‘pst-math’

A PSTricks package for enhancing mathematical operators in PSTricks

ver. 0.3

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‘libre’ is the french word for ‘free’

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1 Trigonometry

‘pst-math’ introduces natural trigonometric postscript operators COS, SIN and TAN defined by

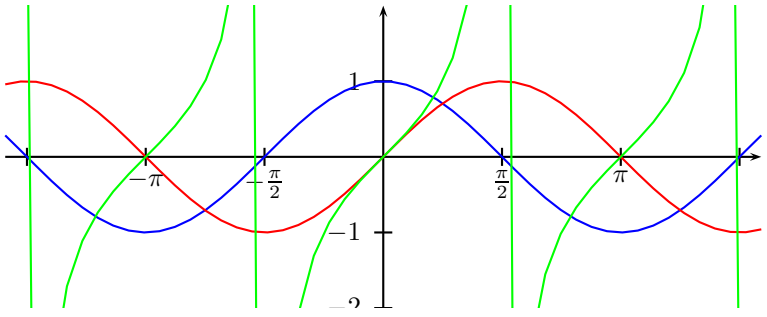
$$\cos : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow & [-1,1] \\ x & \mapsto & \cos(x) \end{array} \right.$$

$$\sin : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow & [-1,1] \\ x & \mapsto & \sin(x) \end{array} \right.$$

$$\tan : \left\{ \begin{array}{ccc} \mathbb{R}\backslash\{k\frac{\pi}{2}, k \in \mathbb{Z}\} & \rightarrow & \mathbb{R} \\ x & \mapsto & \tan(x) \end{array} \right.$$

where x is in *radians*. TAN does *not* produce PS error[1] when $x = k\frac{pi}{2}$.

Stack	Operator	Result	Description
num	**COS**	*real*	Return cosine of *num* radians
num	**SIN**	*real*	Return sine of *num* radians
num	**TAN**	*real*	Return tangent of *num* radians




```
\begin{pspicture}*(-5,-2)(5,2)
\SpecialCoor % For label positionning
\psaxes[labels=y,Dx=\pstPI2]{->}%
    (0,0)(-5,-2)(5,2)
\uput[-90](!PI 0){$\pi$}
\uput[-90](!PI neg 0){$-\pi$}
\uput[-90](!PI 2 div 0){$\frac{\pi}2$}
\uput[-90](!PI 2 div neg 0)%
    {$-\frac{\pi}2$}
\psplot[linecolor=blue]{-5}{5}{x COS}
\psplot[linecolor=red]{-5}{5}{x SIN}
\psplot[linecolor=green]{-5}{5}{x TAN}
\end{pspicture}
```

‘pst-math’ introduces natural trigonometric postscript operators SEC, COSEC and COTAN defined by

$$\sec : \left\{ \begin{array}{ccc} \mathbb{R}\backslash\{k\frac{\pi}{2}, k \in \mathbb{Z}\} & \rightarrow &]-\infty,-1]\bigcup[1,+\infty[\\ x & \mapsto & \sec(x) \end{array} \right.$$

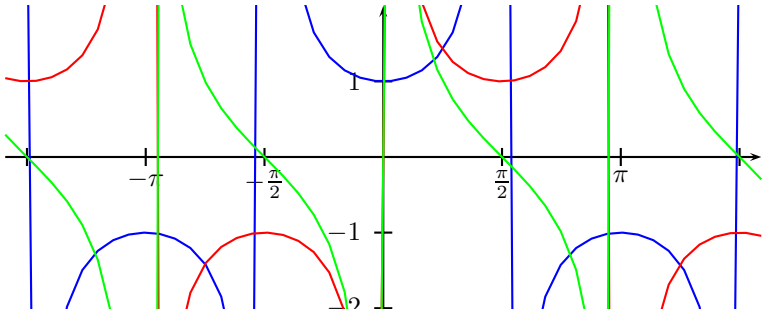
[1] TAN is defined with Div PSTricks operator rather than with div PS operator.

$$\text{cosec} : \left\{ \begin{array}{ccc} \mathbb{R}\backslash\{k\pi, k \in \mathbb{Z}\} & \rightarrow &]-\infty,-1]\bigcup[1,+\infty[\\ x & \mapsto & \text{cosec}(x) \end{array} \right.$$

$$\text{cotan} : \left\{ \begin{array}{ccc} \mathbb{R}\backslash\{k\pi, k \in \mathbb{Z}\} & \rightarrow & \mathbb{R} \\ x & \mapsto & \text{cotan}(x) \end{array} \right.$$

where x is in *radians*.

