(%i1)
```
/* define special summation function */
f(i,j) := sum(R[i,j,sigma,0]*gContr[i,sigma]*gContr[j,0],sigma,0,3)
        + sum(R[i,j,sigma,1]*gContr[i,sigma]*gContr[j,1],sigma,0,3)
        + sum(R[i,j,sigma,2]*gContr[i,sigma]*gContr[j,2],sigma,0,3)
        + sum(R[i,j,sigma,3]*gContr[i,sigma]*gContr[j,3],sigma,0,3);
```

(%o1) $$f(i,j) := sum(R_{i,j,\sigma,0}\,gContr_{i,\sigma}\,gContr_{j,0},\sigma,0,3) + sum(R_{i,j,\sigma,1}\,gContr_{i,\sigma}\,gContr_{j,1},\sigma,0,3) + sum(R_{i,j,\sigma,2}\,gContr_{i,\sigma}\,gContr_{j,2},\sigma,0,3) + sum(R_{i,j,\sigma,3}\,gContr_{i,\sigma}\,gContr_{j,3},\sigma,0,3)$$

(%i2)
```
/* define coordinate vector */
array(x, 3);
[x[0],x[1],x[2],x[3]]: [t, x1, x2, x3];
```

(%o2) x

(%o3) $[\,t\,,\,x1\,,\,x2\,,\,x3\,]$

(%i4)
```
/* g1 is symm. metric with indices 1...4 */
g1: matrix(
  [-1,0,0,0],
  [0,t^(2*p1),0,0],
  [0,0,t^(2*p2),0],
  [0,0,0,t^(2*p3)]
);
```

(%o4)
$$\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & t^{2\,p1} & 0 & 0 \\ 0 & 0 & t^{2\,p2} & 0 \\ 0 & 0 & 0 & t^{2\,p3} \end{bmatrix}$$

(%i5)
```
/* contravariant g is inverse of g */
gContr1: ratsimp(invert(g1));
```

(%o5)
$$\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & \frac{1}{t^{2\,p1}} & 0 & 0 \\ 0 & 0 & \frac{1}{t^{2\,p2}} & 0 \\ 0 & 0 & 0 & \frac{1}{t^{2\,p3}} \end{bmatrix}$$

(%i6)

```
/* g1 and gContr1 are transformed to g and gContr (indices 0...3) */
for mu:0 thru 3 do {
for nu:0 thru 3 do {
    g     [mu,nu]: g1     [mu+1, nu+1],
    gContr[mu,nu]: gContr1[mu+1, nu+1]
}}$
```

```
(%i7)  /* computation of Christoffel symbols Gamma^sigma_mu_nu */
       for sigma:0 thru 3 do {
       for mu:0 thru 3 do {
       for nu:0 thru 3 do {
           Gamma[sigma,mu,nu] :
           /* rho sum by function call: */
           sum(
               1/2 * gContr[sigma,rho]*(
               diff(g[nu,rho],x[mu] ) +
               diff(g[rho,mu],x[nu] ) -
               diff(g[mu,nu] ,x[rho])),
           rho, 0, 3),
           /* evaluate differentiation dy/dr */
           Gamma[sigma,mu,nu]: ev(Gamma[sigma,mu,nu],diff)
       }}}$
```

```
(%i8)  /* dislplay Gamma's being different from zero */
       for i:0 thru 3 do {
       for j:0 thru 3 do {
       for k:0 thru 3 do {
           if Gamma[i,j,k] # 0 then {
               display(Gamma[i,j,k])
           }}}}$
```

$$\Gamma_{0,1,1} = p1\ t^{2\,p1-1}$$

$$\Gamma_{0,2,2} = p2\ t^{2\,p2-1}$$

$$\Gamma_{0,3,3} = p3\ t^{2\,p3-1}$$

$$\Gamma_{1,0,1} = \frac{p1}{t}$$

$$\Gamma_{1,1,0} = \frac{p1}{t}$$

$$\Gamma_{2,0,2} = \frac{p2}{t}$$

$$\Gamma_{2,2,0} = \frac{p2}{t}$$

$$\Gamma_{3,0,3} = \frac{p3}{t}$$

$$\Gamma_{3,3,0} = \frac{p3}{t}$$

```
(%i9)  /* compute Riemann tensor elements */
       for rho:0 thru 3 do {
       for sigma:0 thru 3 do {
       for mu:0 thru 3 do {
       for nu:0 thru 3 do {
           R[rho,sigma,mu,nu] :
           diff(Gamma[rho,nu,sigma],x[mu]) -
           diff(Gamma[rho,mu,sigma],x[nu]) +
           /* lambda sums by function call: */
           sum(
               Gamma[rho,mu,lambda] * Gamma[lambda,nu,sigma] -
               Gamma[rho,nu,lambda] * Gamma[lambda,mu,sigma],
               lambda, 0, 3)
       }}}}$
```

```
(%i10)  /* dislplay R's being different from zero */
        for i:0 thru 3 do {
        for j:0 thru 3 do {
        for k:0 thru 3 do {
        for l:0 thru 3 do {
            R[i,j,k,l] : /*ratsimp*/(factor(R[i,j,k,l])),
            if R[i,j,k,l] # 0 then display(R[i,j,k,l])
            }}}}$
```

