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Baryon Deceleration

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IN COLLABORATION WITH RAINER FRIES

The System

- Two nuclei collide at sufficiently close to the speed of light to be considered as color glass condensate.
- The initial field between the nuclei is taken to consist of only that between the color glass. They recoil into 3D space.
- This project tracks the back reaction of the field onto the nuclei.

$$\partial_\mu (T^{\mu\nu}) = -f^\nu$$

- There are seven variables to track: $\eta_L \, \eta_T \, M \, \theta \, \phi \, Y_L \, Y_T$
- This is done for Au+Au collisions at RHIC and LHC energies for various impact parameters.

[1] K. A. LYAKHOV, H. J. LEE, I. N. MISHUSTIN, PHYS. REV. C 84, 055202 (2011) DOI:10.1103/PHYSREVC.84.055202

Mechanics

$$\frac{d\eta_L}{d\tau} = \frac{\tanh\left(Y_L - \eta_L\right)}{\tau}$$

$$\frac{d\eta_T}{d\tau} = \frac{\operatorname{sech}\left(\eta_L\right)\cosh\left(Y_L\right)\cosh^2\left(\eta_T\right)\operatorname{sech}\left(Y_L - \eta_L\right)\left(\cos(\theta - \phi)\tanh\left(Y_T\right) - \tanh\left(\eta_T\right)\right)}{\tau}$$

$$\frac{dM}{d\tau} = \gamma\operatorname{sech}\left(Y_L - \eta_L\right)\Big(S_z\cosh\left(2Y_L\right)\operatorname{sech}\left(Y_L\right) - 2\epsilon_T\sinh\left(Y_L\right) + \tanh(Y_T)\big[\sinh\left(Y_L\right)\left(\cos(\theta)S_x + \sin(\theta)S_y\right) + \cosh\left(Y_L\right)\left(\cos(\theta)\sigma_{xz} + \sin(\theta)\sigma_{yz}\right)\big]\Big)$$

$$\frac{d\theta}{d\tau} = \frac{\coth(Y_T)}{M\gamma}\operatorname{sech}\left(Y_L - \eta_L\right)\left[\sinh\left(Y_L\right)\left(\sin(\theta)S_x - \cos(\theta)S_y\right) + \cosh\left(Y_L\right)\left(\sin(\theta)\sigma_{xz} - \cos(\theta)\sigma_{yz}\right)\right]$$

Mechanics

$$\frac{d\phi}{d\tau} = \frac{\sin(\theta-\phi)\operatorname{sech}(\eta_L)\cosh(Y_L)\coth(\eta_T)\tanh(Y_T)\operatorname{sech}(Y_L-\eta_L)}{\tau}$$

$$\frac{dY_L}{d\tau} = -\frac{\operatorname{sech}(Y_T)\operatorname{sech}(Y_L-\eta_L)}{2M}\sqrt{3+\cosh(2Y_L)-2\sinh^2(Y_L)\cosh(2Y_T)}\left(S_z\sinh(2Y_L)-\epsilon_T\cosh(2Y_L)+\epsilon_L\right)$$

$$\begin{aligned}\frac{dY_T}{d\tau} = &-\frac{1}{2M\gamma\left(1+\gamma^2\tanh^2(Y_T)\right)}\cosh^2(Y_T)\operatorname{sech}(Y_L-\eta_L)\Bigg(2\cos(\theta)\left(S_x\sinh(Y_L)+\sigma_{xz}\cosh(Y_L)\right)\\ &+2\sin(\theta)\left(S_y\sinh(Y_L)+\sigma_{yz}\cosh(Y_L)\right)-\gamma^3\operatorname{sech}^2(Y_L)\operatorname{sech}(Y_T)\sqrt{3+\cosh(2Y_L)-2\sinh^2(Y_L)\cosh(2Y_T)}\\ &\times\left(S_z\sinh(2Y_L)-\epsilon_T\cosh(2Y_L)+\epsilon_L\right)\tanh(Y_L)\tanh(Y_T)+2\gamma^2\tanh(Y_T)\Big(\cosh(2Y_L)\operatorname{sech}(Y_L)S_z\\ &-2\sinh(Y_L)\epsilon_T+\tanh(Y_T)\left(\sinh(Y_L)\left(\cos(\theta)S_x+\sin(\theta)S_y\right)+\cosh(Y_L)\left(\cos(\theta)\sigma_{xz}+\sin(\theta)\sigma_{yz}\right)\right)\Big)\Bigg)\end{aligned}$$