Stack	Operator	Result	Description
num	**SEC**	*real*	Return secant of *num* radians
num	**COSEC**	*real*	Return cosecant of *num* radians
num	**COTAN**	*real*	Return cotangent of *num* radians




```
\begin{pspicture}*(-5,-2)(5,2)
\SpecialCoor % For label positionning
\psaxes[labels=y,Dx=\pstPI2]{->}%
    (0,0)(-5,-2)(5,2)
\uput[-90](!PI 0){$\pi$}
\uput[-90](!PI neg 0){$-\pi$}
\uput[-90](!PI 2 div 0)%
  {$\frac{\pi}{2}$}
\uput[-90](!PI 2 div neg 0)%
  {$-\frac{\pi}{2}$}
\psplot[linecolor=blue]{-5}{5}{x SEC}
\psplot[linecolor=red]{-5}{5}{x COSEC}
\psplot[linecolor=green]{-5}{5}{x COTAN}
\end{pspicture}
```

'pst-math' introduces natural trigonometric postscript operators ACOS, ASIN and ATAN defined by

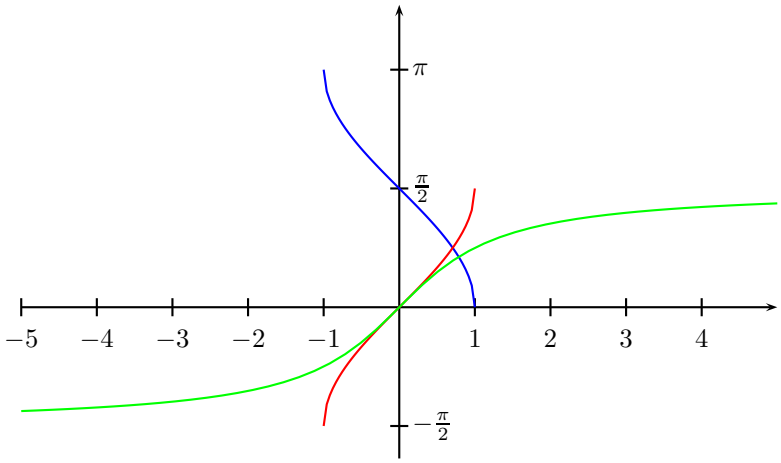
$$\text{acos} : \left\{ \begin{array}{ccc} [-1,1] & \rightarrow & [0,\pi] \\ x & \mapsto & \text{acos}(x) \end{array} \right.$$

$$\text{asin} : \left\{ \begin{array}{ccc} [-1,1] & \rightarrow & [-\frac{\pi}{2},\frac{\pi}{2}] \\ x & \mapsto & \text{asin}(x) \end{array} \right.$$

$$\text{atan} : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow &]-\frac{\pi}{2},\frac{\pi}{2}[\\ x & \mapsto & \text{atan}(x) \end{array} \right.$$

Stack	Operator	Result	Description
num	**ACOS**	*angle*	Return arccosine of *num* in radians
num	**ASIN**	*angle*	Return arcsine of *num* in radians
num	**ATAN**	*angle*	Return arctangent of *num* in radians

