$$\boldsymbol{A} = A + A^{x} e_{x} + A^{y} e_{y} + A^{z} e_{z} + A^{xy} e_{x}\wedge e_{y} + A^{xz} e_{x}\wedge e_{z} + A^{yz} e_{y}\wedge e_{z} + A^{xyz} e_{x}\wedge e_{y}\wedge e_{z}$$

$$\begin{aligned}\boldsymbol{A} = &A \\ &+ A^{x} e_{x} + A^{y} e_{y} + A^{z} e_{z} \\ &+ A^{xy} e_{x}\wedge e_{y} + A^{xz} e_{x}\wedge e_{z} + A^{yz} e_{y}\wedge e_{z} \\ &+ A^{xyz} e_{x}\wedge e_{y}\wedge e_{z}\end{aligned}$$

$$\begin{aligned}\boldsymbol{A} = &A \\ &+ A^{x} e_{x} \\ &+ A^{y} e_{y} \\ &+ A^{z} e_{z} \\ &+ A^{xy} e_{x}\wedge e_{y} \\ &+ A^{xz} e_{x}\wedge e_{z} \\ &+ A^{yz} e_{y}\wedge e_{z} \\ &+ A^{xyz} e_{x}\wedge e_{y}\wedge e_{z}\end{aligned}$$

$$\boldsymbol{A} = A^{x} e_{x} + A^{y} e_{y} + A^{z} e_{z}$$

$$\boldsymbol{B} = B^{xy} e_{x}\wedge e_{y} + B^{xz} e_{x}\wedge e_{z} + B^{yz} e_{y}\wedge e_{z}$$

$$\boldsymbol{\nabla} f = \partial_{x} f e_{x} + \partial_{y} f e_{y} + \partial_{z} f e_{z}$$

$$\boldsymbol{\nabla}\cdot\boldsymbol{A} = \partial_{x} A^{x} + \partial_{y} A^{y} + \partial_{z} A^{z}$$

$$\boldsymbol{\nabla}\boldsymbol{A} = \left(\partial_{x} A^{x} + \partial_{y} A^{y} + \partial_{z} A^{z}\right) + \left(-\partial_{y} A^{x} + \partial_{x} A^{y}\right) e_{x}\wedge e_{y} + \left(-\partial_{z} A^{x} + \partial_{x} A^{z}\right) e_{x}\wedge e_{z} + \left(-\partial_{z} A^{y} + \partial_{y} A^{z}\right) e_{y}\wedge e_{z}$$

$$-I(\boldsymbol{\nabla}\wedge\boldsymbol{A}) = \left(-\partial_{z} A^{y} + \partial_{y} A^{z}\right) e_{x} + \left(\partial_{z} A^{x} - \partial_{x} A^{z}\right) e_{y} + \left(-\partial_{y} A^{x} + \partial_{x} A^{y}\right) e_{z}$$

$$\boldsymbol{\nabla}\boldsymbol{B} = \left(-\partial_{y} B^{xy} - \partial_{z} B^{xz}\right) e_{x} + \left(\partial_{x} B^{xy} - \partial_{z} B^{yz}\right) e_{y} + \left(\partial_{x} B^{xz} + \partial_{y} B^{yz}\right) e_{z} + \left(\partial_{z} B^{xy} - \partial_{y} B^{xz} + \partial_{x} B^{yz}\right) e_{x}\wedge e_{y}\wedge e_{z}$$

$$\boldsymbol{\nabla}\wedge\boldsymbol{B} = \left(\partial_{z} B^{xy} - \partial_{y} B^{xz} + \partial_{x} B^{yz}\right) e_{x}\wedge e_{y}\wedge e_{z}$$

$$\boldsymbol{\nabla}\cdot\boldsymbol{B} = \left(-\partial_{y} B^{xy} - \partial_{z} B^{xz}\right) e_{x} + \left(\partial_{x} B^{xy} - \partial_{z} B^{yz}\right) e_{y} + \left(\partial_{x} B^{xz} + \partial_{y} B^{yz}\right) e_{z}$$

$$g_{ij} = \left[\begin{array}{cccc}(a\cdot a) & (a\cdot b) & (a\cdot c) & (a\cdot d)\\ (a\cdot b) & (b\cdot b) & (b\cdot c) & (b\cdot d)\\ (a\cdot c) & (b\cdot c) & (c\cdot c) & (c\cdot d)\\ (a\cdot d) & (b\cdot d) & (c\cdot d) & (d\cdot d)\end{array}\right]$$