$$R_{0,1,0,1} = (p1 - 1)\, p1\, t^{2\,p1 - 2}$$

$$R_{0,1,1,0} = -(p1 - 1)\, p1\, t^{2\,p1 - 2}$$

$$R_{0,2,0,2} = (p2 - 1)\, p2\, t^{2\,p2 - 2}$$

$$R_{0,2,2,0} = -(p2 - 1)\, p2\, t^{2\,p2 - 2}$$

$$R_{0,3,0,3} = (p3 - 1)\, p3\, t^{2\,p3 - 2}$$

$$R_{0,3,3,0} = -(p3 - 1)\, p3\, t^{2\,p3 - 2}$$

$$R_{1,0,0,1} = \frac{(p1 - 1)\, p1}{t^2}$$

$$R_{1,0,1,0} = -\frac{(p1 - 1)\, p1}{t^2}$$

$$R_{1,2,1,2} = p1\, p2\, t^{2\,p2 - 2}$$

$$R_{1,2,2,1} = -p1\, p2\, t^{2\,p2 - 2}$$

$$R_{1,3,1,3} = p1\, p3\, t^{2\,p3 - 2}$$

$$R_{1,3,3,1} = -p1\, p3\, t^{2\,p3 - 2}$$

$$R_{2,0,0,2} = \frac{(p2 - 1)\, p2}{t^2}$$

$$R_{2,0,2,0} = -\frac{(p2 - 1)\, p2}{t^2}$$

$$R_{2,1,1,2} = -p1\ p2\ t^{2\,p1-2}$$

$$R_{2,1,2,1} = p1\ p2\ t^{2\,p1-2}$$

$$R_{2,3,2,3} = p2\ p3\ t^{2\,p3-2}$$

$$R_{2,3,3,2} = -p2\ p3\ t^{2\,p3-2}$$

$$R_{3,0,0,3} = \frac{(p3-1)p3}{t^2}$$

$$R_{3,0,3,0} = -\frac{(p3-1)p3}{t^2}$$

$$R_{3,1,1,3} = -p1\ p3\ t^{2\,p1-2}$$

$$R_{3,1,3,1} = p1\ p3\ t^{2\,p1-2}$$

$$R_{3,2,2,3} = -p2\ p3\ t^{2\,p2-2}$$

$$R_{3,2,3,2} = p2\ p3\ t^{2\,p2-2}$$

```
(%i11)  /* Ricci tensor Ric[mu,nu] */
        for mu:0 thru 3 do {
        for nu:0 thru 3 do {
            Ric[mu,nu]: sum(R[lambda,mu,lambda,nu], lambda, 0, 3)
        }}$
```

```
(%i12)  /* dislplay Ric's being different from zero */
        for i:0 thru 3 do {
        for j:0 thru 3 do {
            Ric[i,j] : /*ratsimp*/(factor(Ric[i,j])),
            if Ric[i,j] # 0 then display(Ric[i,j])
            }}$
```

$$Ric_{0,0} = -\frac{p3^2 - p3 + p2^2 - p2 + p1^2 - p1}{t^2}$$

$$Ric_{1,1} = p1\,(p3+p2+p1-1)\,t^{2\,p1-2}$$

$$Ric_{2,2} = p2\,(p3+p2+p1-1)\,t^{2\,p2-2}$$

$$Ric_{3,3} = p3\,(p3+p2+p1-1)\,t^{2\,p3-2}$$

```
(%i13)  /* Ricci Scalar */
        RicSc: sum(gContr[0,lambda]*Ric[lambda,0], lambda, 0, 3)
            +  sum(gContr[1,lambda]*Ric[lambda,1], lambda, 0, 3)
            +  sum(gContr[2,lambda]*Ric[lambda,2], lambda, 0, 3)
            +  sum(gContr[3,lambda]*Ric[lambda,3], lambda, 0, 3)
        ;
```

