```
(%i1)  kill(all);
(%o0)  done

(%i1)  assume(c>0, v>0);
(%o1)  [c>0,v>0]
```

1 Self-consistent determination of gamma factor

```
(%i2)  E0: gamma = (1-p^2/(4*m^2*c^2))^(-1/2);
```

$$(E0)\quad \Gamma=\frac{1}{\sqrt{1-\frac{p^2}{4\,c^2\,m^2}}}$$

```
(%i3)  p: gamma*m*v;
```

$$(p)\quad m\,v\,\Gamma$$

```
(%i4)  E1: ev(E0);
```

$$(E1)\quad \Gamma=\frac{1}{\sqrt{1-\frac{v^2\,\Gamma^2}{4\,c^2}}}$$

```
(%i5)  E2: 1/E1^2;
```

$$(E2)\quad \frac{1}{\Gamma^2}=1-\frac{v^2\,\Gamma^2}{4\,c^2}$$

```
(%i6)  E3: E2*gamma^2;
```

$$(E3)\quad 1=\Gamma^2\left(1-\frac{v^2\,\Gamma^2}{4\,c^2}\right)$$

```
(%i7)  E4: subst(Gamma_2, gamma^2, E3);
```

$$(E4)\quad 1=\Gamma_2\left(1-\frac{\Gamma_2\,v^2}{4\,c^2}\right)$$

```
(%i8)  E5: solve(E4,Gamma_2);
```

$$(E5)\quad \left[\Gamma_2=-\frac{2\,c\sqrt{c^2-v^2}-2\,c^2}{v^2},\Gamma_2=\frac{2\,c\sqrt{c^2-v^2}+2\,c^2}{v^2}\right]$$

2 First solution for gamma^2

```
(%i9)  G1: rhs(first(E5));
```

$$(G1)\quad -\frac{2\,c\sqrt{c^2-v^2}-2\,c^2}{v^2}$$

```
(%i10)  G2: 2/1*c^2/v^2*(1-sqrt(1-v^2/c^2));
```

$$(G2)\quad \frac{2\,c^2\left(1-\sqrt{1-\frac{v^2}{c^2}}\right)}{v^2}$$

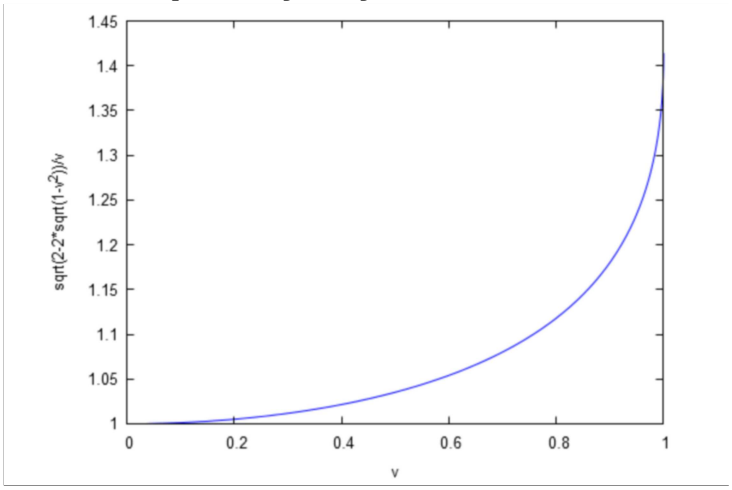
```
(%i11)  ratsimp(G1-G2);
(%o11)  0

(%i12)  Ga: sqrt(ev(G1, [c=1]));
```

$$(Ga)\quad \frac{\sqrt{2-2\sqrt{1-v^2}}}{v}$$

```
(%i13)  wxplot2d([Ga], [v,0,1])$
 plot2d: expression evaluates to non-numeric
value somewhere in plotting range.
```

(%t13)



3 Second solution for gamma^2

```
(%i14)  G1: rhs(second(E5));
```

(G1)
$$\frac{2\,c\sqrt{c^2-v^2}+2\,c^2}{v^2}$$

```
(%i15)  G2: 2/1*c^2/v^2*(1+sqrt(1-v^2/c^2));
```

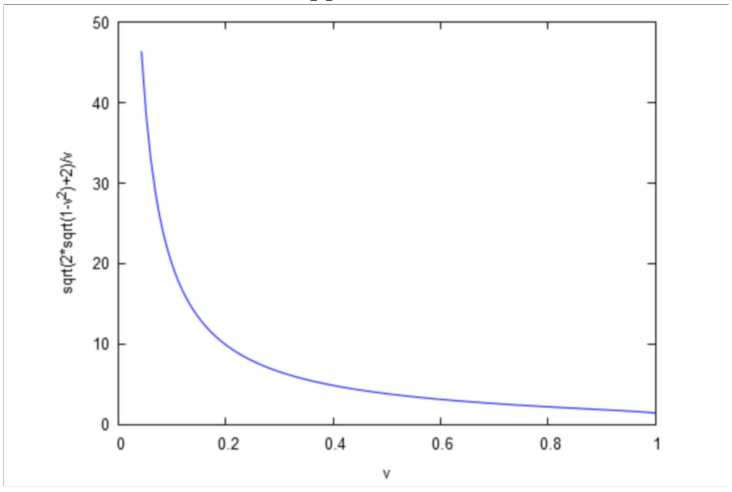
(G2)
$$\frac{2\,c^2\left(\sqrt{1-\frac{v^2}{c^2}}+1\right)}{v^2}$$

```
(%i16)  ratsimp(G1-G2);
(%o16)  0
(%i17)  Gb: sqrt(ev(G1, [c=1]));
```

(Gb)
$$\frac{\sqrt{2\sqrt{1-v^2}+2}}{v}$$

```
(%i18)  wxplot2d([Gb], [v,0,1], [y,0,50])$
 plot2d: expression evaluates to non-numeric value somewhere in p
lotting range.
plot2d: some values were clipped.
```

(%t18)



4 Comparison with gamma of Photons

```
(%i19)  G4: (1-v^2/(2*c^2))^(-1/2);
```

(G4)
$$\frac{1}{\sqrt{1-\frac{v^2}{2\,c^2}}}$$

(%i20)
```
Gc: ev(G4, [c=1]);
```

(Gc)
$$\frac{1}{\sqrt{1-\frac{v^2}{2}}}$$

(%i21)
```
wxplot2d([Gc, Gc], [v,0,1],
    [legend, "relativ. gamma", "gamma of photons"])$
```

(%t21)