```
> with(Physics):with(DifferentialGeometry):with(plots):with
  (PDEtools):with(Tensor):
> #The sign convention for the Ricci tensor of the DifferentialGeometry and Physics
      packages is the same followed in MTW.
>
> #Manifold definition:
> DGsetup([t, r, u, v], M, verbose)
```

The following coordinates have been protected:

$$[t, r, u, v]$$

The following vector fields have been defined and protected:

$$[\text{`*`}(D\_t), \text{`*`}(D\_r), \text{`*`}(D\_u), \text{`*`}(D\_v)]$$

The following differential 1-forms have been defined and protected:

$$[\text{`*`}(dt), \text{`*`}(dr), \text{`*`}(du), \text{`*`}(dv)]$$

frame name: M **(1)**

```
M >
M > g1 := evalDG( dt &t dt +  ((1 - u*chi*cos(int(-tau(r), r) +
    v))^2)*dr &t dr +  du &t du + (u^2)*dv &t dv)
```

$$g1 := (\text{`*`}(dt))\, dt + \left(\left(u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)-1\right)^2 dr\right) dr + (\text{`*`}(du))\, du + (u^2\, dv)\, dv \quad \textbf{(2)}$$

```
M > g1i:= InverseMetric(g1)
```

$$g1i := (\text{`*`}(D\_t))\, D\_t + \left(\frac{1}{\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)^2\chi^2 u^2 - 2\,u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)+1}\, D\_r\right) D\_r + (\text{`*`}(D\_u))\, D\_u + \left(\frac{1}{u^2}\, D\_v\right) D\_v \quad \textbf{(3)}$$

```
M > #Christoffel symbols of the second kind:
M > C1 := Christoffel(g1, "SecondKind")
```

$$C1 := \left(\left(\frac{u\chi\tau(r)\sin\left(-\left(\int\tau(r)\,dr\right)+v\right)}{u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)-1}\, D\_r\right) dr\right) dr + \left(\left(\frac{\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)}{u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)-1}\, D\_r\right) dr\right) du - \left(\left(\left(\frac{u\chi\sin\left(-\left(\int\tau(r)\,dr\right)+v\right)}{u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)-1}\, D\_r\right) dr\right) dv\right) \quad \textbf{(4)}$$

$$+\left(\left(\frac{\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)}{u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)-1}\,D\_r\right)du\right)dr$$

$$-\left(\left(\left(\frac{u\chi\sin\left(-\left(\int\tau(r)\,dr\right)+v\right)}{u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)-1}\,D\_r\right)dv\right)dr\right)-\left(\left(\left(\left(u\chi\cos\left(-\left(\int\tau(r)\right.\right.\right.\right.\right.$$

$$\left.\left.\left.\left.\left.dr\right)+v\right)-1\right)\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)D\_u\right)dr\right)dr\right)-(((u\,D\_u)\,dv)\,dv)$$

$$+\left(\left(\frac{\left(u\chi\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)-1\right)\chi\sin\left(-\left(\int\tau(r)\,dr\right)+v\right)}{u}\,D\_v\right)dr\right)dr$$

$$+\left(\left(\frac{1}{u}\,D\_v\right)du\right)dv+\left(\left(\frac{1}{u}\,D\_v\right)dv\right)du$$

```
M > #Ricci tensor:
M > R1:=RicciTensor(C1)
```

$$R1 := (0\,dt)\,dt \tag{5}$$

```
M >
M >
M > #4-potential vector:
M > A := DGzip([At, Ar, Au, Av])(t, r, u, v), [D_t, D_r, D_u,
    D_v], "plus")
```

$$A := At(t, r, u, v)\,D\_t + Ar(t, r, u, v)\,D\_r + Au(t, r, u, v)\,D\_u + Av(t, r, u, v)\,D\_v \tag{6}$$

```
M > #Covariant derivative of the 4-potential:
M > Dc:=CovariantDerivative(A, C1):
M > #The second covariant derivative of the 4-potential:
M > Dc2:=CovariantDerivative(Dc, C1):
M > #Contraction of the indices of the covariant derivatives to get the Laplacian:
M > L:=ContractIndices(g1i, Dc2, [[1, 2], [2,3]]):
M >
M > ####"Mass term" of the Maxwell equations, i.e, contraction of the Ricci tensor
        with the 4-potential:
M > #Rising one index of the Ricci tensor:
M > R1up:=ContractIndices(g1i, R1, [[1, 1]]):
M > #Contraction of the Ricci tensor with the four-potential:
M > Mass:=ContractIndices(A, R1up, [[1,2]]):
```

```
M > #Maxwell equations!!!!!!!!!!!!!!!!:
M > Me:= L &minus Mass
```