$$\boldsymbol{a\cdot (bc)} = -(a\cdot c)\, b + (a\cdot b)\, c$$

$$\boldsymbol{a\cdot (b\wedge c)} = -(a\cdot c)\, b + (a\cdot b)\, c$$

$$\boldsymbol{a\cdot (b\wedge c\wedge d)} = (a\cdot d)\, b\wedge c - (a\cdot c)\, b\wedge d + (a\cdot b)\, c\wedge d$$

$$\boldsymbol{a\cdot (b\wedge c) + c\cdot (a\wedge b) + b\cdot (c\wedge a)} = 0$$

$$\boldsymbol{a(b\wedge c) - b(a\wedge c) + c(a\wedge b)} = 3a\wedge b\wedge c$$

$$\boldsymbol{a(b\wedge c\wedge d) - b(a\wedge c\wedge d) + c(a\wedge b\wedge d) - d(a\wedge b\wedge c)} = 4a\wedge b\wedge c\wedge d$$

$$\boldsymbol{(a\wedge b)\cdot (c\wedge d)} = -(a\cdot c)\,(b\cdot d) + (a\cdot d)\,(b\cdot c)$$

$$\boldsymbol{((a\wedge b)\cdot c)\cdot d} = -(a\cdot c)\,(b\cdot d) + (a\cdot d)\,(b\cdot c)$$

$$\boldsymbol{(a\wedge b)\times (c\wedge d)} = -(b\cdot d)\, a\wedge c + (b\cdot c)\, a\wedge d + (a\cdot d)\, b\wedge c - (a\cdot c)\, b\wedge d$$

$$E = e_{1}\wedge e_{2}\wedge e_{3}$$

$$E^{2} = (e_{1}\cdot e_{2})^{2} - 2\,(e_{1}\cdot e_{2})\,(e_{1}\cdot e_{3})\,(e_{2}\cdot e_{3}) + (e_{1}\cdot e_{3})^{2} + (e_{2}\cdot e_{3})^{2} - 1$$

$$E1 = (e2\wedge e3)E = \left((e_{2}\cdot e_{3})^{2} - 1\right) e_{1} + \left((e_{1}\cdot e_{2}) - (e_{1}\cdot e_{3})\,(e_{2}\cdot e_{3})\right) e_{2} + \left(-(e_{1}\cdot e_{2})\,(e_{2}\cdot e_{3}) + (e_{1}\cdot e_{3})\right) e_{3}$$

$$E2 = -(e1\wedge e3)E = \left((e_{1}\cdot e_{2}) - (e_{1}\cdot e_{3})\,(e_{2}\cdot e_{3})\right) e_{1} + \left((e_{1}\cdot e_{3})^{2} - 1\right) e_{2} + \left(-(e_{1}\cdot e_{2})\,(e_{1}\cdot e_{3}) + (e_{2}\cdot e_{3})\right) e_{3}$$

$$E3 = (e1\wedge e2)E = \left(-(e_{1}\cdot e_{2})\,(e_{2}\cdot e_{3}) + (e_{1}\cdot e_{3})\right) e_{1} + \left(-(e_{1}\cdot e_{2})\,(e_{1}\cdot e_{3}) + (e_{2}\cdot e_{3})\right) e_{2} + \left((e_{1}\cdot e_{2})^{2} - 1\right) e_{3}$$

$E1 \cdot e2 = 0$

$E1 \cdot e3 = 0$

$E2 \cdot e1 = 0$

$E2 \cdot e3 = 0$

$E3 \cdot e1 = 0$

$E3 \cdot e2 = 0$

$(E1 \cdot e1)/E^2 = 1$

$(E2 \cdot e2)/E^2 = 1$

$(E3 \cdot e3)/E^2 = 1$

$A = A^r e_r + A^\theta e_\theta + A^\phi e_\phi$

$B = B^{r\theta} e_r \wedge e_\theta + B^{r\phi} e_r \wedge e_\phi + B^{\phi\phi} e_\theta \wedge e_\phi$

$\boldsymbol{\nabla} f = \partial_r f e_r + \frac{1}{r}\partial_\theta f e_\theta + \frac{\partial_\phi f}{r \sin(\theta)} e_\phi$

$\boldsymbol{\nabla} \cdot A = \frac{1}{r}\left(r\partial_r A^r + 2A^r + \frac{A^\theta}{\tan(\theta)} + \partial_\theta A^\theta + \frac{\partial_\phi A^\phi}{\sin(\theta)}\right)$