Important : ATAN is *not* defined as PS operator atan. ATAN needs only *one* argument on the stack.




```
\begin{pspicture}(-5,-2)(5,4)
\SpecialCoor % For label positionning
\psaxes[labels=x,Dy=\pstPI2]{->}%
    (0,0)(-5,-2)(5,4)
\uput[0](!0 PI){$\pi$}
\uput[0](!0 PI 2 div){$\frac{\pi}2$}
\uput[0](!0 PI 2 div neg)%
    {$-\frac{\pi}2$}
\psplot[linecolor=blue]{-1}{1}%
    {x ACOS}
\psplot[linecolor=red]{-1}{1}%
    {x ASIN}
\psplot[linecolor=green]{-5}{5}%
    {x ATAN}
\end{pspicture}
```

2 Hyperbolic trigonometry

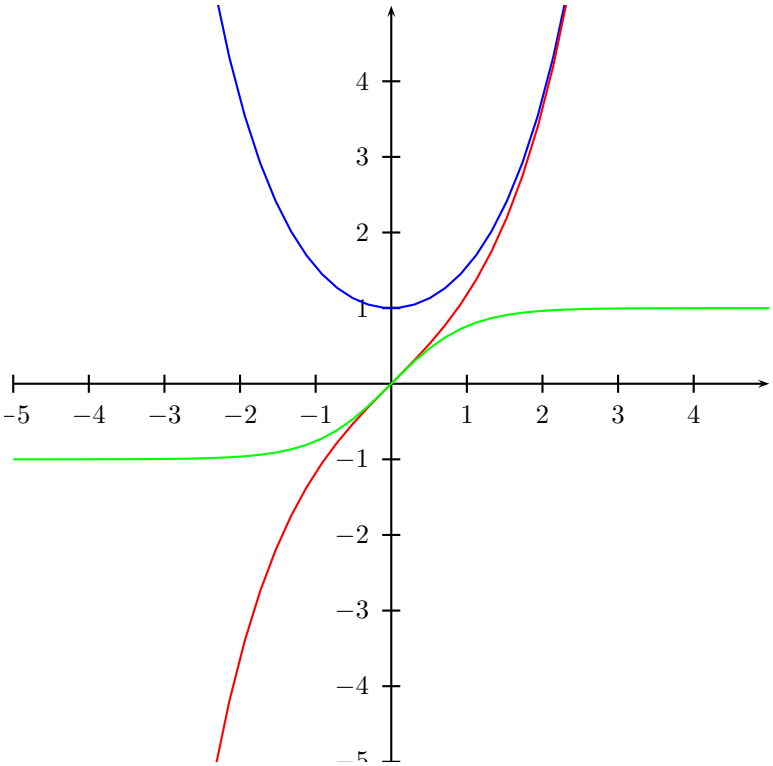
'pst-math' introduces hyperbolic trigonometric postscript operators COSH, SINH and TANH defined by

$$\cosh : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow & [1, +\infty[\\ x & \mapsto & \cosh(x) \end{array} \right.$$

$$\sinh : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \sinh(x) \end{array} \right.$$

$$\tanh : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow &]-1, 1[\\ x & \mapsto & \tanh(x) \end{array} \right.$$

Stack	Operator	Result	Description
num	**COSH**	*real*	Return hyperbolic cosine of *num*
num	**SINH**	*real*	Return hyperbolic sine of *num*
num	**TANH**	*real*	Return hyperbolic tangent of *num*




```
\begin{pspicture}*(-5,-5)(5,5)
\psaxes{->}(0,0)(-5,-5)(5,5)
\psplot[linecolor=blue]{-5}{5}{x COSH}
\psplot[linecolor=red]{-5}{5}{x SINH}
\psplot[linecolor=green]{-5}{5}{x TANH}
\end{pspicture}
```