$$Me := \left(\left(\frac{\partial^2}{\partial u^2}\,At(t, r, u, v)\right)\cos\left(-\left(\int\tau(r)\,dr\right)+v\right)^3\chi^3\,u^5+\left(\frac{\partial^2}{\partial t^2}\,At(t, r, u,\right. \tag{7}$$

$$
\begin{aligned}
&\nu)\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^3\chi^3u^5+2\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^3\Big(\frac{\partial}{\partial u}At(t,r,u,\\
&\nu)\Big)\chi^3u^4-\Big(\frac{\partial}{\partial\nu}At(t,r,u,\nu)\Big)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)\\
&+\nu\Big)^2\chi^3u^3+\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^3\Big(\frac{\partial^2}{\partial\nu^2}At(t,r,u,\nu)\Big)\chi^3u^3-3\Big(\frac{\partial^2}{\partial u^2}At(t,\\
&r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\chi^2u^4-3\Big(\frac{\partial^2}{\partial t^2}At(t,r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\\
&dr\Big)+\nu\Big)^2\chi^2u^4-5\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\Big(\frac{\partial}{\partial u}At(t,r,u,\nu)\Big)\chi^2u^3+2\Big(\frac{\partial}{\partial\nu}\\
&At(t,r,u,\nu)\Big)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi^2u^2-\tau(r)\Big(\frac{\partial}{\partial r}\\
&At(t,r,u,\nu)\Big)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^3-3\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\Big(\frac{\partial^2}{\partial\nu^2}\\
&At(t,r,u,\nu)\Big)\chi^2u^2+3\Big(\frac{\partial^2}{\partial u^2}At(t,r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^3+\Big(\frac{\partial^2}{\partial r^2}\\
&At(t,r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^3+3\Big(\frac{\partial^2}{\partial t^2}At(t,r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\\
&dr\Big)+\nu\Big)\chi u^3+4\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\Big(\frac{\partial}{\partial u}At(t,r,u,\nu)\Big)\chi u^2-\Big(\frac{\partial}{\partial\nu}At(t,\\
&r,u,\nu)\Big)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u+3\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\Big(\frac{\partial^2}{\partial\nu^2}At(t,r,u,\\
&\nu)\Big)\chi u-\Big(\frac{\partial^2}{\partial u^2}At(t,r,u,\nu)\Big)u^2-\Big(\frac{\partial^2}{\partial r^2}At(t,r,u,\nu)\Big)u^2-\Big(\frac{\partial^2}{\partial t^2}At(t,r,u,\\
&\nu)\Big)u^2-u\Big(\frac{\partial}{\partial u}At(t,r,u,\nu)\Big)-\Big(\frac{\partial^2}{\partial\nu^2}At(t,r,u,\nu)\Big)\Big)\Big/\Big(u^2\Big(\cos\Big(-\Big(\int\tau(r)\\
&dr\Big)+\nu\Big)^3\chi^3u^3-3\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\chi^2u^2+3u\chi\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\\
&-1\Big)\Big)D\_t+\Big(3u\chi\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\Big(\frac{\partial}{\partial\nu}Ar(t,r,u,\nu)\Big)-4\cos\Big(-\Big(\\
&\int\tau(r)\,dr\Big)+\nu\Big)\Big(\frac{\partial^2}{\partial\nu^2}Ar(t,r,u,\nu)\Big)\chi u+6\Big(\frac{\partial^2}{\partial\nu^2}Ar(t,r,u,\nu)\Big)\cos\Big(-\Big(\\
&\int\tau(r)\,dr\Big)+\nu\Big)^2\chi^2u^2+\Big(\frac{\partial^2}{\partial u^2}Ar(t,r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^4\chi^4u^6\\
&+\Big(\frac{\partial^2}{\partial t^2}Ar(t,r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^4\chi^4u^6+\cos\Big(-\Big(\int\tau(r)\,dr\Big)\\
&+\nu\Big)^4\Big(\frac{\partial^2}{\partial\nu^2}Ar(t,r,u,\nu)\Big)\chi^4u^4-4\Big(\frac{\partial^2}{\partial u^2}Ar(t,r,u,\nu)\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)
\end{aligned}
$$

$$+\nu\Big)^3\chi^3u^5-4\left(\frac{\partial^2}{\partial t^2}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^3\chi^3u^5-4\cos\Big($$

$$-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^3\left(\frac{\partial^2}{\partial v^2}\,Ar(t,r,u,\nu)\right)\chi^3u^3+6\left(\frac{\partial^2}{\partial u^2}\,Ar(t,r,u,\nu)\right)\cos\Big($$

