Tempas Script Language

Tempas has a built in scripting C like scripting language with some C++ like member functions. Since many users of Tempas might be familiar with Digital Micrograph (DM) by Gatan Inc., there has been an effort made to make much of the scripting functionality of DM available in Tempas. Thus while many functionalities have alternate function names and arguments, in most cases there will be a DM syntax compatible function available. This is so that many DM scripts can be directly translated to Tempas with minimal effort. There is a basic difference in the syntax between DM and MT scripting when subroutines are used, but the difference is rather trivial and is explained below.

When using subroutines, the main entry point must have the routine main() declared as in

```
main() {
  number x = 10
  number y = 5
  number z = test(x,y)
  print(z)
}
int test(number x, number y) {
  return (x + y)
}
```

If there are no function / subroutine calls, then one can use either

```
main() {
  number x = 10
  number y = 5
  number z = x + y
  print(z)
}
```

or simply

```
number x = 10
number y = 5
number z = x + y
print(z)
```

without the main() { .... } declaration

This document parallels the DM scripting documentation such that differences and compatible syntax are clearly described.

There are some major differences between the scripting in DM and MT as far as the support of HRTEM simulation is concerned. MT allows the user to script the simulation.

At this point not all aspects of the simulation can be controlled, but this will change with further development. Functions marked with an * are DM functions that are not (yet) implemented in Tempas.

EXECUTING THE SCRIPT: Execution of the script is done by pressing the "Enter" key when the Script window has keyboard focus. This is fn+Return on a MacBook or MacBook Pro. *While the above is still true, the Script Window has now gained a "Run" button which starts the script. The "Run" button changes to a "Stop" button when the script is running.*

Language Syntax

The Tempas scripting language is very similar to the syntax of the "C" programming language. The language is fairly simple, but is still quite powerful as in that it supports such types as "Image" , "ImageStack", "Microscope"… and so on as built in types. In many respects the types correspond to the type "Class" as used in C++ as they have built in "member functions" that operate on the type.
The language is case insensitive such that number, Number, NumBer etc. are all interpreted as the lower case type number

Types

int , short or bool	: Integer number
Number, float	: Real number
ComplexNumber or Cmplx	: Complex number {x,y}
String	: Holds a string like "This is a String"
Image	: a 2D Image, Height (or)Width can be 1
ComplexImage	: a Complex Image of the above
Image3D	: a 3D Volume "Image" of (width,height,depth)
ComplexImage3D	: a Complex Image3D of the above
ImageStack	: a "stack" of Images of any number
Simulation	: an instance of a "Simulation"
Microscope	: an instance of a "Microscope"
Vector	: a Vector of real or complex numbers
Matrix	: a Matrix (ncols,nrows) of real or complex numbers
File	: a "File" that can be written to

The language allows the use of the following type names
bool
short
int
float
"bool", "short" and "int" are all Integers (int) while the type "number" is a real number (float). The built in constants "True" , "False", "Yes" ,"No", "On" and "Off" (not case sensitive) correspond to the numbers 1 and 0 respectively. The constant π can be

expressed either as just "Pi" or as a function pi(). The constant "e" is expressed as a function exp(..).

Comments at the end of lines are specified using "//"

Multiple lines comments can be started and ended by a pair of /* and */
Take must be taken to not have other such pairs within the outer set.
Example

```
/*
number i
Image  testImage = NewImage(512,512)
Image  anotherImage(512,512,sin(2*pi*icol/128)+cos(2*pi*irow/64))
*/
```

The three lines in the middle will be ignored as if they were not present.

Arrays

The scripting language supports arrays of Types
Hence one can write

number x[100]	Declares x to hold 100 numbers. Each element is indexed as x[i]
Image img[5]	Declares 5 "Pointers" to Images. Each Image must be created separately, using NewImage or something similar
String str[40]	Declares 40 empty strings

etc.

The syntax allows

```
x[0] = 5
x[1] = x[0]
int i
number x[100],y
image img[2],img2
for(int i=0; i < 100; i++) x[i] = sin(2*pi*i/64)
img[0] = NewImage("name",512,512)
img[1] = img[0]
str[0] = "Hello there"
str[1] = str[0]
y = img2[3,5] // y is assigned the value of the pixel at position [3,5]
y = img[1].getpixel(3,5)
```

and so on.

