

## General Gauge:

$$\eta^{\alpha\beta} \partial_\alpha h_{\beta\gamma} = \frac{J}{\Omega} \eta^{\alpha\beta} h_{\gamma\alpha} \frac{\partial_\beta \Omega}{\Omega} + P \Omega^2 \partial_\gamma h + R h \Omega \partial_\gamma \Omega$$

## Ricci Tensor, $\Omega = 1/Ht$

No gauge usage. Has  $h_{0i}$  and other terms present

$$\begin{aligned} \eta^{\mu\nu} \delta R_{\mu\nu} = & -2 H^2 h_{11} - 2 H^2 h_{22} - 2 H^2 h_{33} + \frac{2 \partial_0 h}{t} - \frac{\partial_0 \partial_0 h}{2} + \frac{\partial_1 \partial_1 h}{2} + \frac{\partial_2 \partial_2 h}{2} + \\ & t \left( 3 H^2 \partial_0 h_{00} - H^2 \partial_0 h_{11} - H^2 \partial_0 h_{22} - H^2 \partial_0 h_{33} - 2 H^2 \partial_1 h_{01} - 2 H^2 \partial_2 h_{02} - 2 H^2 \partial_3 h_{03} \right) + \\ & t^2 \left( -\frac{1}{2} H^2 \partial_0 \partial_0 h_{00} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{11} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{22} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{33} + H^2 \partial_0 \partial_1 h_{01} + \right. \\ & H^2 \partial_0 \partial_2 h_{02} + H^2 \partial_0 \partial_3 h_{03} + H^2 \partial_1 \partial_0 h_{01} - \frac{1}{2} H^2 \partial_1 \partial_1 h_{00} - \frac{1}{2} H^2 \partial_1 \partial_1 h_{11} + \frac{1}{2} H^2 \partial_1 \partial_1 h_{22} + \\ & \frac{1}{2} H^2 \partial_1 \partial_1 h_{33} - H^2 \partial_1 \partial_2 h_{12} - H^2 \partial_1 \partial_3 h_{13} + H^2 \partial_2 \partial_0 h_{02} - H^2 \partial_2 \partial_1 h_{12} - \frac{1}{2} H^2 \partial_2 \partial_2 h_{00} + \\ & \frac{1}{2} H^2 \partial_2 \partial_2 h_{11} - \frac{1}{2} H^2 \partial_2 \partial_2 h_{22} + \frac{1}{2} H^2 \partial_2 \partial_2 h_{33} - H^2 \partial_2 \partial_3 h_{23} + H^2 \partial_3 \partial_0 h_{03} - H^2 \partial_3 \partial_1 h_{13} - \\ & \left. H^2 \partial_3 \partial_2 h_{23} - \frac{1}{2} H^2 \partial_3 \partial_3 h_{00} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{11} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{22} - \frac{1}{2} H^2 \partial_3 \partial_3 h_{33} \right) + \frac{\partial_3 \partial_3 h}{2} \end{aligned}$$

General Gauge

$$\begin{aligned} \eta^{\mu\nu} \delta R_{\mu\nu} = & H^2 J h_{00} - 2 H^2 h_{11} - 2 H^2 h_{22} - 2 H^2 h_{33} + \frac{4 J h + 2 R h}{t^2} + \frac{2 \partial_0 h - P \partial_0 h - R \partial_0 h}{t} - \\ & \frac{\partial_0 \partial_0 h}{2} + P \partial_0 \partial_0 h + \frac{\partial_1 \partial_1 h}{2} - P \partial_1 \partial_1 h + \frac{\partial_2 \partial_2 h}{2} - P \partial_2 \partial_2 h + t \left( H^2 \partial_0 h_{00} + H^2 J \partial_0 h_{00} - \right. \\ & H^2 \partial_0 h_{11} - H^2 \partial_0 h_{22} - H^2 \partial_0 h_{33} - H^2 J \partial_1 h_{01} - H^2 J \partial_2 h_{02} - H^2 J \partial_3 h_{03} \left. \right) + \\ & t^2 \left( \frac{1}{2} H^2 \partial_0 \partial_0 h_{00} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{11} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{22} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{33} - \frac{1}{2} H^2 \partial_1 \partial_1 h_{00} + \frac{1}{2} H^2 \partial_1 \partial_1 h_{11} + \right. \\ & \frac{1}{2} H^2 \partial_1 \partial_1 h_{22} + \frac{1}{2} H^2 \partial_1 \partial_1 h_{33} - \frac{1}{2} H^2 \partial_2 \partial_2 h_{00} + \frac{1}{2} H^2 \partial_2 \partial_2 h_{11} + \frac{1}{2} H^2 \partial_2 \partial_2 h_{22} + \frac{1}{2} H^2 \partial_2 \partial_2 h_{33} - \\ & \left. \frac{1}{2} H^2 \partial_3 \partial_3 h_{00} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{11} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{22} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{33} \right) + \frac{\partial_3 \partial_3 h}{2} - P \partial_3 \partial_3 h \end{aligned}$$

We see that we need  $J=0$ , so then we have

$$\begin{aligned} \eta^{\mu\nu} \delta R_{\mu\nu} = & -2 H^2 h_{11} - 2 H^2 h_{22} - 2 H^2 h_{33} + \frac{2 R h}{t^2} + t \left( H^2 \partial_0 h_{00} - H^2 \partial_0 h_{11} - H^2 \partial_0 h_{22} - H^2 \partial_0 h_{33} \right) + \\ & \frac{2 \partial_0 h - P \partial_0 h - R \partial_0 h}{t} - \frac{\partial_0 \partial_0 h}{2} + P \partial_0 \partial_0 h + \frac{\partial_1 \partial_1 h}{2} - P \partial_1 \partial_1 h + \frac{\partial_2 \partial_2 h}{2} - P \partial_2 \partial_2 h + \\ & t^2 \left( \frac{1}{2} H^2 \partial_0 \partial_0 h_{00} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{11} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{22} - \frac{1}{2} H^2 \partial_0 \partial_0 h_{33} - \frac{1}{2} H^2 \partial_1 \partial_1 h_{00} + \frac{1}{2} H^2 \partial_1 \partial_1 h_{11} + \right. \\ & \frac{1}{2} H^2 \partial_1 \partial_1 h_{22} + \frac{1}{2} H^2 \partial_1 \partial_1 h_{33} - \frac{1}{2} H^2 \partial_2 \partial_2 h_{00} + \frac{1}{2} H^2 \partial_2 \partial_2 h_{11} + \frac{1}{2} H^2 \partial_2 \partial_2 h_{22} + \frac{1}{2} H^2 \partial_2 \partial_2 h_{33} - \\ & \left. \frac{1}{2} H^2 \partial_3 \partial_3 h_{00} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{11} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{22} + \frac{1}{2} H^2 \partial_3 \partial_3 h_{33} \right) + \frac{\partial_3 \partial_3 h}{2} - P \partial_3 \partial_3 h \end{aligned}$$

This is equivalent to

$$\eta^{\mu\nu} \delta R_{\mu\nu} =$$

$$-2 H^2 h_{11} - 2 H^2 h_{22} - 2 H^2 h_{33} + \left( \frac{1}{2} - P \right) \Box h + \frac{1}{2} H^2 \Box h t^2 + \frac{2 R h}{t^2} + H^2 t \partial_t h + \frac{2 \partial_t h - P \partial_t h - R \partial_t h}{t}$$

No choice of P or R can yield  $\eta^{\mu\nu} \delta R_{\mu\nu}$  in terms of h entirely.