Errata for: **"Probing the Universe: A Geometrical View for Observers of Spacetime Physics"**

Robin W. Tucker and Timothy J. Walton (Springer: 2026)

A list of typographical errors and correction for the book will be kept here. Corrections are emphasised in **red** text.

Please email TWalton@lancashire.ac.uk if you find any typographical errors not already listed.

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page 16: The third displayed equation on this page should read:

$$\boldsymbol{v}_P(t) \;=\; -R_0 \sin(\,\Phi(t)\,)\,\dot{\boldsymbol{\Phi}}(t)\,\boldsymbol{i}_1 + R_0 \cos(\,\Phi(t)\,)\,\dot{\boldsymbol{\Phi}}(t)\,\boldsymbol{i}_2$$

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page 177: The line immediately below the first displayed equation should read:

"In the $\mathbf{g}_{\mathbb{R}^3}$-orthonormal cobasis for. . ."

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page 285: The line directly above the only displayed equation on this page should read:

"Since $\Pi_Q^{\perp}(W') = \boldsymbol{W}$, both the spacelike. . ."

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page 290: The sentence directly preceding equation (15.45) should read:

"Recalling $W \equiv \boldsymbol{\Pi}_{\mathbf{Q}}^{\perp}(W')$ where Q is geodesic with $\mathrm{g}(Q,Q) = -L_0^2$ and W' is Lie-parallel with respect to Q, the vector fields Q, W **satisfy** the conditions. . ."

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page 376: The last displayed equation on this page should read:

$$\begin{aligned} \mathcal{G}_c &= \mathcal{R} \star e_c - 2(i_a P_c) \star e^a + \mathbf{2}(i_c i_a i_b\, \mathfrak{D}T^b) \star e^a \\ &= \mathcal{R} \star e_c - 2 \star P_c - 2 i_a (i_c i_b\, \mathfrak{D}T^b) \star e^a \end{aligned}$$

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page 380: The line immediately below the first displayed equation should read:

". . .is a type-preserving *derivation* on the algebra of exterior forms on $\mathcal{M}$ **(see appendix H for further details)** that commutes with the exterior derivative. . ."

There is also a typographical error here: the 8th line below equation (20.8) should read

". . .equality modulo d will below be **denoted** by. . ."

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page 382: The line immediately below equation (20.13) should read:

"…of the interior operator $i_c \equiv i_{\mathbf{X}_c}$,…"

page 383: The top displayed equation on this page should read:

$$\psi_2 = \dot{e}^{a} \wedge e^b \wedge \star R_{ab}.$$

The displayed equation between (20.17) and (20.18) should read:

$$\begin{aligned} \mathfrak{D}\star e^{ab} &= \frac{1}{2}\,\epsilon^{ab}{}_{cd}\,\mathfrak{D}e^{cd} = \frac{1}{2}\,\epsilon^{ab}{}_{cd}\,\left(T^c \wedge e^d - e^c \wedge T^d\right) \\ &= \epsilon^{ab}{}_{cd}\,T^c \wedge e^d = T_c \wedge \star e^{abc} \end{aligned}$$

page 384: The line of text above equation (20.22) should read:

"In this case the 3-forms $\{\mathcal{G}_c^{(\mathrm{EH})} \equiv -\frac{1}{2}\mathcal{G}_c\}$ define…"

page 385: Equation (20.24) should read:

$$\begin{aligned} \Lambda_{\mathrm{TOTAL}}(e,\omega,A,\phi,\overline{\phi}) \equiv \frac{1}{2\kappa}\,R_{ab}(\omega) \wedge \star e^{ab} + \kappa_A dA \wedge \star dA \\ + \kappa_1 \mathrm{Re}\left(\overline{\mathfrak{D}_{\mathrm{U}(1)}\phi} \wedge \star \mathfrak{D}_{\mathrm{U}(1)}\phi\right) \\ + \kappa_2\,\phi\,\overline{\phi}\,\star 1 + \kappa_3\,R_{ab}(\omega) \wedge R^{ab}(\omega) \end{aligned} \tag{20.24}$$

page 386: Equation (20.30) should read:

$$\mathcal{I}_{\mathrm{EH}}[e,\omega] \equiv \frac{1}{2\kappa}\int_{\mathcal{M}} R_{ab}(\omega) \wedge \star(\,e^a \wedge e^b\,), \tag{20.30}$$

and the displayed equation below becomes:

$$\mathcal{G}_c^{(\mathrm{EH})} \equiv -\frac{1}{2}\,R_{ab} \wedge i_c \star(\,e^a \wedge e^{b}\,) = 0, \quad a,b,c = 0,1,2,3,\; e^a(X_c) = \delta^a_c$$

$$T^c = 0.$$

page 388: Equation (20.31) should read:

