

‘pst-math’

A PSTricks package for enhancing mathematical operators in PSTricks
ver. 0.2

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‘libre’ is the french word for ‘free’

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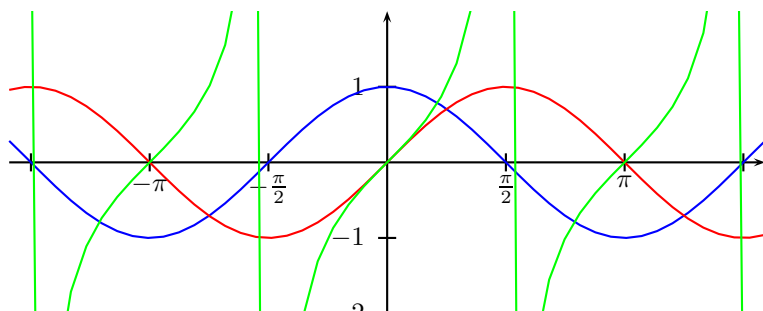
1 Trigonometry

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

$$\begin{aligned} \cos : & \begin{cases} \mathbb{R} & \rightarrow & [-1, 1] \\ x & \mapsto & \cos(x) \end{cases} \\ \sin : & \begin{cases} \mathbb{R} & \rightarrow & [-1, 1] \\ x & \mapsto & \sin(x) \end{cases} \\ \tan : & \begin{cases} \mathbb{R} \setminus \{k\frac{\pi}{2}, k \in \mathbb{Z}\} & \rightarrow & \mathbb{R} \\ x & \mapsto & \tan(x) \end{cases} \end{aligned}$$

where x is in *radians*. TAN does *not* produce PS error¹ when $x = k\frac{\pi}{2}$.

Stack	Operator	Result	Description
<i>num</i>	COS	<i>real</i>	Return cosine of <i>num</i> radians
<i>num</i>	SIN	<i>real</i>	Return sine of <i>num</i> radians
<i>num</i>	TAN	<i>real</i>	Return tangent of <i>num</i> 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 ACOS, ASIN and ATAN defined by

$$\text{acos} : \begin{cases} [-1, 1] & \rightarrow & [0, \pi] \\ x & \mapsto & \text{acos}(x) \end{cases}$$

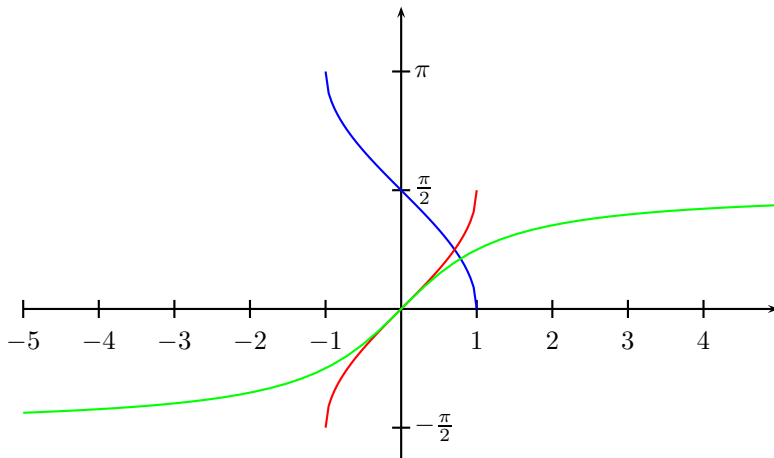
¹TAN is defined with Div PSTricks operator rather than with div PS operator.

$$\operatorname{asin} : \begin{cases} [-1, 1] & \rightarrow [-\frac{\pi}{2}, \frac{\pi}{2}] \\ x & \mapsto \operatorname{asin}(x) \end{cases}$$

$$\operatorname{atan} : \begin{cases} \mathbb{R} & \rightarrow]-\frac{\pi}{2}, \frac{\pi}{2}[\\ x & \mapsto \operatorname{atan}(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	ACOS	<i>angle</i>	Return arccosine of <i>num</i> in radians
<i>num</i>	ASIN	<i>angle</i>	Return arcsine of <i>num</i> in radians
<i>num</i>	ATAN	<i>angle</i>	Return arctangent of <i>num</i> 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

