```
> restart: grtw();
```

GRTensorII Version 1.80-pre2 (R6)

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Developed by Peter Musgrave, Denis Pollney and Kayll Lake

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e:/Grtii(6)/Metrics

Coordinate calculation

```
> qload(visser);
```

Default spacetime = visser

For the visser spacetime:

Coordinates : $\mathrm{x}(up)$

$$x^{a} = [t, r, \theta, \phi]$$

Spacetime signature : sig

Signature $= 2$

Line element : ds

$$ds^2 = -\mathbf{e}^{\mathrm{A1}(r)}\ d\,t^2 + \mathbf{e}^{\mathrm{B1}(r)}\ d\,r^2 + \mathbf{e}^{\mathrm{B1}(r)}\ r^2\ d\,\theta^2 + \mathbf{e}^{\mathrm{B1}(r)}\ r^2 \sin(\theta)^2\ d\,\phi^2$$

Constraints =

$$\left[\mathrm{A1}(r) = \int_0^r 2\,\frac{\varepsilon\sqrt{-x\left(\frac{\partial}{\partial x}\mathrm{z}(x)\right)}}{1-\mathrm{z}(x)\,x^2}\,dx,\ \mathrm{B1}(r) = \int_0^r -2\,\frac{\varepsilon\sqrt{-x\left(\frac{\partial}{\partial x}\mathrm{z}(x)\right)-2\,x\,\mathrm{z}(x)}}{1-\mathrm{z}(x)\,x^2}\,dx,\ \varepsilon^2 = 1 \right]$$

```
> grcalc(G(up,dn));
Created definition for G(up,dn)
```

CPU Time $= .230$

```
> gralter(_,13,2,7);
Component simplification of a GRTensorII object:

Applying routine `Apply constraints repeatedly` to object G(up,dn)
Applying routine `simplify[trig]` to object G(up,dn)
Applying routine factor to object G(up,dn)
```

CPU Time $= .140$

```
> grdisplay(_);
```

For the visser spacetime:

G(up,dn) : $\mathrm{G}(up, dn)$

$$G^{t}{}_{t} = \left(\mathbf{e}^{\left(\int_{0}^{r} \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} z(x)\right)} + 2\, x\, z(x)}{-1 + z(x)\, x^{2}}\, dx\right)}\right)^{2} \left(5\, \varepsilon \left(\frac{\partial}{\partial r} z(r)\right) + 3\, \varepsilon \left(\frac{\partial}{\partial r} z(r)\right) r^{2}\, z(r) + 12\, z(r) \sqrt{-r \left(\frac{\partial}{\partial r} z(r)\right)} + 2\, \varepsilon\, r^{3} \left(\frac{\partial}{\partial r} z(r)\right)^{2} + \varepsilon\, r \left(\frac{\partial^{2}}{\partial r^{2}} z(r)\right) - \varepsilon\, r^{3} \left(\frac{\partial^{2}}{\partial r^{2}} z(r)\right) z(r) + 3\, r \left(\frac{\partial}{\partial r} z(r)\right) \sqrt{-r \left(\frac{\partial}{\partial r} z(r)\right)}\right) \Big/ \left(\left(-1 + z(r)\, r^{2}\right)^{2} \sqrt{-r \left(\frac{\partial}{\partial r} z(r)\right)}\right)$$

$$G^{r}{}_{r} = \frac{\left(\mathbf{e}^{\left(\int_{0}^{r} \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} z(x)\right)} + 2\, x\, z(x)}{-1 + z(x)\, x^{2}}\, dx\right)}\right)^{2} \left(r \left(\frac{\partial}{\partial r} z(r)\right) + 4\, z(r)\right)}{\left(-1 + z(r)\, r^{2}\right)^{2}}$$

$$G^{\theta}{}_{\theta} = \frac{\left(\mathbf{e}^{\left(\int_{0}^{r} \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} z(x)\right)} + 2\, x\, z(x)}{-1 + z(x)\, x^{2}}\, dx\right)}\right)^{2} \left(r \left(\frac{\partial}{\partial r} z(r)\right) + 4\, z(r)\right)}{\left(-1 + z(r)\, r^{2}\right)^{2}}$$

$$G^{\phi}{}_{\phi} = \frac{\left(\mathbf{e}^{\left(\int_{0}^{r} \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} z(x)\right)} + 2\, x\, z(x)}{-1 + z(x)\, x^{2}}\, dx\right)}\right)^{2} \left(r \left(\frac{\partial}{\partial r} z(r)\right) + 4\, z(r)\right)}{\left(-1 + z(r)\, r^{2}\right)^{2}}$$

Basis calculation

```
> qload(visserb);
```

Default spacetime = visserb

For the visserb spacetime:

Coordinates : x(*up*)

$$x^{a} = [t, r, \theta, \phi]$$

Spacetime signature : sig

$$Signature = 2$$

Basis inner product : $\eta(bup, bup)$

$$\eta^{(a)\ \ (b)} = \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Basis (covariant components) : $\mathrm{w1}(dn)$

$$\omega 1_a = [\mathbf{e}^{(1/2\,\mathrm{A1}(r))}, 0, 0, 0]$$

Basis (covariant components) : $\mathrm{w2}(dn)$

$$\omega 2_a = [0, \mathbf{e}^{(1/2\,\mathrm{B1}(r))}, 0, 0]$$

Basis (covariant components) : $\mathrm{w3}(dn)$

$$\omega 3_a = [0, 0, \mathbf{e}^{(1/2\,\mathrm{B1}(r))}\, r, 0]$$

Basis (covariant components) : $\mathrm{w4}(dn)$

$$\omega 4_a = [0, 0, 0, \mathbf{e}^{(1/2\,\mathrm{B1}(r))}\, r \sin(\theta)]$$

Constraints =

$$\left[\mathrm{A1}(r) = \int_0^r 2 \frac{\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} \mathrm{z}(x)\right)}}{1 - \mathrm{z}(x)\, x^2}\, dx, \mathrm{B1}(r) = \int_0^r -2 \frac{\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} \mathrm{z}(x)\right)} - 2\, x\, \mathrm{z}(x)}{1 - \mathrm{z}(x)\, x^2}\, dx, \varepsilon^2 = 1 \right]$$

```
> grcalc(G(bdn,bdn));
Created definition for rot(bdn,bup,bdn)
Created a definition for e(bdn,dn,pdn)
```

$$CPU\ Time = .220$$

```
> gralter(_,13,2,7);
Component simplification of a GRTensorII object:

Applying routine `Apply constraints repeatedly` to object G(bdn,bdn)
Applying routine `simplify[trig]` to object G(bdn,bdn)
Applying routine factor to object G(bdn,bdn)
```

$$CPU\ Time = .060$$

```
> grdisplay(_);
```

For the visserb spacetime:

Covariant Einstein : $\mathrm{G}(bdn, bdn)$

$$G_{(1)\ (1)} = -\left(\mathbf{e}^{\left(\int_0^r \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} \mathrm{z}(x)\right)} + 2\, x\, \mathrm{z}(x)}{-1 + \mathrm{z}(x)\, x^2}\, dx\right)}\right)^2 \left(5\, \varepsilon \left(\frac{\partial}{\partial r} \mathrm{z}(r)\right) + 3\, \varepsilon \left(\frac{\partial}{\partial r} \mathrm{z}(r)\right) r^2\, \mathrm{z}(r)\right.$$

$$+ 12\, z(r) \sqrt{-r \left(\frac{\partial}{\partial r} z(r)\right)} + 2\, \varepsilon\, r^3 \left(\frac{\partial}{\partial r} z(r)\right)^2 + \varepsilon\, r \left(\frac{\partial^2}{\partial r^2} z(r)\right) - \varepsilon\, r^3 \left(\frac{\partial^2}{\partial r^2} z(r)\right) z(r)$$

$$+ 3\, r \left(\frac{\partial}{\partial r} z(r)\right) \sqrt{-r \left(\frac{\partial}{\partial r} z(r)\right)} \Bigg) \Bigg/ \left(\left(-1 + z(r)\, r^2\right)^2 \sqrt{-r \left(\frac{\partial}{\partial r} z(r)\right)} \right)$$

$$G_{(2)\,(2)} = \frac{\left(\mathbf{e}^{\left(\int_0^r \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} z(x)\right)} + 2\, x\, z(x)}{-1 + z(x)\, x^2} \, dx\right)}\right)^2 \left(r \left(\frac{\partial}{\partial r} z(r)\right) + 4\, z(r)\right)}{\left(-1 + z(r)\, r^2\right)^2}$$

$$G_{(3)\,(3)} = \frac{\left(\mathbf{e}^{\left(\int_0^r \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} z(x)\right)} + 2\, x\, z(x)}{-1 + z(x)\, x^2} \, dx\right)}\right)^2 \left(r \left(\frac{\partial}{\partial r} z(r)\right) + 4\, z(r)\right)}{\left(-1 + z(r)\, r^2\right)^2}$$

$$G_{(4)\,(4)} = \frac{\left(\mathbf{e}^{\left(\int_0^r \frac{-\varepsilon \sqrt{-x \left(\frac{\partial}{\partial x} z(x)\right)} + 2\, x\, z(x)}{-1 + z(x)\, x^2} \, dx\right)}\right)^2 \left(r \left(\frac{\partial}{\partial r} z(r)\right) + 4\, z(r)\right)}{\left(-1 + z(r)\, r^2\right)^2}$$

>