$$\mathtt{Ein} \equiv (\star^{-1}\mathcal{G}_c^{(\mathrm{EH})}) \otimes e^c = \kappa\,(\star^{-1}\tau_c^{(\mathrm{SOURCE})}) \otimes e^c. \tag{20.31}$$

page 392: The first equation of section 20.4 should read:

$$\mathcal{I}_{\text{EH}}[e,\omega] \;\equiv\; \frac{\mathbf{1}}{\mathbf{2}\boldsymbol{\kappa}} \int_{\mathcal{M}} R_{ab}(\omega) \wedge \star(\, e^a \wedge e^b\,), \tag{20.30}$$

and the second equation becomes:

$$\mathcal{I}_{\text{SOURCE}}[e,A,\phi,\overline{\phi}] \;\equiv\; \kappa_A \int_{\mathcal{M}} \Lambda_2(e,A) + \kappa_1 \int_{\mathcal{M}} \Lambda_1(e,A,\phi,\overline{\phi}\,) + \mu^2 \int_{\mathcal{M}} \Lambda_3(e,\phi,\overline{\phi}\,) \qquad (\kappa_1,\mu \in \mathbb{R})$$

page 395: The displayed equation immediately above equation (20.37) should read:

$$\widehat{\widehat{\delta}} \Big(\mathcal{I}_{\text{EH}}[e,\omega] + \mathcal{I}_{\text{SOURCE}}[e,A,\phi,\overline{\phi}] \Big) \;\simeq\; 0,$$

page 396: Equation (20.39) should read:

$$\frac{\mathcal{G}_c^{(\text{EH})}}{\kappa} \;=\; \tau_c \tag{20.39}$$

and the text immediately after this displayed equation becomes:

> "where $\mathcal{G}_c^{(\text{EH})} \equiv -\frac{1}{2} R_{ab} \wedge i_c \star e^{ab} \ldots$".

The text in the first paragraph immediately below the last displayed equation of this page should be:

> "Note $[\tau_c] \;=\; \mathbf{M}[c_0^2]$. Since the $\dot{\omega}_{ab}$ partial variations in $\mathcal{I}_{\text{EH}}[e,\omega]$ *and* $\mathcal{I}_{\text{SOURCE}}[e,A,\phi,\overline{\phi}]$ yield a set of zero-torsion connection 1-forms (see section above), if these are assumed to be metric-compatible with respect to the metric tensor $\mathrm{g} \;=\; \eta_{ab}\, e^a \otimes e^b$ then (20.37), (20.38), (20.20) constitute the necessary conditions for the functional $\mathcal{I}_{\textbf{EH}}[e,\omega] + \mathcal{I}_{\textbf{SOURCE}}[e,A,\phi,\overline{\phi}]$ to be extremal and (20.39) yields a *Levi-Civita Einstein tensor field equation with sources.* "

page 402: The penultimate displayed equation on this page should read:

$$\mathrm{T}^{(\text{MAX})}(X_0,X_0) \;=\; (\star\tau_c^{(\text{MAX})})(X_0)\, \boldsymbol{\delta}_{\mathbf{0}}^{\mathbf{c}} \;=\; i_0(\star\tau_0^{(\text{MAX})})$$

page 405: The second displayed equation in section 21.1 should read:

$$(\nabla \cdot \Xi)(\boldsymbol{Y}) \;\equiv\; (\nabla_{X_a}\Xi)(X^a, Y) \qquad \text{for all } Y \in \Gamma T\mathcal{U}_{\mathcal{M}}.$$

page 414: Equation (22.8) should read:

$$\mathcal{G}_a^{(\mathrm{EH})} \;=\; \kappa\,\tau_a^{(\mathrm{SOURCE})}, \qquad a = 0,1,2,3. \tag{22.8}$$

The text immediately following this line should then read:

"Recall that it follows from $\left[\mathcal{G}_a^{(\mathrm{EH})}\right]$ and …".

Equation (22.9) should read:

$$\mathcal{G}_a^{(\mathrm{EH})} \;=\; \kappa \sum_N \tau_a^N \;\equiv\; \kappa\,\tau_a^{(\mathrm{SOURCE})}. \tag{22.9}$$

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page 488: The first displayed equation on this page should read:

$$\begin{aligned}
\frac{1}{L_0}\,\mathrm{g}_{\mathrm{PG}}(\dot{C}, X_0)\Big|_{C(\tau)} \;&=\; -\dot{T}(\tau) \\
\frac{1}{L_0^2}\,\mathrm{g}_{\mathrm{PG}}(\dot{C}, \dot{C})\Big|_{C(\tau)} \;&=\; -\left(1 - \frac{\Sigma}{R(\tau)}\right)\dot{T}(\tau)^2 + 2\sqrt{\frac{\Sigma}{R(\tau)}}\,\dot{T}(\tau)\dot{R}(\tau) + \dot{R}(\tau)^2 \\
&\qquad + R(\tau)^2\left(\dot{\Theta}(\tau)^2 + \sin^2(\,\boldsymbol{\Theta}(\tau)\,)\dot{\Phi}(\tau)^2\right).
\end{aligned}$$