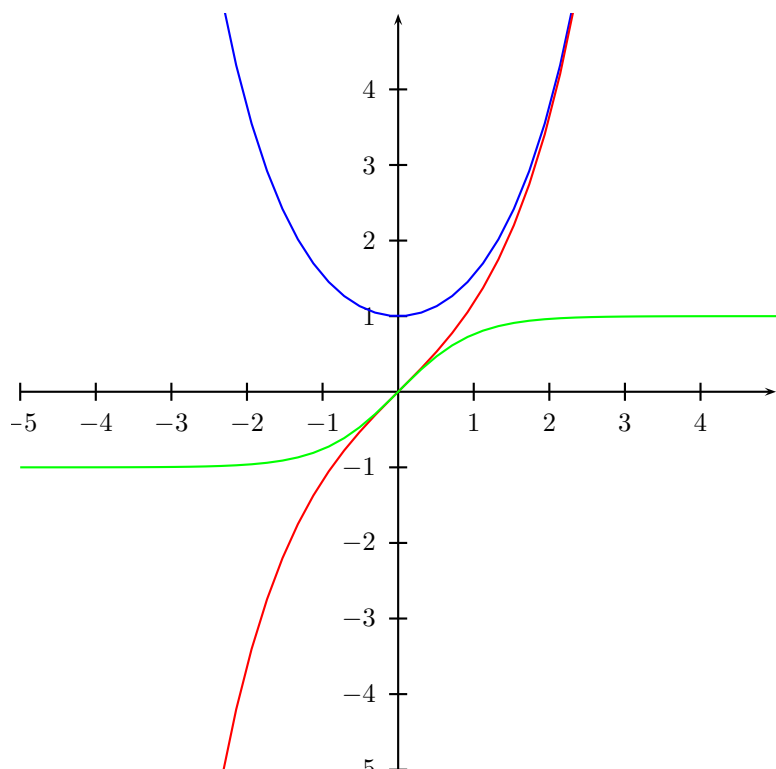
‘pst-math’ introduces hyperbolic trigonometric postscript operators COSH, SINH and TANH defined by

$$\operatorname{cosh} : \begin{cases} \mathbb{R} & \rightarrow [1, +\infty[\\ x & \mapsto \operatorname{cosh}(x) \end{cases}$$

$$\operatorname{sinh} : \begin{cases} \mathbb{R} & \rightarrow \mathbb{R} \\ x & \mapsto \operatorname{sinh}(x) \end{cases}$$

$$\operatorname{tanh} : \begin{cases} \mathbb{R} & \rightarrow]-1, 1[\\ x & \mapsto \operatorname{tanh}(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	COSH	<i>real</i>	Return hyperbolic cosine of <i>num</i>
<i>num</i>	SINH	<i>real</i>	Return hyperbolic sine of <i>num</i>
<i>num</i>	TANH	<i>real</i>	Return hyperbolic tangent of <i>num</i>



```
\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}
```

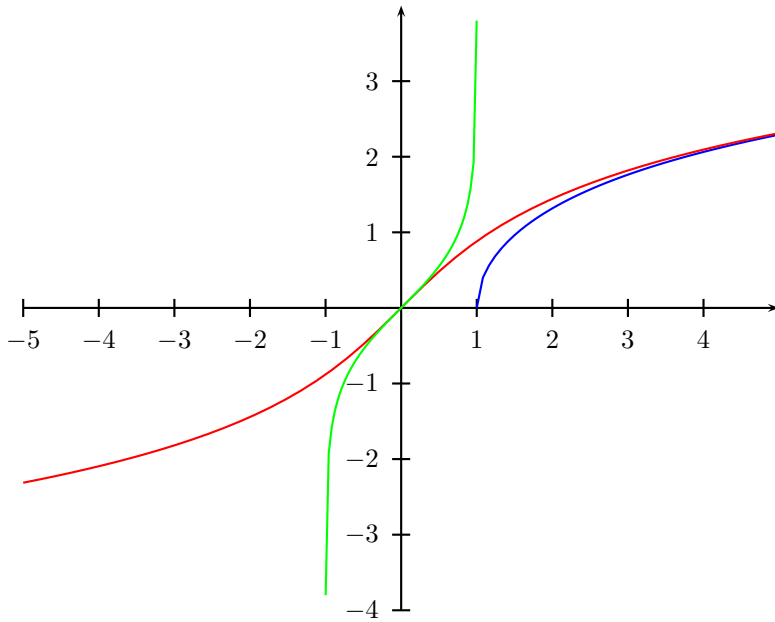
‘pst-math’ introduces reciprocal hyperbolic trigonometric postscript operators ACOSH, ASINH and ATANH defined by