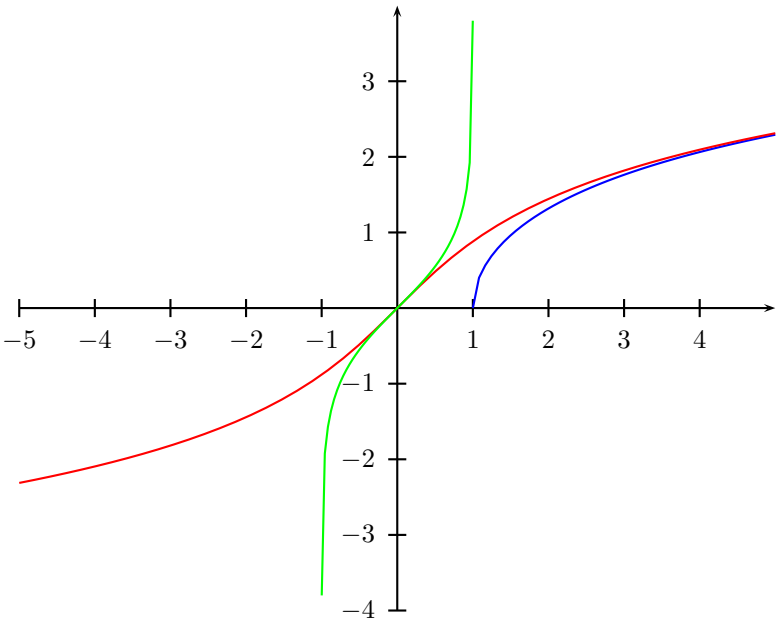
'pst-math' introduces reciprocal hyperbolic trigonometric postscript operators ACOSH, ASINH and ATANH defined by

$$\text{acosh} : \left\{ \begin{array}{ccc} [1, +\infty[& \rightarrow & \mathbb{R} \\ x & \mapsto & \text{acosh}(x) \end{array} \right.$$

$$\text{asinh} : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \text{asinh}(x) \end{array} \right.$$

$$\text{atanh} : \left\{ \begin{array}{ccc}]-1, 1[& \rightarrow & \mathbb{R} \\ x & \mapsto & \text{atanh}(x) \end{array} \right.$$

Stack	Operator	Result	Description
num	**ACOSH**	*real*	Return reciprocal hyperbolic cosine of *num*
num	**ASINH**	*real*	Return reciprocal hyperbolic sine of *num*
num	**ATANH**	*real*	Return reciprocal hyperbolic tangent of *num*



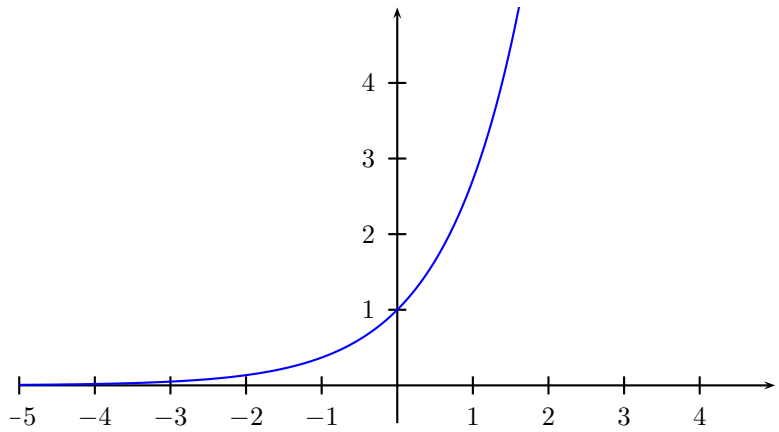

```
\begin{pspicture}(-5,-4)(5,4)
\psaxes{->}(0,0)(-5,-4)(5,4)
\psplot[linecolor=blue]{1}{5}%
    {x ACOSH}
\psplot[linecolor=red]{-5}{5}%
    {x ASINH}
\psplot[linecolor=green]{-.999}{.999}%
    {x ATANH}
\end{pspicture}
```

3 Other operators

'pst-math' introduces postscript operator EXP defined by

$$\exp : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \exp(x) \end{array} \right.$$

