higgs production in association with a jet via gluon fusion at the LHC, with exact dependence on the mass of the quark circulating in the heavy-quark loops. The NLO corrections were presented including the top-quark mass, and for the first time, the bottom-quark mass as well. Further, besides the on-shell mass scheme, we considered for the first time a running mass renormalisation scheme.

Energy-momentum tensor of linearized gravity

Finding a satisfactory definition of the energy and momentum of the gravitational field is one of the fundamental problems of the theory of gravitation. For the linearized gravitational field in Minkowski background we found an energy-momentum tensor (T_{lg}) that appears to be satisfactory, considering its properties [9]. Most notably, T_{lg} is traceless, and in the transverse traceless gauge it is also symmetric, duality symmetric, and satisfies the dominant energy condition.

Publications of the group

- [1] L. B. Szabados, *A note on Penrose's Spin-Geometry Theorem and the geometry of 'empirical quantum angles'*, Foundations of Physics 52, 96 (2022)
- [2] L. B. Szabados, *Three-space from quantum mechanics*, Foundations of Physics 52, 102 (2022)
- [3] L. B. Szabados, *An odd feature of the 'most classical' states of SU(2)-invariant quantum mechanical systems*, J. Math. Phys. 64, 032104 (2023)
- [4] L. B. Szabados, *The 'most classical' states of Euclidean invariant elementary quantum mechanical systems*, J. Math. Phys. 64, 032103 (2023)
- [5] L. Fehér, *Bi-Hamiltonian structure of Sutherland models coupled to two $u(n)^*$ -valued spins from Poisson reduction*, Nonlinearity 35, 2971 (2022)
- [6] L. Fehér, B. Juhász, *A note on quadratic Poisson brackets on $gl(n,R)$ related to Toda lattices*, Lett. Math. Phys. 112, 45 (2022)
- [7] L. Fehér, *Poisson reductions of master integrable systems on doubles of compact Lie groups*, Ann. Henri Poincaré 24, 1823 (2023)
- [8] R. Bonciani, V. Del Duca, H. Frellesvig, M. Hidding, V. Hirschi, F. Moriello, G. Salvatori, G. Somogyi and F. Tramontano, *Next-to-leading-order QCD corrections to Higgs production in association with a jet*, Phys. Lett. B 843 (2023), 137995.
- [9] G. Zs. Tóth, *Energy-momentum tensor and duality symmetry of linearized gravity in the Fierz formalism*, Classical and Quantum Gravity 39, 075003 (2022)

