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Regular Session:

Speaker: Luiz Agostinho Ferreira (Instituto de Física de São Carlos; IFSC/USP; Universidade de São Paulo, São Carlos-SP, Brazil)

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Title: *The hidden symmetries of Yang-Mills theory in $(3 + 1)$ -dimensions*¹

Abstract: We show that classical, non-supersymmetric, Yang-Mills theories coupled to spin-1/2 and spin-0 matter fields, in $(3 + 1)$ -dimensional Minkowski space-time, possess an exact integrability structure with an infinite number of conserved charges in involution. Such an integrability lives on the space of non-abelian electric and magnetic charges, and is based on flat connections in generalized loop spaces, presenting an R -matrix, and Sklyanin relation. We present two novel symmetries of Yang-Mills theories. The first one are global transformations generated by the infinity of conserved charges under the Poisson brackets. The gauge and matter fields, as well as Wilson lines and fluxes have interesting transformation laws under such a global symmetry. The second one corresponds to symmetries of the integral Yang-Mills equations, which lead to the conserved charges. They generate an infinite dimensional group, where the elements are holonomies of connections on the loop space. The conserved charges are gauge invariant, and so in the case of QCD they are color singlets, and perhaps are not confined. Therefore, the hadrons may carry such charges. Our results open up the way for the construction of non-perturbative methods for Yang-Mills theories.

¹L. A. Ferreira and H. Malavazzi, “The hidden symmetries of Yang-Mills theory in $(3 + 1)$ -dimensions,” Journal of High Energy Physics, JHEP **11**, 102 (2025) doi:10.1007/JHEP11(2025)102; [arXiv:2506.15832 [hep-th]]