Stack	Operator	Result	Description
num	**EXP**	*real*	Return exponential of *num*

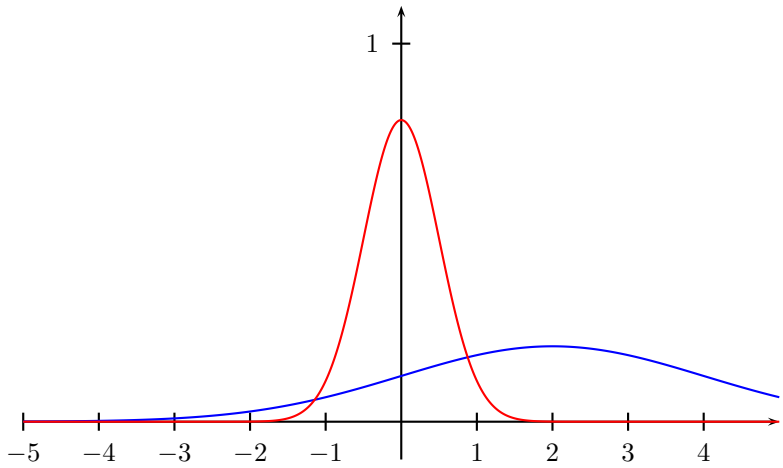



```
\begin{pspicture}*(-5,-1)(5,5)
\psaxes{->}(0,0)(-5,-0.5)(5,5)
\psplot[linecolor=blue,
    plotpoints=1000]{-5}{5}{x EXP}
\end{pspicture}
```

'pst-math' introduces postscript operator GAUSS defined by

$$\text{gauss} : \left\{ \begin{array}{ccc} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \dfrac{1}{\sqrt{2\pi\sigma^2}} \exp -\dfrac{(x-\overline{x})^2}{2\sigma^2} \end{array} \right.$$

Stack	Operator	Result	Description
num_1 num_2 num_3	**GAUSS**	*real*	Return gaussian of num_1 with mean num_2 and standart deviation num_3

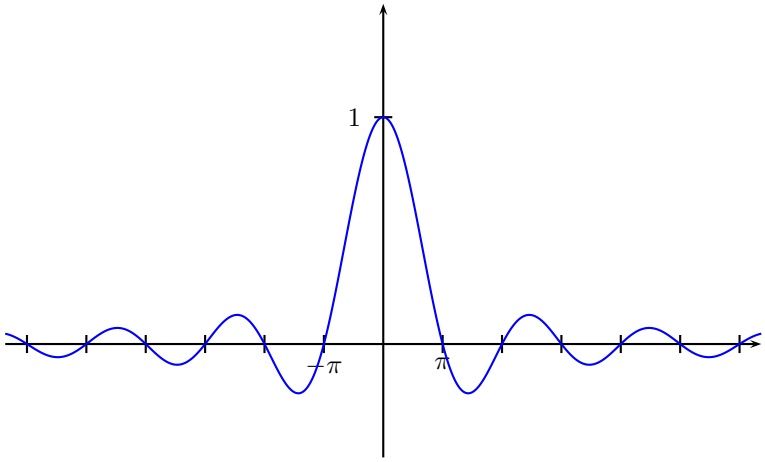



```
\psset{yunit=5}
\begin{pspicture}(-5,-.1)(5,1.1)
\psaxes{->}(0,0)(-5,-.1)(5,1.1)
\psplot[linecolor=blue,
    plotpoints=1000]%
    {-5}{5}{x 2 2 GAUSS}
\psplot[linecolor=red,
    plotpoints=1000]%
    {-5}{5}{x 0 .5 GAUSS}
\end{pspicture}
```

'pst-math' introduces postscript operator SINC defined by

$$\text{sinc} : \left\{ \begin{array}{ccc} \mathbb{R} & \to & \mathbb{R} \\ x & \mapsto & \dfrac{\sin x}{x} \end{array} \right.$$

Stack	Operator	Result	Description
num	**SINC**	*real*	Return cardinal sine of *num* radians