$$-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\chi^2u^4+\left(\frac{\partial^2}{\partial r^2}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\chi^2u^4$$

$$+6\left(\frac{\partial^2}{\partial t^2}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\chi^2u^4-4\left(\frac{\partial^2}{\partial u^2}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^3-2\left(\frac{\partial^2}{\partial r^2}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)\chi u^3-4\left(\frac{\partial^2}{\partial t^2}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^3-3\left(\frac{\partial}{\partial\nu}\,Ar(t,r,u,\nu)\right)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^3\chi^4u^4+9\left(\frac{\partial}{\partial\nu}\,Ar(t,r,u,\nu)\right)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^2\chi^3u^3-2\left(\frac{\partial}{\partial r}\,Av(t,r,u,\nu)\right)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi^2u^4-7\cos\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)\left(\frac{\partial}{\partial u}\,Ar(t,r,u,\nu)\right)\chi u^2-9\left(\frac{\partial}{\partial\nu}\,Ar(t,r,u,\nu)\right)\sin\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi^2u^2+\left(\frac{d}{dr}\,\tau(r)\right)Ar(t,r,u,\nu)\sin\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi^2u^4+\tau(r)\left(\frac{\partial}{\partial r}\,Ar(t,r,u,\nu)\right)\sin\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi^2u^4+\left(\frac{\partial^2}{\partial u^2}\,Ar(t,r,u,\nu)\right)u^2+\left(\frac{\partial^2}{\partial r^2}\,Ar(t,r,u,\nu)\right)u^2+\left(\frac{\partial^2}{\partial t^2}\,Ar(t,r,u,\nu)\right)u^2+Ar(t,r,u,\nu)\,\tau(r)^2\cos\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)\chi u^3-\left(\frac{d}{dr}\,\tau(r)\right)Ar(t,r,u,\nu)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^3-\tau(r)\left(\frac{\partial}{\partial r}\,Ar(t,r,u,\nu)\right)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^3-\tau(r)\,Av(t,r,u,\nu)\cos\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)\chi u^3-\tau(r)\,Au(t,r,u,\nu)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)\chi u^2+4\left(\frac{\partial}{\partial u}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+\nu\Big)^4\chi^4u^5-13\left(\frac{\partial}{\partial u}\,Ar(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)$$

$$+\nu\Big)^3\chi^3u^4-Ar(t,r,u,\nu)\,\tau(r)^2\chi^2u^4+2\left(\frac{\partial}{\partial r}\,Au(t,r,u,\nu)\right)\cos\Big(-\Big(\int\tau(r)$$

$$\left(\int \tau(r)\,dr\right)+v\Big)^2\chi^2u^3+\tau(r)\,Av(t,r,u,v)\,\chi^2u^4+15\left(\frac{\partial}{\partial u}\,Ar(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2\chi^2u^3+2\left(\frac{\partial}{\partial r}\,Av(t,r,u,v)\right)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\chi\,u^3-2\left(\frac{\partial}{\partial r}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\chi\,u^2+\frac{\partial^2}{\partial v^2}\,Ar(t,r,u,v)+\left(\frac{\partial}{\partial u}\,Ar(t,r,u,v)\right)u\Big)\Big/\Big(u^2\Big(\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^4\chi^4u^4-4\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^3\chi^3u^3+6\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2\chi^2u^2-4\,u\chi\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)+1\Big)\Big)D\_r+\Big(Au(t,r,u,v)-2\,Ar(t,r,u,v)\,\tau(r)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2\chi^3u^4+3\,Ar(t,r,u,v)\,\tau(r)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\chi^2u^3+\left(\frac{\partial^2}{\partial u^2}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^3\chi^3u^5+\left(\frac{\partial^2}{\partial t^2}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^3\chi^3u^5+\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^3\left(\frac{\partial^2}{\partial v^2}\,Au(t,r,u,v)\right)\chi^3u^3-3\left(\frac{\partial^2}{\partial u^2}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2\chi^2u^4-3\left(\frac{\partial^2}{\partial t^2}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2\chi^2u^4-3\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2\left(\frac{\partial^2}{\partial v^2}\,Au(t,r,u,v)\right)\chi^2u^2+3\left(\frac{\partial^2}{\partial u^2}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\chi\,u^3+\left(\frac{\partial^2}{\partial r^2}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\chi\,u^3+3\left(\frac{\partial^2}{\partial t^2}\,Au(t,r,u,v)\right)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\chi\,u^3+3\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\left(\frac{\partial^2}{\partial v^2}\,Au(t,r,u,v)\right)\chi\,u+2\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2Av(t,r,u,v)\,\chi^3u^4-\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)^2\left(\frac{\partial}{\partial v}\,Au(t,r,u,v)\right)\chi^3u^3-3\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)Av(t,r,u,v)\,\chi^2u^3-\left(\frac{\partial}{\partial r}\,Au(t,r,u,v)\right)\tau(r)\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\chi\,u^3+2\sin\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\cos\Big(-\Big(\int\tau(r)\,dr\Big)+v\Big)\left(\frac{\partial}{\partial v}\,Au(t,r,u,v)\right)\chi^2u^2$$