Control loops key words

for , do , while , continue , break

Examples. **for:**

```
number x,y                 // Declares the two variables x and y
number a = 10.2 , b = -3.5 // Declares a and b and sets a to 10.2 and b to -3.5
//
------------------------------------------------------------------------------
--
// Initializes x to 0, executes the loop as long as x is less than 10
// and at the end of the loop increments x with 1
// The syntax x++ is equivalent to x = x + 1
//
------------------------------------------------------------------------------
--
for ( x = 0; x < 10; x++) {
      y = a*x + b          // Defines a line segment
}
```

// Alternatively one could have done something like this
// Statements between /* … */ are not executed. Treated as comments

```
number x[10],y[10]
for ( int i = 0;i < 10; i++) {
      /* y = slope * x + intercept */
      y[i] = a*x[i] + b
}
// or
for ( x = 0; x < 10;) {
      y = a*(x++) + b            // here x is incremented after evaluating the
expression
      // y = a*(++x) + b ;       here x is incremented before evaluating the
expression
}
```

do and **while:**

```
number x[10],y[10]         // Declares the two arrays x and y of real numbers
number a = 10.2 , b = -3.5 // Declares a and b and sets a to 10.2 and b to -3.5
int i = 0
do {
      y[i] = a*x[i] + b          // Defines a line segment
      i++
} while (i < 10)
```

while:

```
number x[10],y[10]         // Declares the two arrays x and y of real numbers
number a = 10.2 , b = -3.5 // Declares a and b and sets a to 10.2 and b to -3.5
int i = 0
while (i < 10) {
      y[i] = a*x[i] + b    // Defines a line segment
      i++
}
```

Use of “break” and “continue”

break:

```
number x,i
for ( i = 0; i < 10; i++) {
       x = i
       if (x == 5) break   // Break out of the loop if x is equal to 5
}
```

continue:

```
number x,i
for ( i = 0; i < 10; i++) {
       if (i == 5) continue       // Do not execute the next step(s) and go to
       x = 2*i                    // top of the loop ( next cycle)
}                                 // x = 2* i except for when i is equal to 5
```

Library Functions

Library functions are a number of predefined functions that operate on numbers, strings and images and image-volumes(Image3D) .

Library functions operating on image]/image3D usually take the image(3D) of interest as an argument and returns an instance of the “result”, leaving the argument unchanged.

An example of the use of a predefined function is FFT. The function takes an image as an argument and returns the Fourier Transform of the argument as a new image.
Usage could be

```
Image ftimg = fft(img)     // Returns the Fourier Transform of the image “img”,
                           // “ftimg” is assigned to the return image
                           // The argument “img”is left unchanged

Image rotImg = Rotate(img,45)     // Makes a copy of “img” and rotates
                                  // the copy 45 deg. anti-clockwise
                                  // Returns the rotated image and
                                  // leaves “img” unchanged
```

Member Functions

Member functions are functions that operate on an instance of a variable type.
An example of this would be the various functions that belong to the variable type “Image”. The member functions operate directly on “itself”. Thus while many library return a new image resulting from an operation on a copy of its argument, the member function will change itself and return nothing (except when specifically noted).
Thus if one wanted to take the Fourier transform of an image using a member function, this would be

```
img.fft()          // Take the Fourier Transform of itself
img.rotate(45)     // Rotate oneself 45 degrees anti-clockwise
```

Built-in Implied loop keywords (follows the use in DM and clearly inspired by DM)

icol	// The index of the column in an implicit loop over entire image
irow	// The index of the row in an implicit loop over entire image
iradius	// The value of the radius in an implicit loop over entire image
itheta	// The value of the angle in an implicit loop over entire image
iplane	// The index of the plane in an implicit loop over entire image3D
iwidth	// The width of the image while within an implied loop
iheight	// The height of the image while within an implied loop
idepth	// The depth of the image while within an implied loop
ipoint	// The number of points of the image while within an implied loop

The built in loop key words are incredibly powerful and save an enormous amount of computing time. They should always be used whenever possible.

Whenever one wants to do a loop over the entire image
such as

```
number i,j,value
number width = img.GetWidth()
number height = img.GetHeight()
for (j = 0; j < height; j++) {
       for (i = 0; i < width ; i++) {
              value = Some Expression
              img[i,j] = value
       }
}
```

and "Some Expression" can be expressed in terms of icol, irow, iradius etc.. , one should use these implied loops.
For instance the Expression

img = sin(2*pi*icol/32)+sin(2*pi*irow/32)

Is equivalent to evaluating the following.

```
number i,j,x,y
number width = img.GetWidth()
number height = img.GetHeight()
for (j = 0; j < height; j++) {
       y = sin(2*pi*j/32)
       for (i = 0; i < width ; i++) {
              x = sin(2*pi*i/32)
              img[i,j] = x+y
              // or one could write
              //     SetPixel(img,i,j,x+y)
              //     img.SetPixel(i,j,x+y)
```

```
        }
}
```

Similarly

```
img = exp(-iradius*iradius/64) or img = exp(-iradius**2/64)
```

Is equivalent to

```
number i,j,x,y,val
number width = img.GetWidth()
number height = img.GetHeight()
for (j = 0; j < height; j++) {
        y = j – height/2
        for (i = 0; i < width ; i++) {
                x = i - width/2
                val = exp(-(x**2+y**2)/64)  // iradius = sqrt(x*x+y*y)
                SetPixel(img,i,j,val)
        }
}
```