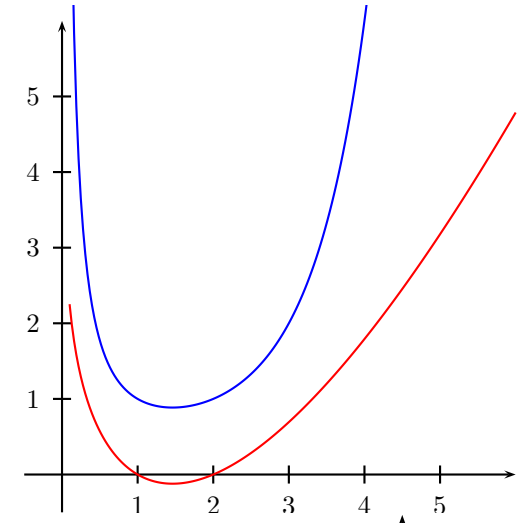

```
\psset{xunit=.25,yunit=3}
\begin{pspicture}(-20,-.5)(20,1.5)
\SpecialCoor % For label positionning
\psaxes[labels=y,Dx=\pstPI1]{->}%
    (0,0)(-20,-.5)(20,1.5)
\uput[-90](!PI 0){$\pi$}
\uput[-90](!PI neg 0){$-\pi$}
\psplot[linecolor=blue,
    plotpoints=1000]{-20}{20}{x SINC}
\end{pspicture}
```

'pst-math' introduces postscript operator GAMMA and GAMMALN defined by

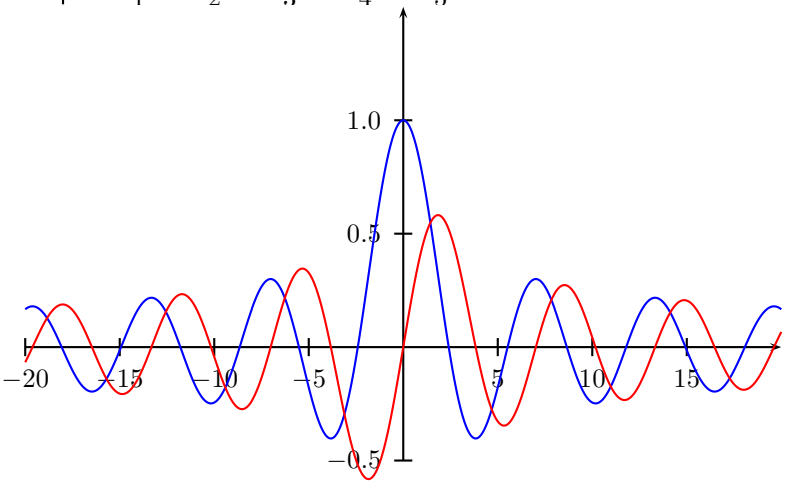
$$\Gamma : \left\{ \begin{array}{ccc} \mathbb{R}\backslash\mathbb{Z} & \to & \mathbb{R} \\ x & \mapsto & \displaystyle\int_0^{\infty} t^{x-1}\mathrm{e}^{-t}\,\mathrm{d}t \end{array} \right.$$

$$\ln\Gamma : \left\{ \begin{array}{ccc}]0,+\infty[& \to & \mathbb{R} \\ x & \mapsto & \ln \displaystyle\int_0^{t} t^{x-1}\mathrm{e}^{-t}\,\mathrm{d}t \end{array} \right.$$

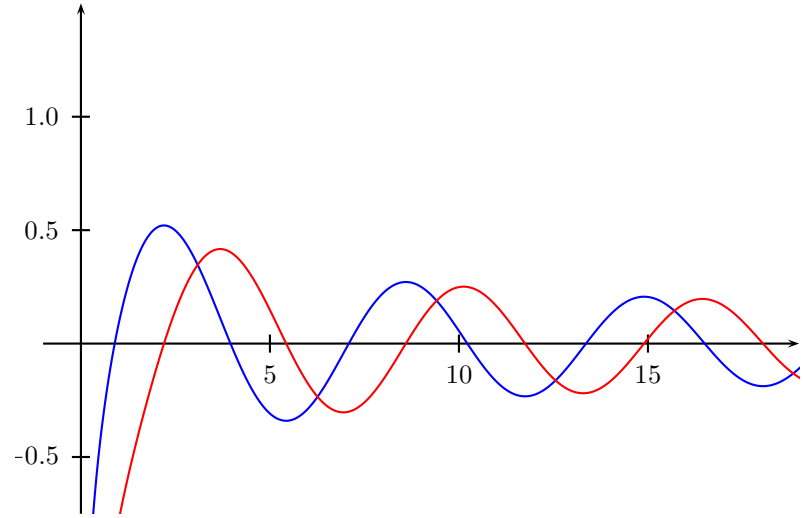
Stack	Operator	Result	Description
num	**GAMMA**	*real*	Return Γ function of *num*
num	**GAMMALN**	*real*	Return logarithm of Γ function of *num*




```
\begin{pspicture*}(-.5,-.5)(6.2,6.2)
\psaxes{->}(0,0)(-.5,-.5)(6,6)
\psplot[linecolor=blue,
    plotpoints=200]{.1}{6}{x GAMMA}
\psplot[linecolor=red,
    plotpoints=200]{.1}{6}{x GAMMALN}
\end{pspicture*}
```