$$\operatorname{acosh} : \begin{cases} [1, +\infty[& \rightarrow \mathbb{R} \\ x & \mapsto \operatorname{acosh}(x) \end{cases}$$

$$\operatorname{asinh} : \begin{cases} \mathbb{R} & \rightarrow \mathbb{R} \\ x & \mapsto \operatorname{asinh}(x) \end{cases}$$

$$\operatorname{atanh} : \begin{cases}]-1, 1[& \rightarrow \mathbb{R} \\ x & \mapsto \operatorname{atanh}(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	ACOSH	<i>real</i>	Return reciprocal hyperbolic cosine of <i>num</i>
<i>num</i>	ASINH	<i>real</i>	Return reciprocal hyperbolic sine of <i>num</i>
<i>num</i>	ATANH	<i>real</i>	Return reciprocal hyperbolic tangent of <i>num</i>



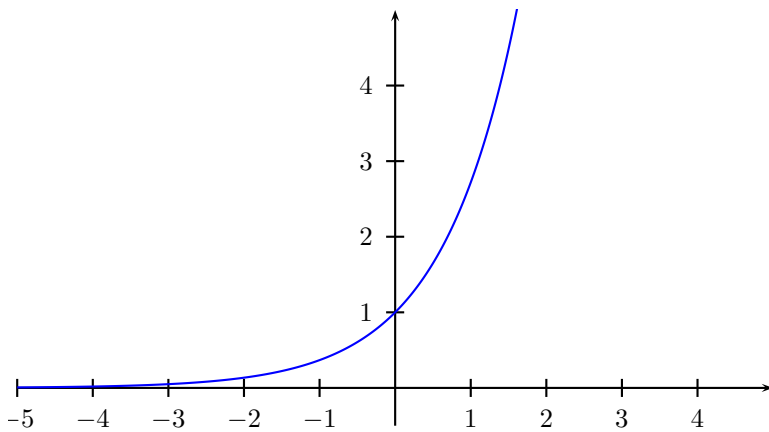
```
\begin{pspicture}(-5,-4)(5,4)
\psaxes{->}(0,0)(-5,-4)(5,4)
\psplot[linecolor=blue]{1}{5}%
{x ACOSH}
\psplot[linecolor=red]{-5}{5}%
{x ASINH}
\psplot[linecolor=green]{-.999}{.999}%
{x ATANH}
\end{pspicture}
```

3 Other operators

‘pst-math’ introduces postscript operator EXP defined by

$$\exp : \begin{cases} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \exp(x) \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	EXP	<i>real</i>	Return exponential of <i>num</i>

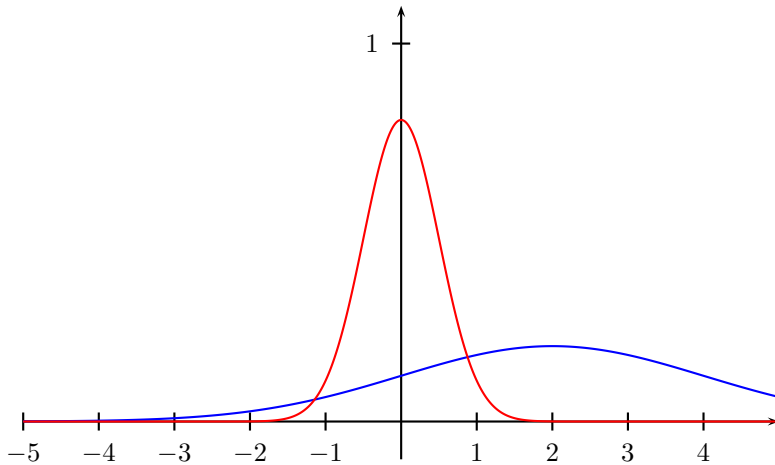


```
\begin{pspicture}*(-5,-1)(5,5)
\psaxes{->}(0,0)(-5,-0.5)(5,5)
\psplot[linecolor=blue,
plotpoints=1000]{-5}{5}{x EXP}
\end{pspicture}
```

