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New analytic solution of (linearised) Balistky-Kovchegov equation

A typical scattering event in any collider experiments usually involve rapidly growing cascade of gluons. At high enough energy this cascade of gluons may occupy all the available final state phase space to such an extent that fusion of multiple gluons to single gluon begin to start. This could eventually develop a thermodynamical detail balance, with the usual multiple gluons produced from single gluon, which leads to the origin of gluon saturation with a characteristic momentum scale Q_s.

Balaistky-Kovchegov (BK) equation for S-matrix is the evolution equation that describe this pQCD evolution at small-x in the large N_c-limit. It describes the scattering of a dipole off a large nucleus in the high energy regime.
So far there is no exact full analytical solution to the BK equation.

In this study we have derived an exact analytical solution, for a linearised form of BK equation (linear in S-matrix), valid both within and outside the saturation region. Here we regulated the dipole integral by taking a dipole transverse-width dependent cutoff. We had also taken care of all the higher order terms which have been ignored earlier. The dipole-nucleus amplitude takes the following form,
$N = 1 - S_0 \exp\left(\frac{1+2i\nu_0}{2\chi(0,\nu_0)}\left[Li_2(-\lambda_1 x_{10}^2 Q_s^2(Y))\right]\right)$
where Li_2 is dilogarithm function and ${}_1(\ 7.22)$ is a parameter which is fixed by the definition of Q_s.

This new solution, containing a dilogarithmic function, reproduces both the Mclerran-Venugopalan initial conditions (Gaussian in scaling variable) and Levin-Tuchin solution (Gaussian in logarithm of scaling variable) in their appropriate limits. It also connects this two opposite limit smoothly with a better accuracy when compared to numerical solutions of full LO BK equation.

[1] Mariyah Siddiqah and Raktim Abir, "Solution of the linearized Balitsky-Kovchegov equation," Phys. Rev. D 95, no.7, 074035 (2017).

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