$$(\%o13)\quad \frac{p3^2 - p3 + p2^2 - p2 + p1^2 - p1}{t^2} + \frac{p3\,(p3+p2+p1-1)}{t^2} + \frac{p2\,(p3+p2+p1-1)}{t^2} +$$

$$\frac{p1\,(p3+p2+p1-1)}{t^2}$$

```
(%i14)  ratsimp(RicSc);
```

$$(\%o14)\quad \frac{2\,p3^2+(2\,p2+2\,p1-2)\,p3+2\,p2^2+(2\,p1-2)\,p2+2\,p1^2-2\,p1}{t^2}$$

```
(%i15)
/* Test for R^q */
for mu:   0 thru 3 do (
for sigma:0 thru 3 do (
for nu:   0 thru 3 do (
for rho:  0 thru 3 do (
    R_q: R[mu,sigma,nu,rho] + R[mu,rho,sigma,nu] + R[mu,nu,rho,sigma],
    if R_q # 0 then (
        display("==============Einstein equation R^q=0 not fulfilled! "),
        display(mu,sigma,nu,rho),
        display(R_q)
    )
))));
(%o15)  done

(%i16)  /* Raising of indices,
           contravarinat metric el. is g^x^x(contr.) = 1/g_x_x(cov.) */
        /*print("Riemann elements R^0_1^0^1, R^0_2^0^2, R^0_3^0^3:");*/

        R0101: f(0,1);
        R0202: f(0,2);
        R0303: f(0,3);
```

$$(\%o16)\quad -\frac{(p1-1)\,p1}{t^2}$$

$$(\%o17)\quad -\frac{(p2-1)\,p2}{t^2}$$

$$(\%o18)\quad -\frac{(p3-1)\,p3}{t^2}$$

```
(%i19)  R0101: factor(R0101);
        R0202: factor(R0202);
        R0303: factor(R0303);
```

$$(\%o19)\quad -\frac{(p1-1)\,p1}{t^2}$$

$$(\%o20)\quad -\frac{(p2-1)\,p2}{t^2}$$

$$(\%o21)\quad -\frac{(p3-1)\,p3}{t^2}$$

```
(%i22) R1010: f(1,0);
       R1212: f(1,2);
       R1313: f(1,3);
```

$$(\%o22)\quad (p1-1)\,p1\,t^{-2\,p1-2}$$

$$(\%o23)\quad p1\,p2\,t^{-2\,p1-2}$$

$$(\%o24)\quad p1\,p3\,t^{-2\,p1-2}$$

```
(%i25) R1010: factor(R1010);
       R1212: factor(R1212);
       R1313: factor(R1313);
```

$$(\%o25)\quad (p1-1)\,p1\,t^{-2\,p1-2}$$

$$(\%o26)\quad p1\,p2\,t^{-2\,p1-2}$$

$$(\%o27)\quad p1\,p3\,t^{-2\,p1-2}$$

```
(%i28) R2020: f(2,0);
       R2121: f(2,1);
       R2323: f(2,3);
```

$$(\%o28)\quad (p2-1)\,p2\,t^{-2\,p2-2}$$

$$(\%o29)\quad p1\,p2\,t^{-2\,p2-2}$$

$$(\%o30)\quad p2\,p3\,t^{-2\,p2-2}$$

```
(%i31) R2020: factor(R2020);
       R2121: factor(R2121);
       R2323: factor(R2323);
```

$$(\%o31)\quad (p2-1)\,p2\,t^{-2\,p2-2}$$

$$(\%o32)\quad p1\,p2\,t^{-2\,p2-2}$$

$$(\%o33)\quad p2\,p3\,t^{-2\,p2-2}$$

```
(%i34) R3030: f(3,0);
       R3131: f(3,1);
       R3232: f(3,2);
```

$$(\%o34)\quad (p3-1)\,p3\,t^{-2\,p3-2}$$

$$(\%o35)\quad p1\,p3\,t^{-2\,p3-2}$$

$$(\%o36)\quad p2\,p3\,t^{-2\,p3-2}$$

```
(%i37) R3030: factor(R3030);
       R3131: factor(R3131);
       R3232: factor(R3232);
```

