1 Cartesian definitions

```
(%i1) kill(all); numer: false;
```
(%o0) *done*
(%o1) false

```
(%i2) curl(a) := [diff(a[3],y) - diff(a[2],z),
                  diff(a[1],z) - diff(a[3],x),
                  diff(a[2],x) - diff(a[1],y)];
```
(%o2) $\mathrm{curl}(a):=[\mathrm{diff}(a_3,y)-\mathrm{diff}(a_2,z),\mathrm{diff}(a_1,z)-\mathrm{diff}(a_3,x),\mathrm{diff}(a_2,x)-\mathrm{diff}(a_1,y)]$

```
(%i3) div(a) :=  diff(a[1], x) + diff(a[2], y) + diff(a[3], z);
```
(%o3) $\mathrm{div}(a):=\mathrm{diff}(a_1,x)+\mathrm{diff}(a_2,y)+\mathrm{diff}(a_3,z)$

2 Rodriguez-Vaz solution

2.1 Define W and parameters

```
(%i4) W: -C*[alpha*Omega*y/r^3 - %beta*x*z/r^5,
      alpha*Omega*x/r^3+%beta*y*z/r^5,
      %beta*(x^2+y^2)/r^5 - 2*alpha/r^3];
```
(%o4) $\left[-\left(\frac{\alpha\,\Omega\,y}{r^3}-\frac{\beta\,x\,z}{r^5}\right)C,-\left(\frac{\beta\,y\,z}{r^5}+\frac{\alpha\,\Omega\,x}{r^3}\right)C,-\left(\frac{\beta\,(y^2+x^2)}{r^5}-\frac{2\,\alpha}{r^3}\right)C\right]$

```
(%i5) factor(W);
```
(%o5) $\left[\frac{(\beta\,x\,z-\alpha\,\Omega\,r^2\,y)\,C}{r^5},-\frac{(\beta\,y\,z+\alpha\,\Omega\,r^2\,x)\,C}{r^5},-\frac{(\beta\,y^2+\beta\,x^2-2\,\alpha\,r^2)\,C}{r^5}\right]$

```
(%i6) alpha: Omega*r*cos(Omega*r) - sin(Omega*r);
```
(%o6) $\Omega\,r\,\cos(\Omega\,r)-\sin(\Omega\,r)$

```
(%i7) %beta: 3*alpha+Omega^2*r^2*sin(Omega*r);
```
(%o7) $\Omega^2\,r^2\,\sin(\Omega\,r)+3\,(\Omega\,r\,\cos(\Omega\,r)-\sin(\Omega\,r))$

```
(%i8) r: sqrt(x^2+y^2+z^2);
```
(%o8) $\sqrt{z^2+y^2+x^2}$

```
(%i9) W2: ev(W);
```

(%o9) $$\left[-\left(\frac{\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))y}{(z^2+y^2+x^2)^{3/2}}-\frac{(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))xz}{(z^2+y^2+x^2)^{5/2}}\right)c,-\left(\frac{\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))x}{(z^2+y^2+x^2)^{3/2}}+\frac{(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))yz}{(z^2+y^2+x^2)^{5/2}}\right)c,-\left(\frac{(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))(y^2+x^2)}{(z^2+y^2+x^2)^{5/2}}-\frac{2(\Omega r\cos(\Omega r)-\sin(\Omega r))}{(z^2+y^2+x^2)^{3/2}}\right)c\right]$$

2.2 Compute curl W

```
(%i10) cW: curl(ev(W));
```

(%o10) $$\left[\left(-\frac{3\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))xz}{(z^2+y^2+x^2)^{5/2}}+\frac{(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))y}{(z^2+y^2+x^2)^{5/2}}-\frac{5(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))yz^2}{(z^2+y^2+x^2)^{7/2}}\right)c-\left(\frac{2(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))y}{(z^2+y^2+x^2)^{5/2}}+\frac{6(\Omega r\cos(\Omega r)-\sin(\Omega r))y}{(z^2+y^2+x^2)^{5/2}}-\frac{5(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))y(y^2+x^2)}{(z^2+y^2+x^2)^{7/2}}\right)c,\left(\frac{2(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))x}{(z^2+y^2+x^2)^{5/2}}+\frac{6(\Omega r\cos(\Omega r)-\sin(\Omega r))x}{(z^2+y^2+x^2)^{5/2}}-\frac{5(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))x(y^2+x^2)}{(z^2+y^2+x^2)^{7/2}}\right)c-\left(-\frac{3\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))yz}{(z^2+y^2+x^2)^{5/2}}-\frac{(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))x}{(z^2+y^2+x^2)^{5/2}}+\frac{5(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))xz^2}{(z^2+y^2+x^2)^{7/2}}\right)c,\left(\frac{\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))}{(z^2+y^2+x^2)^{3/2}}-\frac{3\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))y^2}{(z^2+y^2+x^2)^{5/2}}+\frac{5(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))xyz}{(z^2+y^2+x^2)^{7/2}}\right)c-\left(\frac{\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))}{(z^2+y^2+x^2)^{3/2}}-\frac{3\Omega(\Omega r\cos(\Omega r)-\sin(\Omega r))x^2}{(z^2+y^2+x^2)^{5/2}}-\frac{5(\Omega^2 r^2\sin(\Omega r)+3(\Omega r\cos(\Omega r)-\sin(\Omega r)))xyz}{(z^2+y^2+x^2)^{7/2}}\right)c\right]$$

```
(%i11) kill(r,alpha,%beta);
```

