space_time_para_4.1.3.wxm

An application document for Geometric Algebra using wxMaxima

Ref: The Survey, para.4.1.3

investigate the use of the fourth axis, e4, as a possible imitation of G(1,3)

Initialization

```
(%i1) ext:["wxm"]$
      file_type_maxima:append(ext,file_type_maxima)$
      batchload("initialize_fns")$
```

the pseudoscalar and its inverse
the lowest useable dimension pseudoscalar should be {e1,e2} i.e. Plen = 2
e.g. for four dimensions edit Pseudos:{e1,e2,e3}$ to Pseudos:{e1,e2,e3,e4}$

```
(%i1) Pseudos:{e1,e2,e3,e4}$
      Pvar:listofvars(Pseudos)$
      Plen:length(Pvar)$
      I:Pseudos$
      ni:(Plen-1)*Plen/2$
      Ii:(-1)^ni*I$
      kill(ni)$
      ldisplay(Pvar)$
```

Result

```
(%i9) batchload("initialize_lsts")$
```

Result

end of Initialization

set derivabbrev:false$

```
(%i12) derivabbrev:false$
```

```
(%i13) ratprint:false$
```

The Survey, para.4.1.3

show the spacetime gammas required for the imitation of G(1,3)

```
(%i14) g1:%i*{e1}$
       g2:%i*{e2}$
       g3:%i*{e3}$
       g4:{e4}$
```

```
(%i18) g1&.g1;
       g2&.g2;
       g3&.g3;
       g4&.g4;
```

Result

the spacetime coordinate vector using the gammas

```
(%i22) x:x1*g1+x2*g2+x3*g3+t*g4;
```

Result

choose a simple rotation angle for partial verification of the hyperbolic identity

```
(%i23) alpha:%pi/3$
       ahalf:alpha/2;
```

Result

the velocity magnitude as a fraction of the speed of light

```
(%i25) tanh(alpha)$
       vel:ev(%,numer);
```

Result

choose a simple (imaginary ugh!) unit vector, vhat for the unit velocity

```
(%i27) vhat:g2$
       vhat&*vhat;
```

Result

show the rotation plane and the rotation bivector

```
(%i29) Plane:vhat&*g4$
       B:Plane*ahalf$
       ldisplay(Plane,B)$
```

Result

form a rotation exponential, with accuracy limited using mvexp(,13)

```
(%i33) mvexp(B,13)$
       ev(%,numer,expand);
```

Result

verify that the intrinsic hyperbolic functions are consistent with function mvexp()
while imitating G(1,3) with the intrinsic imaginary, %i

```
(%i35) cosh(ahalf)+Plane*sinh(ahalf)$
       trigsimp(%)$
       Rv:ev(%,numer,expand);
```

Result

numerical comparison of spacetime vector rotation with the Lorentz transformation
e.g. for a simple velocity, vel*vhat (= vel*g1)

```
(%i38) vel:0.8$
       alpha:atanh(vel)$
       ahalf:alpha/2;
```

Result

form the rotation bivector

```
(%i41) vhat:g1$
       B:vhat&*g4*ahalf$
       ev(%,numer,expand);
```

Result

form the left and right exponential multipliers

```
(%i44) mvexp(-B,13)$
       lexp:ev(%,numer,expand);
```

Result

```
(%i46) mvexp(+B,13)$
       rexp:ev(%,numer,expand);
```

Result

apply the rotation to a spacetime coordinate vector "parallel" to the velocity

```
(%i48) x:x1*g1+t*g4;
```

Result

find the rotated spacetime vector

```
(%i49) xbar:lexp&*x&*rexp$
       ev(%,numer,expand)$
       collectterms(%,%i,e1,e4);
```

Result

compare the spacetime rotation result with the Lorentz transformation factors

```
(%i52) L:1/sqrt(1-vel^2);
```

Result

```
(%i53) Lv:vel*1/sqrt(1-vel^2);
```

Result

the Lorentz space and time

```
(%i54) x1bar:(-Lv*t+L*x1)$
```

```
(%i55) tbar:(+L*t-Lv*x1)$
```

the Lorentz spacetime vector

```
(%i56) x1bar*g1+tbar*g4;
```

Result

Created with wxMaxima.