$$(\%o37)\quad (p3-1)\,p3\,t^{-2\,p3-2}$$

(%o38) $p1\ p3\ t^{-2\,p3-2}$

(%o39) $p2\ p3\ t^{-2\,p3-2}$

(%i40)
```
/* Coulomb law */
DivE : R0101 + R0202 + R0303;
```

(%o40) $-\frac{(p3-1)\,p3}{t^2}-\frac{(p2-1)\,p2}{t^2}-\frac{(p1-1)\,p1}{t^2}$

(%i41)
```
ratsimp(DivE);
```

(%o41) $-\frac{p3^2-p3+p2^2-p2+p1^2-p1}{t^2}$

(%i42)
```
/* J[r] */
Jr : -(R1010 + R1212 + R1313);
```

(%o42) $-p1\ p3\ t^{-2\,p1-2}-p1\ p2\ t^{-2\,p1-2}-(p1-1)\,p1\ t^{-2\,p1-2}$

(%i43)
```
ratsimp(Jr);
```

(%o43) $-(p1\,p3+p1\,p2+p1^2-p1)\,t^{-2\,p1-2}$

(%i44)
```
/* J[theta] */
Jtheta : -(R2020 + R2121 + R2323);
```

(%o44) $-p2\ p3\ t^{-2\,p2-2}-(p2-1)\,p2\ t^{-2\,p2-2}-p1\ p2\ t^{-2\,p2-2}$

(%i45)
```
ratsimp(Jtheta);
```

(%o45) $-(p2\,p3+p2^2+(p1-1)p2)\,t^{-2\,p2-2}$

(%i46)
```
/* J[phi] */
Jphi : -(R3030 + R3131 + R3232);
```

(%o46) $-(p3-1)\,p3\ t^{-2\,p3-2}-p2\ p3\ t^{-2\,p3-2}-p1\ p3\ t^{-2\,p3-2}$

(%i47)
```
ev(ratsimp(Jphi),r);
```

(%o47) $-(p3^2+(p2+p1-1)p3)\,t^{-2\,p3-2}$

(%i50)
```
DivE_p: ev(at(DivE,[p1=sqrt(2),p2=sqrt(2),p3=0]));
```

(%o50) $-\frac{2\,(\sqrt{2}-1)\sqrt{2}}{t^2}$

(%i51)
```
DivE_p: ev(at(DivE,[p1=1,p2=-1,p3=0]));
```

(%o51) $-\frac{2}{t^2}$

(%i52)
```
J1_p: ev(at(Jr,[p1=1,p2=-1,p3=0]));
```

(%o52) $\frac{1}{t^4}$

(%i53)
```
J2_p: ev(at(Jtheta,[p1=1,p2=-1,p3=0]));
```

(%o53) - 1

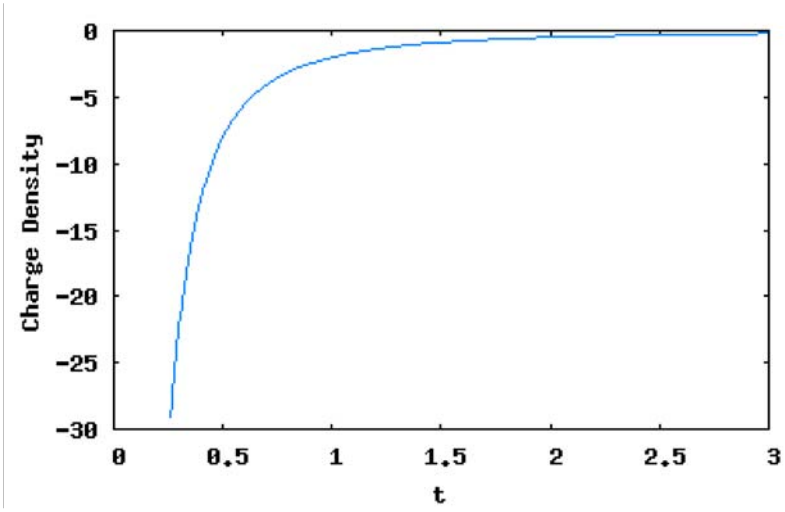
(%i54)
```
J3_p: ev(at(Jphi,[p1=1,p2=-1,p3=0]));
```

(%o54) 0

(%i56)
```
wxplot2d([DivE_p], [t,0,3],[y,-30,0], [gnuplot_preamble, "set zeroaxis;"],
[xlabel, "t"], [ylabel, "Charge Density"])$
```

Output file "C:/Documents and Settings/Administrator/maxout.png".

