GRTensorII Version 1.58 (R3)

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Latest version available from: http://astro.queensu.ca/~gr \ tensor/

To initiate help type ?grtensor

Defaults read from /usr/local/maple/lib/grtensor.ini

> makeg(accelerated);

```
Makeg 2.0: GRTensor metric/basis entry utility

To quit makeg, type 'exit' at any prompt.

Do you wish to enter a 1) metric [g(dn,dn)],
                       2) line element [ds],
                       3) non-holonomic basis [e1...e4]
, or
                       4) NP tetrad [l,n,m,mbar]?
```

1

```
Enter coordinates as a LIST (e.g. [r,theta,phi,t]):
```

[t,x,y,z]

```
Is the metric  1) Diagonal, or
               2) Symmetric?
```

1

```
Enter g[t,t]
```

-(1+a*x)^2

Enter g[x,x]

1

Enter g[y,y]

1

Enter g[z,z]

1

If there are any complex valued coordinates, constants or functions
for this spacetime, please enter them as a SET (eg. { z, psi }).

Complex quantities [default={}]:

{}

The values you have entered are:

$$Coordinates = [\, t, x, y, z \,]$$

Metric:

$$g_{a\,b} = \begin{bmatrix} -(1+a\,x)^2 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

You may choose to 0) Use the metric WITHOUT saving it,
1) Save the metric as it is,
2) Correct an element of the metric,
3) Re-enter the metric,

```
                    4) Add/change constraint equations,
                    5) Add a text description, or
                    6) Abandon this metric and return to
Maple.
```

0

```
Calculating ds for accelerated ... Done. (0.000000 sec.
)
```

$$\textit{Default spacetime} = \textit{accelerated}$$

$$\textit{For the accelerated spacetime:}$$

$$\textit{Coordinates}$$

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

$$x^a = [\,t \quad x \quad y \quad z\,]$$

$$\textit{Line element}$$

$$ds^2 = -(1 + a\,x)^2\ d\,t^2 + d\,x^2 + d\,y^2 + d\,z^2$$

```
makeg completed.
```

> grcalc(R(dn,dn,dn,dn));

```
Calculating detg for accelerated ... Done. (0.000000 se
c.)
Calculating g(up,up) for accelerated ... Done. (0.01000
0 sec.)
Calculating g(dn,dn,pdn) for accelerated ... Done. (0.0
10000 sec.)
Calculating Chr(dn,dn,dn) for accelerated ... Done. (0.
020000 sec.)
Calculating R(dn,dn,dn,dn) for accelerated ... Done. (0
.040000 sec.)
```

$$\textit{CPU Time} = .090$$

> grdisplay(_);

For the accelerated spacetime:

Covariant Riemann

R(dn,dn,dn,dn) = All components are zero

Note that GRTensor uses a different convention than Wald for the Christoffel symbols.
Here, the Christoffel symbols are symmetric in their FIRST TWO indices, rather than
their LAST TWO. Chr(dn,dn,up) corresponds to Wald's Chr(up,dn,dn).

> grdisplay(Chr(dn,dn,up));

```
Chr(dn,dn,up) has not been calculated.
```

> grcalc(Chr(dn,dn,up));

```
Calculating Chr(dn,dn,up) for accelerated ... Done. (0.
020000 sec.)
```

CPU Time = .030

> grdisplay(_);

For the accelerated spacetime:

Christoffel symbol of the second kind (symmetric in first t \ wo indices)

$$\Gamma_{t\,t}{}^{x} = (1 + a\,x)\,a$$

$$\Gamma_{t\,x}{}^{t} = \frac{a}{1 + a\,x}$$