Field Equations

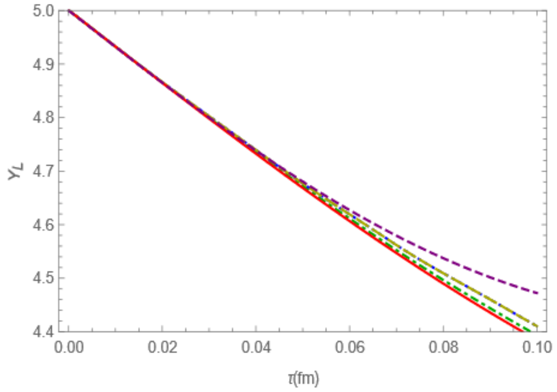
- Existing work [2] found non-Abelian series expansions and approximate Abelian solutions in momentum space for the components in the stress-energy tensor.

$$\epsilon_L(\tau) = \epsilon_{L0} J_0(Q_s\tau)^2$$
$$\sigma_{xz} = \sigma_{xz0}\cosh(\eta_L) J_0(Q_s\tau) J_1(Q_s\tau)$$
$$S_x = -\tanh(\eta_L)\sigma_{xz}$$
$$S_z = \tanh(2\eta_L)\epsilon_T$$

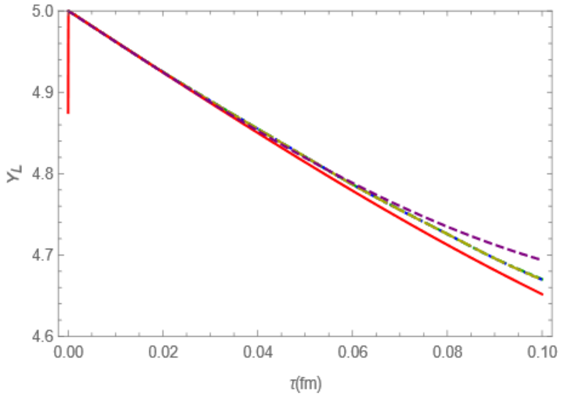
$$\epsilon_T(\tau) = \epsilon_{T0}\cosh(2\eta_L) J_1(Q_s\tau)^2$$
$$\sigma_{yz} = \sigma_{yz0}\cosh(\eta_L) J_0(Q_s\tau) J_1(Q_s\tau)$$
$$S_y = -\tanh(\eta_L)\sigma_{yz}$$