$-I(\boldsymbol{\nabla} \wedge A) = \frac{1}{r}\left(\frac{A^\phi}{\tan(\theta)} + \partial_\theta A^\phi - \frac{\partial_\phi A^\theta}{\sin(\theta)}\right) e_r + \frac{1}{r}\left(-r\partial_r A^\phi - A^\phi + \frac{\partial_\phi A^r}{\sin(\theta)}\right) e_\theta + \frac{1}{r}\left(r\partial_r A^\theta + A^\theta - \partial_\theta A^r\right) e_\phi$

$\boldsymbol{\nabla} \wedge B = \frac{1}{r}\left(r\partial_r B^{\phi\phi} - \frac{B^{r\phi}}{\tan(\theta)} + 2B^{\phi\phi} - \partial_\theta B^{r\phi} + \frac{\partial_\phi B^{r\theta}}{\sin(\theta)}\right) e_r \wedge e_\theta \wedge e_\phi$

$B = \boldsymbol{B\gamma_t} = -B^x \gamma_t \wedge \gamma_x - B^y \gamma_t \wedge \gamma_y - B^z \gamma_t \wedge \gamma_z$

$E = \boldsymbol{E\gamma_t} = -E^x \gamma_t \wedge \gamma_x - E^y \gamma_t \wedge \gamma_y - E^z \gamma_t \wedge \gamma_z$

$F = E + IB = -E^x \gamma_t \wedge \gamma_x - E^y \gamma_t \wedge \gamma_y - E^z \gamma_t \wedge \gamma_z - B^z \gamma_x \wedge \gamma_y + B^y \gamma_x \wedge \gamma_z - B^x \gamma_y \wedge \gamma_z$

$J = J^t \gamma_t + J^x \gamma_x + J^y \gamma_y + J^z \gamma_z$

$$\begin{aligned}
\boldsymbol{\nabla} F = & \left(\partial_x E^x + \partial_y E^y + \partial_z E^z\right) \gamma_t \\
& + \left(-\partial_z B^y + \partial_y B^z - \partial_t E^x\right) \gamma_x \\
& + \left(\partial_z B^x - \partial_x B^z - \partial_t E^y\right) \gamma_y \\
& + \left(-\partial_y B^x + \partial_x B^y - \partial_t E^z\right) \gamma_z \\
& + \left(-\partial_t B^z + \partial_y E^x - \partial_x E^y\right) \gamma_t \wedge \gamma_x \wedge \gamma_y \\
& + \left(\partial_t B^y + \partial_z E^x - \partial_x E^z\right) \gamma_t \wedge \gamma_x \wedge \gamma_z \\
& + \left(-\partial_t B^x + \partial_z E^y - \partial_y E^z\right) \gamma_t \wedge \gamma_y \wedge \gamma_z \\
& + \left(\partial_x B^x + \partial_y B^y + \partial_z B^z\right) \gamma_x \wedge \gamma_y \wedge \gamma_z
\end{aligned}$$

$\boldsymbol{\nabla} F = J$

$$\begin{aligned}
\langle \nabla F \rangle_1 - J = 0 = & \left(-J^t + \partial_x E^x + \partial_y E^y + \partial_z E^z\right) \gamma_t \\
& + \left(-J^x - \partial_z B^y + \partial_y B^z - \partial_t E^x\right) \gamma_x \\
& + \left(-J^y + \partial_z B^x - \partial_x B^z - \partial_t E^y\right) \gamma_y \\
& + \left(-J^z - \partial_y B^x + \partial_x B^y - \partial_t E^z\right) \gamma_z
\end{aligned}$$

$$\begin{aligned}
\langle \nabla F \rangle_3 = 0 = & \left(-\partial_t B^z + \partial_y E^x - \partial_x E^y\right) \gamma_t \wedge \gamma_x \wedge \gamma_y \\
& + \left(\partial_t B^y + \partial_z E^x - \partial_x E^z\right) \gamma_t \wedge \gamma_x \wedge \gamma_z \\
& + \left(-\partial_t B^x + \partial_z E^y - \partial_y E^z\right) \gamma_t \wedge \gamma_y \wedge \gamma_z \\
& + \left(\partial_x B^x + \partial_y B^y + \partial_z B^z\right) \gamma_x \wedge \gamma_y \wedge \gamma_z
\end{aligned}$$