$$
\begin{aligned}
&- Ar(t, r, u, v)\,\tau(r)\,\sin\left(-\left(\int \tau(r)\,dr\right)+v\right)\chi\,u^2-\left(\frac{\partial^2}{\partial u^2}\,Au(t, r, u, v)\right)u^2\\
&-\left(\frac{\partial^2}{\partial r^2}\,Au(t, r, u, v)\right)u^2-\left(\frac{\partial^2}{\partial t^2}\,Au(t, r, u, v)\right)u^2+2\left(\frac{\partial}{\partial v}\,Av(t, r, u, v)\right)u\\
&-\left(\frac{\partial}{\partial u}\,Au(t, r, u, v)\right)u-\left(\frac{\partial^2}{\partial v^2}\,Au(t, r, u, v)\right)-2\left(\frac{\partial}{\partial r}\,Ar(t, r, u,\right.\\
&\left.v)\right)\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^3\chi^3\,u^4+2\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^3\left(\frac{\partial}{\partial u}\,Au(t, r, u,\right.\\
&\left.v)\right)\chi^3\,u^4-2\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^3\left(\frac{\partial}{\partial v}\,Av(t, r, u, v)\right)\chi^3\,u^4-2\cos\left(-\left(\right.\right.\\
&\left.\left.\int \tau(r)\,dr\right)+v\right)^3 Au(t, r, u, v)\,\chi^3\,u^3+4\left(\frac{\partial}{\partial r}\,Ar(t, r, u, v)\right)\cos\left(-\left(\int \tau(r)\,dr\right)\right.\\
&\left.+v\right)^2\chi^2\,u^3-5\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^2\left(\frac{\partial}{\partial u}\,Au(t, r, u, v)\right)\chi^2\,u^3+6\cos\left(\right.\\
&\left.-\left(\int \tau(r)\,dr\right)+v\right)^2\left(\frac{\partial}{\partial v}\,Av(t, r, u, v)\right)\chi^2\,u^3+4\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^2 Au(t,\\
&r, u, v)\,\chi^2\,u^2-2\left(\frac{\partial}{\partial r}\,Ar(t, r, u, v)\right)\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)\chi\,u^2+\sin\left(-\left(\int \tau(r)\right.\right.\\
&\left.\left.dr\right)+v\right)Av(t, r, u, v)\,\chi\,u^2+4\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)\left(\frac{\partial}{\partial u}\,Au(t, r, u, v)\right)\chi\,u^2\\
&-6\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)\left(\frac{\partial}{\partial v}\,Av(t, r, u, v)\right)\chi\,u^2-\sin\left(-\left(\int \tau(r)\,dr\right)\right.\\
&\left.+v\right)\left(\frac{\partial}{\partial v}\,Au(t, r, u, v)\right)\chi\,u-3\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)Au(t, r, u, v)\,\chi\,u\Bigg)\Bigg/\\
&\left(u^2\left(\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^3\chi^3\,u^3-3\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^2\chi^2\,u^2\right.\right.\\
&\left.\left.+3\,u\,\chi\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)-1\right)\right)D\_u-\left(\left(-3\cos\left(-\left(\int \tau(r)\,dr\right)\right.\right.\right.\\
&\left.\left.\left.+v\right)\left(\frac{\partial^2}{\partial v^2}\,Av(t, r, u, v)\right)\chi\,u^2-\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^3\left(\frac{\partial^2}{\partial u^2}\,Av(t, r, u,\right.\right.\right.\\
&\left.\left.\left.v)\right)\chi^3\,u^6-\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^3\left(\frac{\partial^2}{\partial t^2}\,Av(t, r, u, v)\right)\chi^3\,u^6-\cos\left(-\left(\int \tau(r)\right.\right.\right.\\
&\left.\left.\left.dr\right)+v\right)^3\left(\frac{\partial^2}{\partial v^2}\,Av(t, r, u, v)\right)\chi^3\,u^4+3\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^2\left(\frac{\partial^2}{\partial u^2}\,Av(t, r,\right.\right.\right.\\
&\left.\left.\left.u, v)\right)\chi^2\,u^5+3\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^2\left(\frac{\partial^2}{\partial t^2}\,Av(t, r, u, v)\right)\chi^2\,u^5+3\cos\left(\right.\right.\right.\\
&\left.\left.\left.-\left(\int \tau(r)\,dr\right)+v\right)^2\left(\frac{\partial^2}{\partial v^2}\,Av(t, r, u, v)\right)\chi^2\,u^3-3\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)\left(\frac{\partial^2}{\partial u^2}\right.\right.\right.\\
&\left.\left.\left.Av(t, r, u, v)\right)\chi\,u^4-\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)\left(\frac{\partial^2}{\partial r^2}\,Av(t, r, u, v)\right)\chi\,u^4-3\cos\left(\right.\right.\right.
\end{aligned}
$$