*The first expressions take a fraction of a second to compute, while the second approach can take minutes. Thus you should always use the expressions **icol** and **irow** whenever possible when you want to do a loop over the entire image pixel by pixel.*
*It will be possible if the pixel value at (i,j) is an expression of i and j (**icol** and **irow**).*
*The power of the use of **icol** and **irow** cannot be overestimated. When using the type Image3D, **iplane** takes on the third dimension (z)*

```
Image3D vol(32,32,32,iplane)      // Creates an image-volume of size 32*32*32
                                  //where each “plane” in the z-dimension is
                                  // set to the value of its z- index ( 0 - 31 )
```

Graphing Options

1 Dimensional data can be visualized using the functions

```
graphxy(…)
```

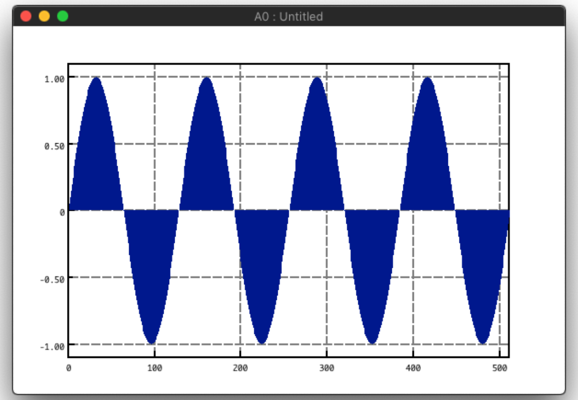
```
plot(…)
```

and implicitly by displaying Images 1D (default)
or 2D (setting the display style)

The code……

```
Image sineWave(512,1,sin(2*pi*icol/128))
sineWave.show()
…
```

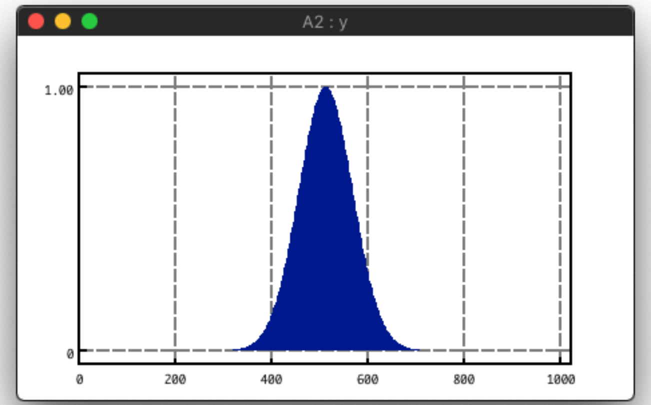
will result in the following output



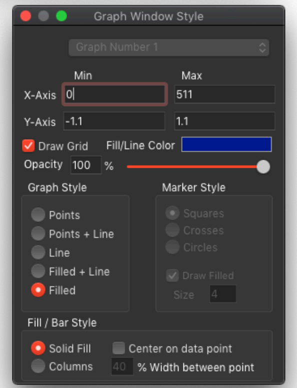
The same output could be produced by

```
.....
number y[512]
for(int i =0; i < 512; i++) {
        y[i] = sin(2*pi*i/128)
}
plot(y)
.....
```

An example of plotting y vs x is the following…



Right Clicking in the Graph Window brings up a window for setting some further display options



	Min	Max
X-Axis	0	511
Y-Axis	-1.1	1.1

[✓ Draw Grid] Fill/Line Color 🟦

Opacity 100 %

Graph Style: Points, Points + Line, Line, Filled + Line, [✓ Filled]

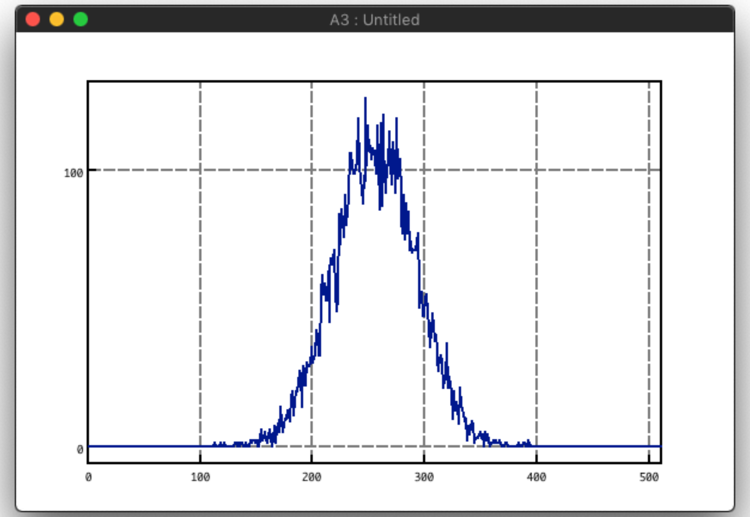
Marker Style: [✓ Squares], Crosses, Circles, [✓ Draw Filled], Size 4

