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A New Formulation of Analytic, Non-Perturbative, Gauge-and Lorentz-Invariant QCD

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A simple and previously overlooked choice of one parameter allows the Schwinger/Symanzik Generating Functional of QCD to be re-written in a manifestly gauge-invariant fashion, without the need of Fadeev-Popov insertions. When combined with Fradkin functional representations for the Green's function, G[A], of a quark in an effective color potential A, and the vacuum loop functional L[A], all QCD correlation functions can be represented as Gaussian, functional-linkage operations connecting relevant combinations of G[A] and L[A]. And because the Fradkin representations for those functionals are Gaussian in their dependence on A, the functional-linkage operation can be done exactly, and one then sees that gauge invariance here is achieved by gauge-independence, as the gauge-dependent gluon propagators exactly cancel out everywhere. In this way, the non-perturbative sums over Feynman graphs reduce to an explicit, gauge-independent functional expression.

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That new, final functional expression now displays a new property we call ``Effective Locality'' (EL), in which

 It should be noted that such progress is possible because the Fradkin representations are Potential Theory con

 This work, by myself (HMF), French colleagues Grandou and Gabellini (of the Universite de Nice), and my ex-Brow
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Summary

This presentation describes a new, non-perturbative, gauge-invariant, analytic formulation of QCD. When the non-perturbative sums over all relevant Feynman graphs are performed (functionally), a new property called "Effective Locality" appears, which greatly simplifies all calculations, reducing a Halpern-type functional integral, as well as other functional integrals associated with color dependence, into a few sets of ordinary integrals, depending on the nature of the amplitude under consideration. A fundamental shift of viewpoint, requiring the original Lagrangian to contain "transverse imprecision" of the subsequently bound quarks, is then required, and is simple to initiate. Using this approach it is a simple matter to calculate quark binding potentials which produce pions and nucleons; and, for the first time ever, to generate nucleon-nucleon scattering and binding potentials, in effect obtaining Nuclear Physics from basic QCD.

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