‘pst-math’ introduces postscript operator GAUSS defined by

$$\text{gauss} : \begin{cases} \mathbb{R} & \rightarrow & \mathbb{R} \\ x & \mapsto & \frac{1}{\sqrt{2\pi\sigma^2}} \exp - \frac{(x - \bar{x})^2}{2\sigma^2} \end{cases}$$

Stack	Operator	Result	Description
<i>num</i> ₁ <i>num</i> ₂ <i>num</i> ₃	GAUSS	<i>real</i>	Return gaussian of <i>num</i> ₁ with mean <i>num</i> ₂ and standard deviation <i>num</i> ₃

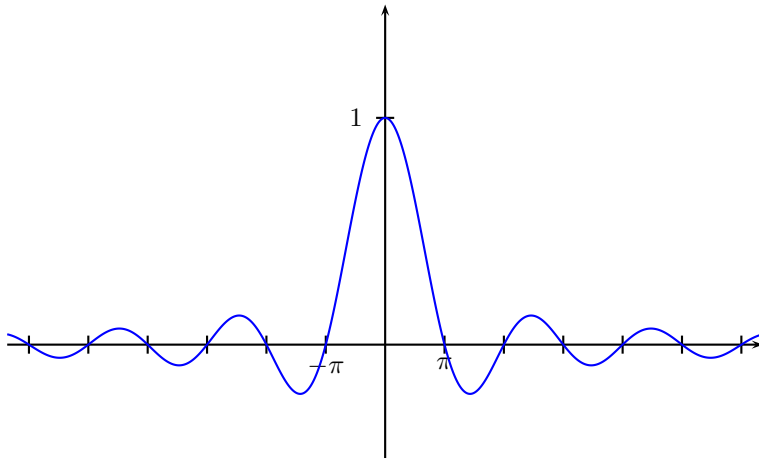


```
\psset{yunit=5}
\begin{pspicture}(-5,-.1)(5,1.1)
\psaxes{->}(0,0)(-5,-.1)(5,1.1)
\psplot[linecolor=blue,
  plotpoints=1000]%
  {-5}{5}{x 2 2 GAUSS}
\psplot[linecolor=red,
  plotpoints=1000]%
  {-5}{5}{x 0 .5 GAUSS}
\end{pspicture}
```

‘pst-math’ introduces postscript operator SINC defined by

$$\text{sinc} : \begin{cases} \mathbb{R} & \rightarrow \mathbb{R} \\ x & \mapsto \frac{\sin x}{x} \end{cases}$$

Stack	Operator	Result	Description
<i>num</i>	SINC	<i>real</i>	Return cardinal sine of <i>num</i> radians



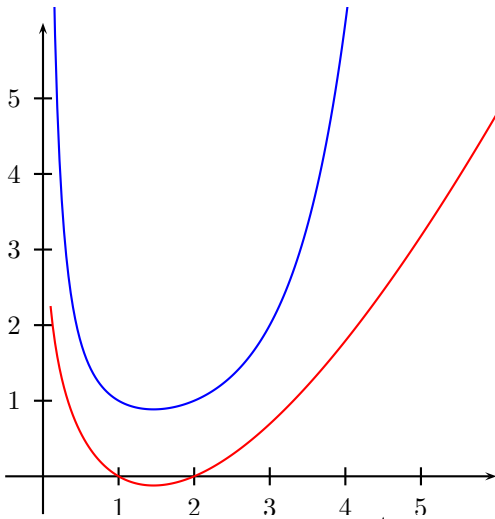
```
\psset{xunit=.25,yunit=3}
\begin{pspicture}(-20,-.5)(20,1.5)
\SpecialCoor % For label positionning
\psaxes[labels=y,Dx=\pstPI1]{->}%
  (0,0)(-20,-.5)(20,1.5)
\uput[-90](!PI 0){$\pi$}
\uput[-90](!PI neg 0){$-\pi$}
\psplot[linecolor=blue,
  plotpoints=1000]{-20}{20}{x SINC}
\end{pspicture}
```

