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# On Exact Kerr-Schild Type Vacuum Solutions to Salam's Two-Tensor Theory of Gravity*

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**Abstract.** A Kerr-Schild type ansatz for the $f$ and $g$ tensor fields leads to a tractable form of the field equations of Salam's two-tensor theory of gravity in vacuo. While the general solution contains the Schwarzschild and Kerr metrics in the pure Einstein vacuum case, we can show in the $f-g$ case that all "non-trivial" ($f \neq g$) solutions are restricted to have the form of "plane-fronted waves".

## I. Introduction and Conclusion

A two-tensor theory has been set up by Salam *et al.* [1] to describe the gravitational interactions of leptons and hadrons. Its field equations in regions free from matter are

$$\begin{aligned} G_{\mu\nu}(f) + \kappa_f^2 |\det f_{\mu\nu}|^{-\frac{1}{2}} \frac{\partial \mathscr{L}_{fg}}{\partial f^{\mu\nu}} &= 0\,, \\ G_{\mu\nu}(g) + \kappa_g^2 |\det g_{\mu\nu}|^{-\frac{1}{2}} \frac{\partial \mathscr{L}_{fg}}{\partial g^{\mu\nu}} &= 0\,. \end{aligned} \tag{1.1}$$

where

$$\mathscr{L}_{fg} \equiv \kappa_f^{-2} |\det f_{\mu\nu}|^{\frac{1}{2}} \frac{m^2}{4} (f^{\alpha\beta} - g^{\alpha\beta})(f^{\kappa\lambda} - g^{\kappa\lambda})(g_{\alpha\kappa} g_{\beta\lambda} - g_{\alpha\beta} g_{\kappa\lambda})\,,$$

$$\begin{aligned} \frac{\partial \mathscr{L}_{fg}}{\partial f^{\mu\nu}} &= \left( -\frac{1}{2} \delta_\mu{}^\alpha \mathscr{L}_{fg} + \frac{m^2}{2\kappa_f} \mathscr{F}_\mu{}^\alpha \right) f_{\alpha\nu} \\ \frac{\partial \mathscr{L}_{fg}}{\partial g^{\mu\nu}} &= -\frac{m^2}{2\kappa_f} \mathscr{F}_\mu{}^\alpha g_{\alpha\nu}\,, \end{aligned} \tag{1.2}$$

$$\mathscr{F}_\mu{}^\alpha \equiv \kappa_f^{-1} |\det f_{\mu\nu}|^{\frac{1}{2}} [g_{\mu\varrho} f^{\varrho\sigma} g_{\sigma\tau} f^{\tau\alpha} - g_{\mu\varrho} f^{\varrho\alpha} (g_{\kappa\lambda} f^{\lambda\kappa} - 3)]\,,$$

$G_{\mu\nu}(f)$, $G_{\mu\nu}(g)$ are the Einstein tensors constructed from the symmetric nonsingular tensor fields $f_{\mu\nu}$, $g_{\mu\nu}$ when considered as "metrics". $m > 0$ is the mass of the $f$-field which in regions containing matter would interact directly only with hadrons, while $g$ would interact directly only with

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