(%o11) *done*

```
(%i12) cW1: ratsubst(r, sqrt(x^2+y^2+z^2), cW);
```

(%o12) $[-(((5\,\Omega^2\,r^2-15)\sin(\Omega\,r)+15\,\Omega\,r\cos(\Omega\,r))\,y\,z^2+(3\,\Omega^2\,r^3\cos(\Omega\,r)-3\,\Omega\,r^2\sin(\Omega\,r))\,x\,z+((15-5\,\Omega^2\,r^2)\sin(\Omega\,r)-15\,\Omega\,r\cos(\Omega\,r))\,y^3+((15-5\,\Omega^2\,r^2)\sin(\Omega\,r)-15\,\Omega\,r\cos(\Omega\,r))\,x^2+(\Omega^2\,r^4-9\,r^2)\sin(\Omega\,r)+9\,\Omega\,r^3\cos(\Omega\,r))\,y)\,C)/r^7,-(((5\,\Omega^2\,r^2-15)\sin(\Omega\,r)+15\,\Omega\,r\cos(\Omega\,r))\,x\,z^2+(3\,\Omega\,r^2\sin(\Omega\,r)-3\,\Omega^2\,r^3\cos(\Omega\,r))\,y\,z+((5\,\Omega^2\,r^2-15)\sin(\Omega\,r)+15\,\Omega\,r\cos(\Omega\,r))\,x\,y^2+((5\,\Omega^2\,r^2-15)\sin(\Omega\,r)+15\,\Omega\,r\cos(\Omega\,r))\,x^3+((15\,r^2-3\,\Omega^2\,r^4)\sin(\Omega\,r)-15\,\Omega\,r^3\cos(\Omega\,r))\,x)\,C)/r^7,(((10\,\Omega^2\,r^2-30)\sin(\Omega\,r)+30\,\Omega\,r\cos(\Omega\,r))\,x\,y\,z+(3\,\Omega\,r^2\sin(\Omega\,r)-3\,\Omega^2\,r^3\cos(\Omega\,r))\,y^2+(3\,\Omega^2\,r^3\cos(\Omega\,r)-3\,\Omega\,r^2\sin(\Omega\,r))\,x^2)\,C)/r^7]$

```
(%i13) cW2: ratsubst(alpha, Omega*r*cos(Omega*r) - sin(Omega*r), cW1);
```

(%o13) $[-(((5\,\Omega^3\,r^3\cos(\Omega\,r)-5\,alpha\,\Omega^2\,r^2+15\,alpha)\,y\,z^2+3\,alpha\,\Omega\,r^2\,x\,z+(-5\,\Omega^3\,r^3\cos(\Omega\,r)+5\,alpha\,\Omega^2\,r^2-15\,alpha)\,y^3+((-5\,\Omega^3\,r^3\cos(\Omega\,r)+5\,alpha\,\Omega^2\,r^2-15\,alpha)\,x^2+\Omega^3\,r^5\cos(\Omega\,r)-alpha\,\Omega^2\,r^4+9\,alpha\,r^2)\,y)\,C)/r^7,-(((5\,\Omega^3\,r^3\cos(\Omega\,r)-5\,alpha\,\Omega^2\,r^2+15\,alpha)\,x\,z^2-3\,alpha\,\Omega\,r^2\,y\,z+(5\,\Omega^3\,r^3\cos(\Omega\,r)-5\,alpha\,\Omega^2\,r^2+15\,alpha)\,x\,y^2+(5\,\Omega^3\,r^3\cos(\Omega\,r)-5\,alpha\,\Omega^2\,r^2+15\,alpha)\,x^3+(-3\,\Omega^3\,r^5\cos(\Omega\,r)+3\,alpha\,\Omega^2\,r^4-15\,alpha\,r^2)\,x)\,C)/r^7,\frac{((10\,\Omega^3\,r^3\cos(\Omega\,r)-10\,alpha\,\Omega^2\,r^2+30\,alpha)\,x\,y\,z-3\,alpha\,\Omega\,r^2\,y^2+3\,alpha\,\Omega\,r^2\,x^2)\,C}{r^7}]$

2.3 Compute div W

```
(%i14) div(W);
```

(%o14) 0

2.4 Create plot data

```
(%i15) /*filebase: "D:/Doc/Artikel-Eck/ECE-Theorie/Paper258/"*/
       filebase: "F:/Paper258/";
```

(%o15) *F:/Paper258/*

```
(%i16) filename: concat (filebase, "x1.dat");
(%o16) F:/Paper258/x1.dat

(%i17) numer: true;
       stream: openw(filename);
       printf(stream, "# x1 x2 x3 v1 v2 v3 cv1 cv2 cv3~%");
(%o17) true
(%o18) Stream [STRING-CHAR]
(%o19) false

(%i20) C: -1; Omega: 1;
(%o20) -1
(%o21) 1

(%i22) r: sqrt(x^2+y^2+z^2);
```

(%o22) $(z^2+y^2+x^2)^{0.5}$

```
(%i23) alpha: Omega*r*cos(Omega*r) - sin(Omega*r);
```

(%o23) $(z^2+y^2+x^2)^{0.5}\cos((z^2+y^2+x^2)^{0.5})-\sin((z^2+y^2+x^2)^{0.5})$

```
(%i24) f: 1.$
       for k:-3.001 step 3 thru 3.001 do (
           nf: 0,
           z: k/2,
           for j:-4 step 1 thru 4 do (
             y: j/2,
             for i:-4 step 1 thru 4 do (
               x: i/2,
               x1: [x,y,z],
               v1: ev(ev(W2)),
               cv1: ev(ev(cW2))*f,
       /*print (x1,v1,cv1),*/
               w1: x1,
               w2: v1*f,
               w3: cv1*f,
               nf: nf+1,
               wa[nf]: append(w1, w2, w3)
             )
           ),
       for n:1 thru nf do write_data(wa[n], stream),
           printf(stream, "~%"),
           printf(stream, "~%")
       );
(%o25) done

(%i26) close(stream);
(%o26) true
```