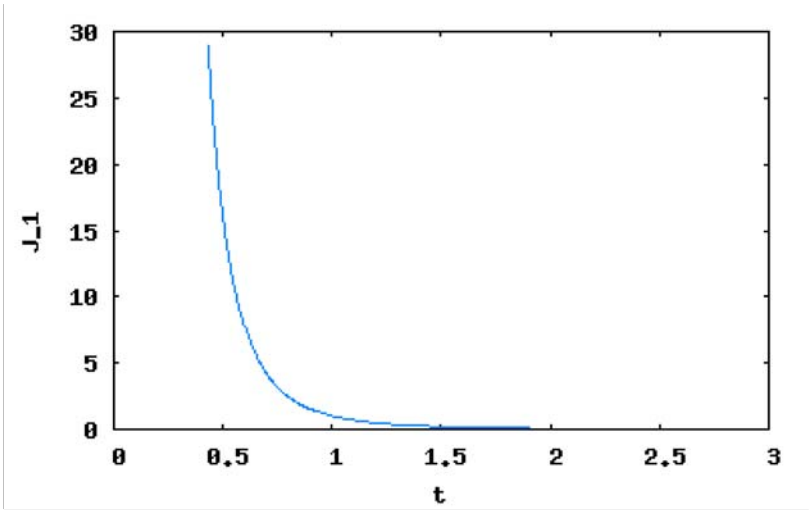
(%t56)



(%i64)
```
wxplot2d([J1_p], [t,0,3],[y,0,30], [gnuplot_preamble, "set zeroaxis;"],
[xlabel, "t"], [ylabel, "J_1"])$
```

Output file "C:/Documents and Settings/Administrator/maxout.png".

(%t64)

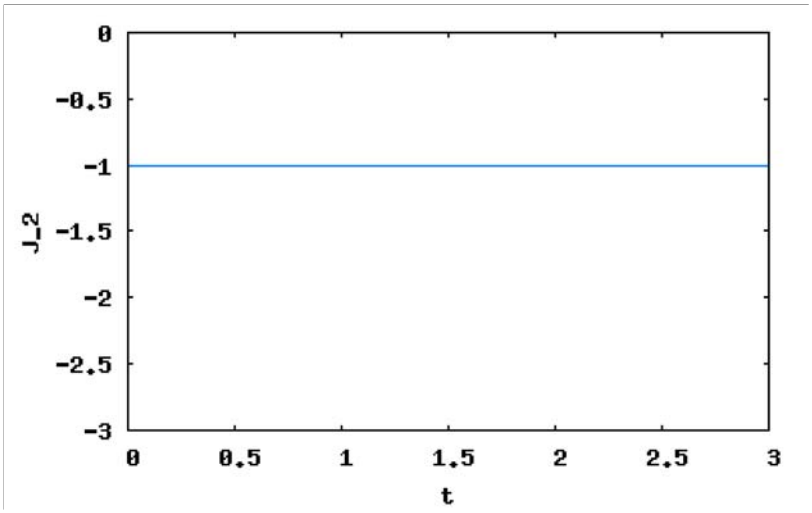


(%i60)

```
wxplot2d([J2_p], [r,0,3],[y,-3,0], [gnuplot_preamble, "set zeroaxis;"],
[xlabel, "t"], [ylabel, "J_2"])$
```

```
Output file "C:/Documents and Settings/Administrator/maxout.png".
```

(%t60)

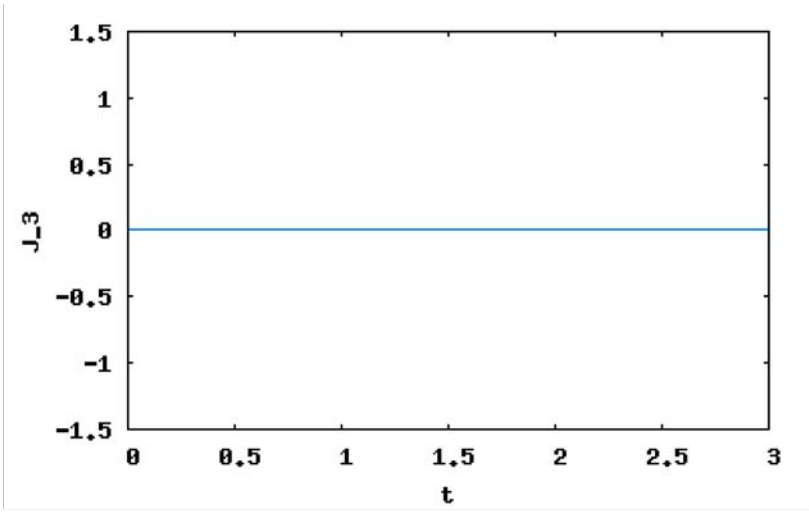


(%i63)

```
wxplot2d([J3_p], [r,0,3],[y,-1.5,1.5], [gnuplot_preamble, "set zeroaxis;"],
[xlabel, "t"], [ylabel, "J_3"])$
```

```
Output file "C:/Documents and Settings/Administrator/maxout.png".
```

(%t63)



(%i65)