‘pst-math’ introduces postscript operator GAMMA and GAMMALN defined by

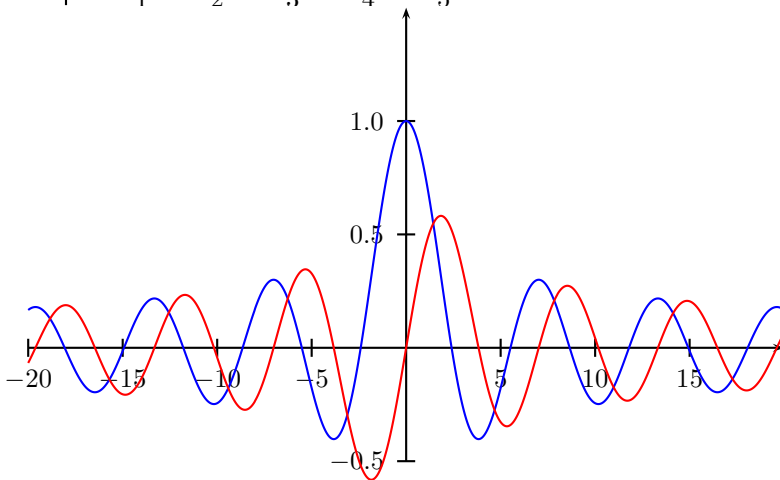
$$\Gamma : \begin{cases} \mathbb{R} \setminus \mathbb{Z} & \rightarrow \mathbb{R} \\ x & \mapsto \int_0^\infty t^{x-1} e^{-t} dt \end{cases}$$

$$\ln \Gamma : \begin{cases}]0, +\infty[& \rightarrow \mathbb{R} \\ x & \mapsto \ln \int_0^t t^{x-1} e^{-t} dt \end{cases}$$

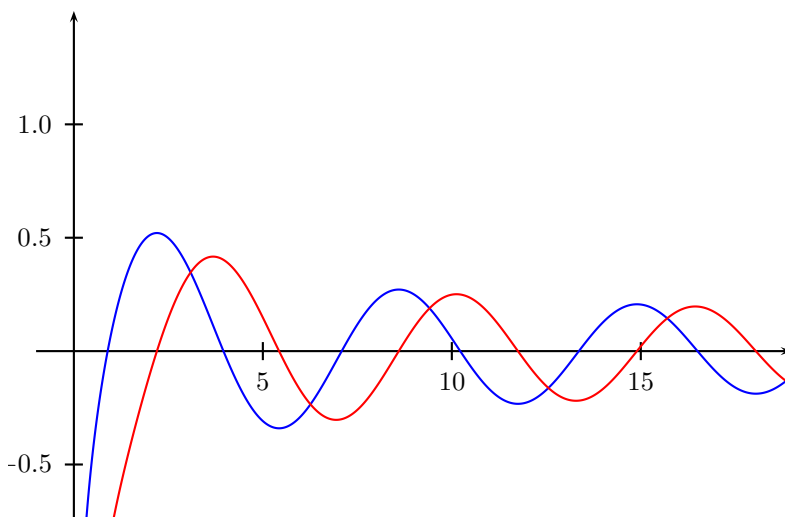
Stack	Operator	Result	Description
<i>num</i>	GAMMA	<i>real</i>	Return Γ function of <i>num</i>
<i>num</i>	GAMMALN	<i>real</i>	Return logarithm of Γ function of <i>num</i>



```
\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 Credits

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