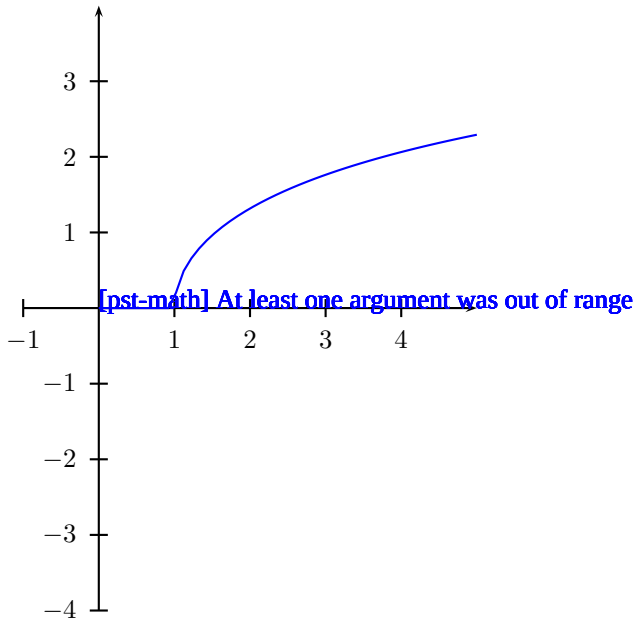

```
\psset{xunit=.25,yunit=3}
\begin{pspicture}(-20,-.5)(20,1.5)
\psaxes[Dx=5,Dy=.5]{->}%
    (0,0)(-20,-.5)(20,1.5)
\psplot[linecolor=blue,
    plotpoints=1000]{-20}{20}%
    {x BESSEL_J0}
\psplot[linecolor=red,
    plotpoints=1000]{-20}{20}%
    {x BESSEL_J1}
\end{pspicture}
```




```
\psset{xunit=.5,yunit=3}
\begin{pspicture}*(-1.5,-.75)(19,1.5)
\psaxes[Dx=5,Dy=.5]{->}%
    (0,0)(-1,-.75)(19,1.5)
\psplot[linecolor=blue,
    plotpoints=1000]{0.0001}{20}%
    {x BESSEL_Y0}
\psplot[linecolor=red,
    plotpoints=1000]{0.0001}{20}%
    {x BESSEL_Y1}
%    \psplot[linecolor=green,
%        plotpoints=1000]{0.0001}{20}%
%        {x 2 BESSEL_Yn}
\end{pspicture}
```

4 Warnings

Since version 0.3, there is a new feature. When an argument of **ACOS**, **ASIN**, **ACOSH** or **ATANH** is out of range, the result of the calculation does not product a PS error: a zero value is substitued and a warning message is printed on the postscript version of the document.




```
\begin{pspicture}(-1,-4)(5,4)
\psaxes{->}(0,0)(-1,-4)(5,4)
\psplot[linecolor=blue]{0}{5}%
  {x ACOSH}
\end{pspicture}
```

5 Credits

Many thanks to Jacques L'helgoualc'h, Herbert Voss and Martin Chicoine.