$$-\left(\int\tau(r)\,dr\right)+v\Big)\left(\frac{\partial^2}{\partial t^2}\,Av(t,r,u,v)\right)\chi\,u^4-Av(t,r,u,v)\,\chi^2\,u^3+3\left(\frac{\partial}{\partial u}\,Av(t,r,u,v)\right)u^2-4\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^3\left(\frac{\partial}{\partial u}\,Av(t,r,u,v)\right)\chi^3\,u^5-2\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^3\,Av(t,r,u,v)\,\chi^3\,u^4-2\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^3\left(\frac{\partial}{\partial v}\,Au(t,r,u,v)\right)\chi^3\,u^3+11\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^2\left(\frac{\partial}{\partial u}\,Av(t,r,u,v)\right)\chi^2\,u^4+\cos\Big(-\Big(\int\tau(r)\,dr\right)+v\Big)\,Av(t,r,u,v)\,\chi^3\,u^4+3\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^2\,Av(t,r,u,v)\,\chi^2\,u^3+Ar(t,r,u,v)\,\tau(r)\,\chi^2\,u^3+6\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^2\left(\frac{\partial}{\partial v}\,Au(t,r,u,v)\right)\chi^2\,u^2-10\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\left(\frac{\partial}{\partial u}\,Av(t,r,u,v)\right)\chi\,u^3-2\left(\frac{\partial}{\partial r}\,Ar(t,r,u,v)\right)\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\chi\,u^2+\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\left(\frac{\partial}{\partial v}\,Av(t,r,u,v)\right)\chi\,u^2-\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\,Av(t,r,u,v)\,\chi\,u^2+\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\,Au(t,r,u,v)\,\chi\,u-6\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\left(\frac{\partial}{\partial v}\,Au(t,r,u,v)\right)\chi\,u+\left(\frac{\partial^2}{\partial u^2}\,Av(t,r,u,v)\right)u^3+\left(\frac{\partial^2}{\partial r^2}\,Av(t,r,u,v)\right)u^3+\left(\frac{\partial^2}{\partial t^2}\,Av(t,r,u,v)\right)u^3+\left(\frac{\partial^2}{\partial v^2}\,Av(t,r,u,v)\right)u+2\,Ar(t,r,u,v)\,\tau(r)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^3\chi^3\,u^4-2\left(\frac{\partial}{\partial r}\,Ar(t,r,u,v)\right)\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^2\chi^3\,u^4+\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^2\left(\frac{\partial}{\partial v}\,Av(t,r,u,v)\right)\chi^3\,u^4-Ar(t,r,u,v)\,\tau(r)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\chi^3\,u^4-3\,Ar(t,r,u,v)\,\tau(r)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)^2\chi^2\,u^3+\left(\frac{\partial}{\partial r}\,Av(t,r,u,v)\right)\tau(r)\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\chi\,u^4+4\left(\frac{\partial}{\partial r}\,Ar(t,r,u,v)\right)\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\chi^2\,u^3-2\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\left(\frac{\partial}{\partial v}\,Av(t,r,u,v)\right)\chi^2\,u^3-\sin\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\cos\Big(-\left(\int\tau(r)\,dr\right)+v\Big)\,Au(t,r,u,v)\,\chi^2\,u^2+Ar(t,r,u,v)\,\tau(r)\cos\Big(-\Big($$

$$\left(\int \tau(r)\,dr\right)+v\Big)\,\chi\,u^2+2\left(\frac{\partial}{\partial v}\,Au(t,r,u,v)\right)\Big)\Big/\Big(u^3\left(\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^3\chi^3\,u^3-3\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)^2\chi^2\,u^2+3\,u\,\chi\cos\left(-\left(\int \tau(r)\,dr\right)+v\right)-1\right)\Big)\,D\_v\Big)$$

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