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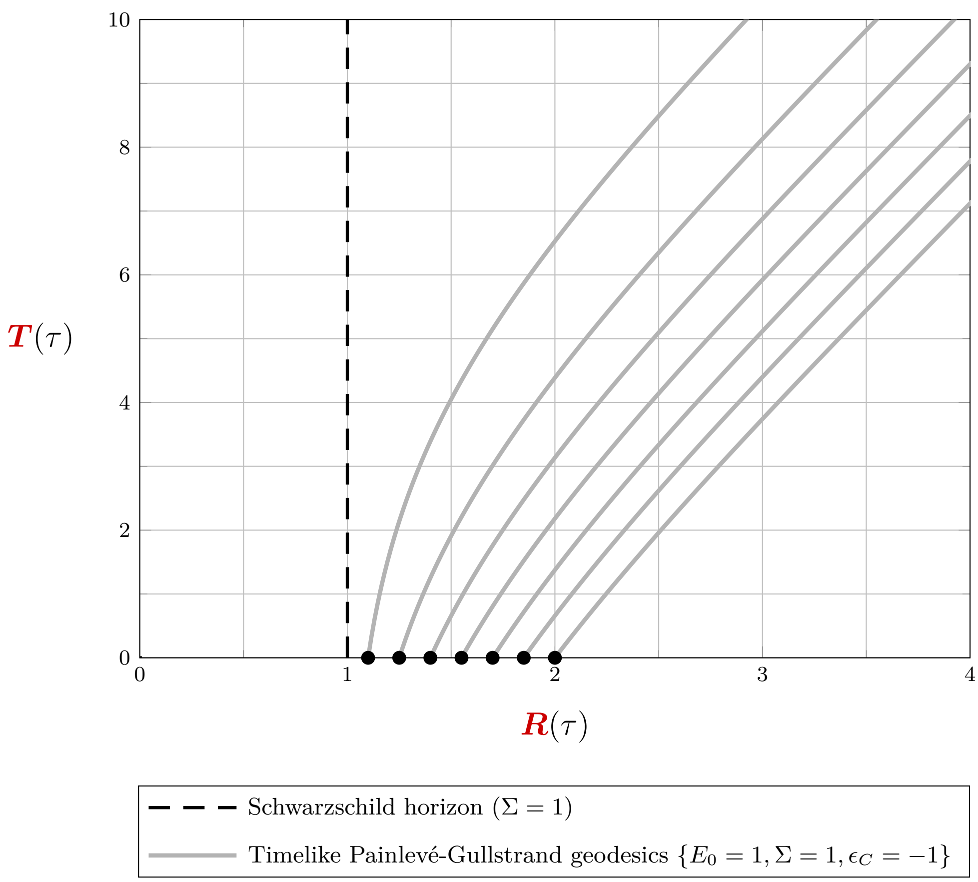
page 491: The axis labels $(\,T(\tau), R(\tau)\,)$ in Fig. 30.1 are the wrong way round and need to be swapped. The figure should be as follows:



page 659: Equation (34.14) for the Bopp-Podolsky field equations should read:

$$d\star\mathcal{F} + \lambda_0^2\, d\delta d\star\mathcal{F} \;=\; 0 \tag{34.14}$$

The change in sign here ensures the static, spherically symmetric solution is finite as $r \to 0$. This correction contributes to a number of changes over the next few pages.

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page 659: Equation (34.16) for the Bopp-Podolsky field equations should read:

$$\begin{aligned} d\star\mathcal{F} + \lambda_0^2\, d\delta d\star\mathcal{F} \;&=\; d\delta d\alpha\wedge\Pi + \lambda_0^2\, d\delta d\delta d\alpha\wedge\Pi \\ &=\; d\left(\delta d\alpha + \lambda_0^2\,\delta d\delta d\alpha\right)\wedge\Pi \;=\; 0. \end{aligned} \tag{34.16}$$

The following equation also needs correcting:

$$\Box\,\alpha + \lambda_0^2\,\Box^2\alpha \;=\; 0, \qquad \Box\,\alpha \;\neq\; 0, \tag{34.17}$$

as does the final displayed equation of the page which should read:

$$\Box\,\alpha + \frac{1}{\lambda_0^2}\alpha \;=\; 0, \qquad \lambda_0 \;\neq\; 0.$$