Y_L Plots

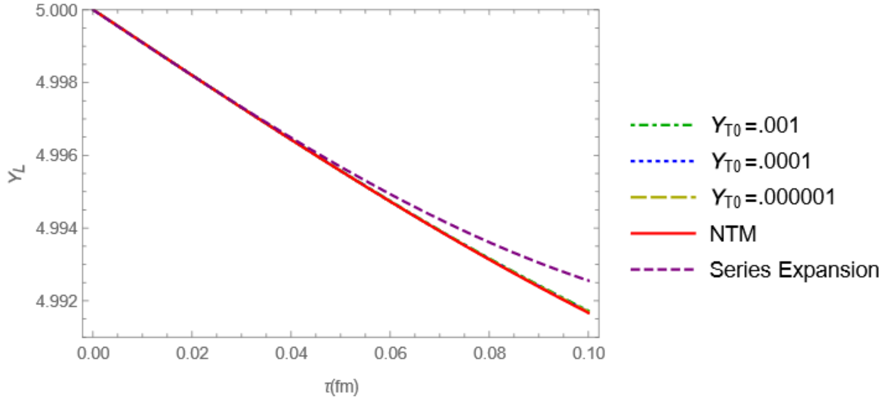
RHIC



(a) $bb = 0fm$

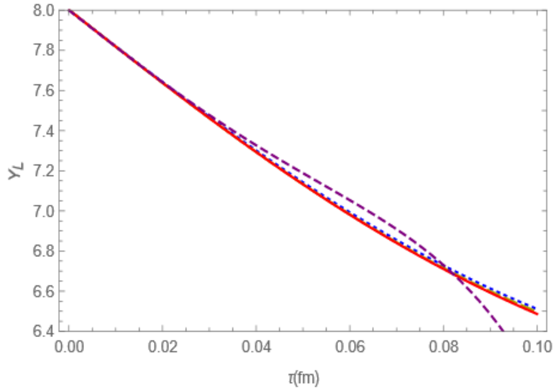


(b) $bb = 5fm$

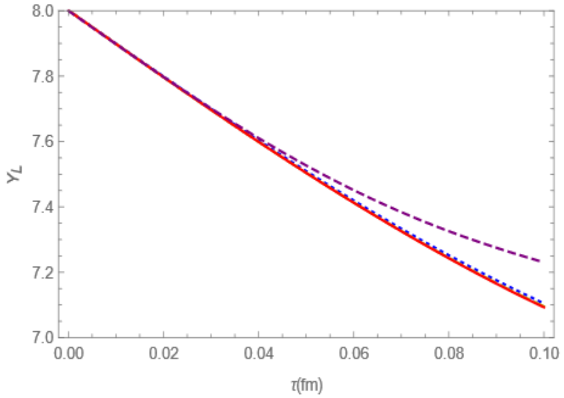


(c) $bb = 12fm$

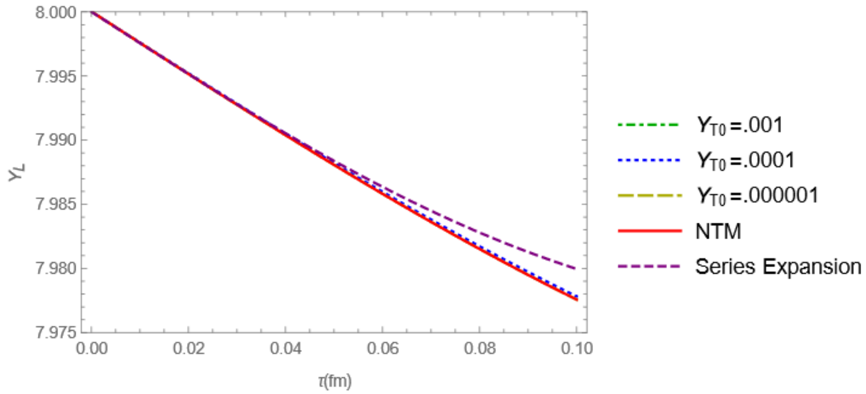
LHC



(a) $bb = 0fm$



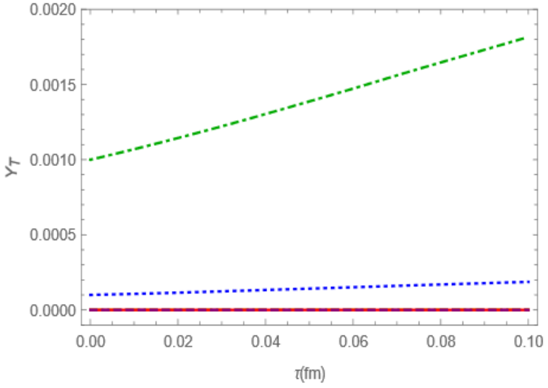
(b) $bb = 5fm$



(c) $bb = 12fm$

Y_T Plots

RHIC



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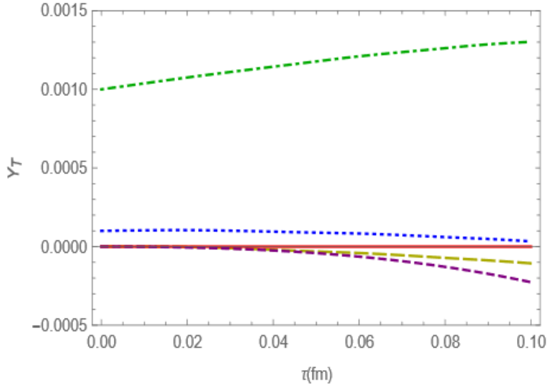
