# Addendum to `The axial gauge for gravity'



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**ADDENDUM**

# Addendum to 'The axial gauge for gravity'

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In a recent preprint Capper and Leibbrandt (1981) point to a discrepancy between their work and mine (Delbourgo 1981). While we agree that the graviton self-energy possesses $n$-dependent infinite parts they prove that it is not transversal, contrary to what Matsuki (1979) stated and what I purported to confirm in my Letter. The disagreement has prompted me to re-examine my calculations and search for a possible error. This I have now located and thus I now agree completely with Capper and Leibbrandt's answers, even though I use the multiplier representation

$$\delta(n \cdot h) = \int \mathrm{d}b \exp(\mathrm{i}bn \cdot h)$$

instead of their quadratic representation

$$\delta(n \cdot h) = \lim_{\alpha \to 0} \exp[\mathrm{i}(n \cdot h)^2/\alpha].$$

The argument up to and including (7′) in my Letter has no errors. However, whereas (7′) does trivially lead to a transverse $\Pi$ in Yang–Mills theory, the corresponding procedure *narrowly fails* for gravity because, in the multiplication of the third term of (7) by $\Delta(q)\ \Delta(r)$, there arise $n$-dependent pieces whose indices are not contracted against the propagator and thereby disappear (which they do in Yang–Mills). Instead, from identities like

$$\Delta^{-1}_{\rho\sigma\mu\nu}(q)\Delta^{\mu\nu\mu'\nu'}(q) = \tfrac{1}{2}(\delta^{\mu'}_{\rho}\delta^{\nu'}_{\sigma} + \delta^{\nu'}_{\rho}\delta^{\mu'}_{\sigma}) - \Delta^{-1}_{\rho\sigma,\tau}(q)\Delta^{\mu\nu,\tau}(q),$$

there survives the residual integral

$$p^{\kappa}\Pi_{\kappa\lambda,\kappa'\lambda'}(p) = -\mathrm{i}K^2 \int \frac{p \cdot n}{q \cdot n} q^{\mu'}\Delta^{\nu',\rho'\sigma'}_{\lambda}(r)\Gamma_{\kappa'\lambda'\mu'\nu'\rho'\sigma'}(pqr)\,\mathrm{d}^4q \neq 0.$$

This identically equals the 'pincer graph' contribution $F$ in equation (3.11) of Capper and Leibbrandt, taken in their limit $\alpha \to 0$. *Note however that the absorptive part of* $\Pi$ *stays transversal.*

The conclusion is thus even more dismal than I portrayed it in my Letter: although effectively ghost-free, axial gauge gravity is so complicated as to be practically useless; this is in sharp contrast with axial gauge chromodynamics.

## References

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