$R = \cosh\left(\frac{\alpha}{2}\right) + \sinh\left(\frac{\alpha}{2}\right) \gamma_t \wedge \gamma_x$

$$t\boldsymbol{\gamma_t} + x\boldsymbol{\gamma_x} = t'\boldsymbol{\gamma_t'} + x'\boldsymbol{\gamma_x'} = R\left(t'\boldsymbol{\gamma_t} + x'\boldsymbol{\gamma_x}\right)R^{\dagger}$$

$$t\boldsymbol{\gamma_t} + x\boldsymbol{\gamma_x} = \left(t'\cosh\left(\alpha\right) - x'\sinh\left(\alpha\right)\right)\gamma_t + \left(-t'\sinh\left(\alpha\right) + x'\cosh\left(\alpha\right)\right)\gamma_x$$

$$\sinh\left(\alpha\right) = \gamma\beta$$

$$\cosh\left(\alpha\right) = \gamma$$

$$t\boldsymbol{\gamma_t} + x\boldsymbol{\gamma_x} = \gamma\left(-\beta x' + t'\right)\gamma_t + \gamma\left(-\beta t' + x'\right)\gamma_x$$

$$\boldsymbol{A} = A^t\gamma_t + A^x\gamma_x + A^y\gamma_y + A^z\gamma_z$$

$$\boldsymbol{\psi} = \psi + \psi^{tx}\gamma_t\wedge\gamma_x + \psi^{ty}\gamma_t\wedge\gamma_y + \psi^{tz}\gamma_t\wedge\gamma_z + \psi^{xy}\gamma_x\wedge\gamma_y + \psi^{xz}\gamma_x\wedge\gamma_z + \psi^{yz}\gamma_y\wedge\gamma_z + \psi^{txyz}\gamma_t\wedge\gamma_x\wedge\gamma_y\wedge\gamma_z$$

$$\begin{aligned}
\nabla\boldsymbol{\psi}I\sigma_z - e\boldsymbol{A}\boldsymbol{\psi} - m\boldsymbol{\psi}\gamma_t = 0 = &\left(-eA^x\psi^{tx} - eA^y\psi^{ty} - eA^z\psi^{tz} + \left(-eA^t - m\right)\psi - \partial_y\psi^{tx} - \partial_z\psi^{txyz} + \partial_x\psi^{ty} + \partial_t\psi^{xy}\right)\gamma_t \\
&+ \left(-eA^x\psi - eA^y\psi^{xy} - eA^z\psi^{xz} + \left(-eA^t + m\right)\psi^{tx} + \partial_y\psi - \partial_t\psi^{ty} - \partial_x\psi^{xy} + \partial_z\psi^{yz}\right)\gamma_x \\
&+ \left(-eA^t\psi^{ty} + eA^x\psi^{xy} - eA^y\psi - eA^z\psi^{yz} + m\psi^{ty} - \partial_x\psi + \partial_t\psi^{tx} - \partial_y\psi^{xy} - \partial_z\psi^{xz}\right)\gamma_y \\
&+ \left(-eA^t\psi^{tz} + eA^x\psi^{xz} + eA^y\psi^{yz} - eA^z\psi + m\psi^{tz} + \partial_t\psi^{txyz} - \partial_z\psi^{xy} + \partial_y\psi^{xz} - \partial_x\psi^{yz}\right)\gamma_z \\
&+ \left(eA^x\psi^{ty} - eA^y\psi^{tx} - eA^z\psi^{txyz} + \left(-eA^t - m\right)\psi^{xy} - \partial_t\psi + \partial_x\psi^{tx} + \partial_y\psi^{ty} + \partial_z\psi^{tz}\right)\gamma_t\wedge\gamma_x\wedge\gamma_y \\
&+ \left(eA^x\psi^{tz} + eA^y\psi^{txyz} - eA^z\psi^{tx} + \left(-eA^t - m\right)\psi^{xz} + \partial_x\psi^{txyz} + \partial_z\psi^{ty} - \partial_y\psi^{tz} - \partial_t\psi^{yz}\right)\gamma_t\wedge\gamma_x\wedge\gamma_z \\
&+ \left(-eA^t\psi^{yz} - eA^x\psi^{txyz} + eA^y\psi^{tz} - eA^z\psi^{ty} - m\psi^{yz} - \partial_z\psi^{tx} + \partial_y\psi^{txyz} + \partial_x\psi^{tz} + \partial_t\psi^{xz}\right)\gamma_t\wedge\gamma_y\wedge\gamma_z \\
&+ \left(-eA^t\psi^{txyz} - eA^x\psi^{yz} + eA^y\psi^{xz} - eA^z\psi^{xy} + m\psi^{txyz} + \partial_z\psi - \partial_t\psi^{tz} - \partial_x\psi^{xz} - \partial_y\psi^{yz}\right)\gamma_x\wedge\gamma_y\wedge\gamma_z
\end{aligned}$$