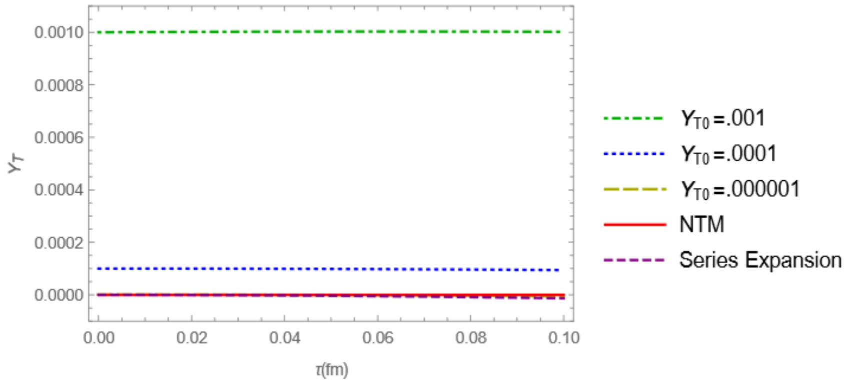


(b) $bb = 5fm$



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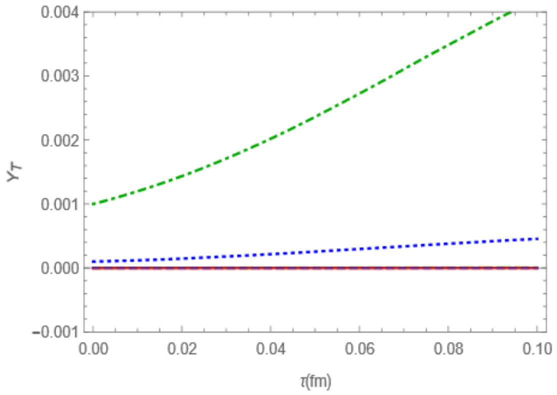
LHC



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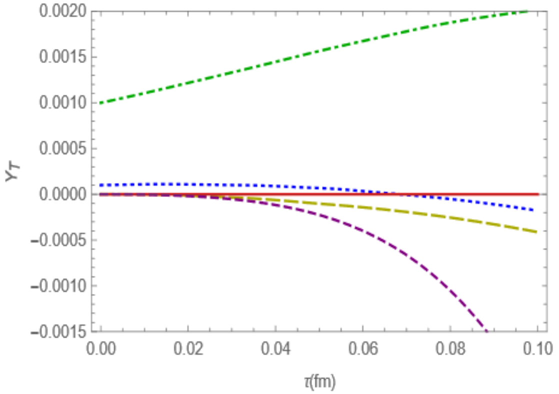

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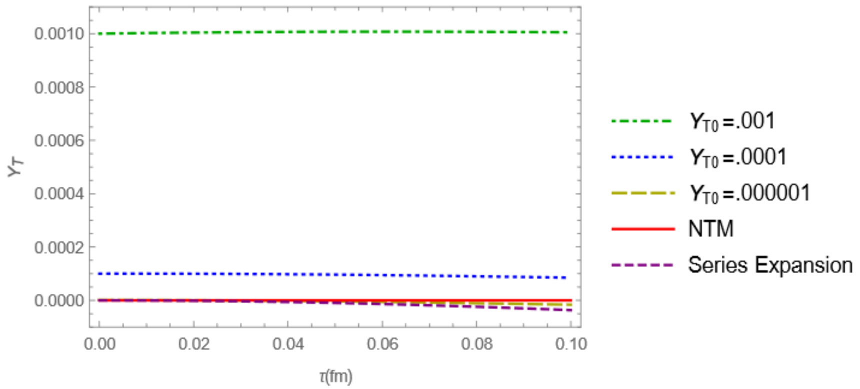

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