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Open Problems Session:

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

Title: *Is there a dressing transformation method for Yang-Mills theory?*

Abstract: It has recently been shown that the dynamics of classical, non-supersymmetric, Yang-Mills theories coupled to spin-1/2 and spin-0 matter fields, in $(3 + 1)$ -dimensional Minkowski space-time M , is equivalent to the zero curvature condition¹

$$\delta\mathcal{A} + \mathcal{A} \wedge \mathcal{A} = 0$$

where \mathcal{A} is a one-form connection on the generalized loop space

$$\mathcal{L}^{(2)} = \{f : S^2 \rightarrow M \mid \text{north pole} \rightarrow x_R\}$$

It then follows that the Yang-Mills theories possess an infinite dimensional hidden symmetry group \widehat{G} , given by the gauge transformations

$$\mathcal{A} \rightarrow \widehat{g} \mathcal{A} \widehat{g}^{-1} + \delta\widehat{g} \widehat{g}^{-1}$$

where the group elements \widehat{g} are holonomies of one-form connections \mathfrak{a} on the loop space

$$\mathcal{L}^{(1)} = \{f : S^1 \rightarrow M \mid \text{north pole} \rightarrow x_R\}$$

The question is: Could we devise a Riemann-Hilbert like problem that could lead us to develop some sort of dressing transformation method for the construction of solutions of Yang-Mills theory?

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]]