Fill / Bar Style: [✓ Solid Fill], Columns; Center on data point; 40 % Width between point

```
number x[512],y[512],sigma = 40
int i
for(i = 0; i < 512; i++) {
        x[i] = 2*i
        y[i] = exp(-(x[i]/2-256)**2/sigma**2)
}
plot (x,y)
```

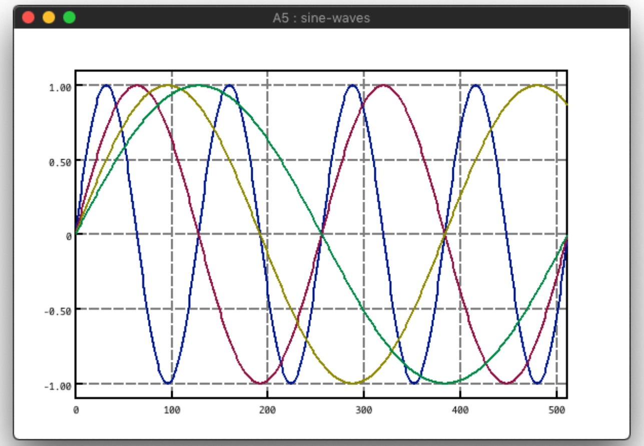
and…

```
number y[512],x,sigma=30
int ndx,i
for(i = 0; i < 10000; i++) {
        x = GaussianRandom(sigma)
        ndx = x + 256
        if (ndx < 0) continue
        if (ndx > 511) continue
        y[ndx]++
}
graphxy (y)
```



and….

```
Image y(512,4)
number x[4]
for(int i = 0; i < 512;i++) {
        for(int j=0; j < 4; j++) {
                x[j] = sin(2*pi*i/
((j+1)*128))
                y[i,j] = x[j]
        }
}
y.setName(“Sine-Waves”)
// 1 = rasterimage, 2 = RGB, 3 = SurfacePlot,
// 4 = Lineplot, 5 = Table, 6 = ArgandPlot,
// 7 =ComplexLinePlot
y.setDisplayType(4)
y.show()
```



Scripting Reference

Real Numbers / Integer Numbers

Declaration

`number x`	
`number x(3.4)`	Declares x and sets it to the value 3.4
`int    ix`	Declares ix and sets it to the value 3
`int    ix(3.4)`	

Operators (operating on numbers), *read* Integer when appropriate

Name	Summary
`!`	Logical NOT operator for a real number
`!=`	Inequality operator for real numbers
`&&`	Logical AND operator for real numbers
`*`	Multiply operator for real numbers
`**`	Exponentiation operator for real numbers
`*=`	Multiply and assign operator for real numbers
`+`	Addition operator for real numbers
`++`	Increment operator for a real number
`+=`	Add and assign operator for real numbers
`-`	Negation operator for a real number
`-`	Subtraction operator for real numbers
`--`	Decrement operator for real numbers
`-=`	Subtract and assign operator for real numbers

`/`	Division operator for real numbers
`/=`	Divide and assign operator for real number
`<`	Less than operator for real numbers
`<=`	Less than or equal operator for real numbers
`=`	Assignment operator for real numbers
`==`	Equality operator for real numbers
`>`	Greater than operator for real numbers
`>=`	Greater than or equal operator for real numbers
`?`	Arithmetic if operator for real numbers
`||`	Logical OR operator for real numbers

Functions (operating on numbers)

Name	Summary
`abs`	Calculates absolute value of a real number
`acos`	Calculates the arccosine of a real number
`acosh`	Calculates the hyperbolic arccosine of a real number
`AiryAi`	Calculates the Airy Ai function
`AiryBi`	Calculates the Airy Bi function
`asin`	Calculates the arcsine of a real number
`asinh`	Calculates the hyperbolic arcsine of a real number
`atan`	Calculates the arctangent of a real number
`atan2`	Calculates the arctangent of y/x for real numbers, real images or a complex image
`atanh`	Calculates the hyperbolic arctangent of a real number
`BesselI`	Calculates the general Bessel

	I function
BesselJ	Calculates the general Bessel J function (0 , 1 and N)
BesselK	Calculates the general Bessel K function
BesselY	Calculates the general Bessel Y function of orders (0,1 and n)
Beta	Calculates the beta function
BinomialCoefficient	Calculates the binomial coefficient ${}_nC_k$
BinomialRandom*	Calculates a random number with binomial distribution
clip	Clip real number to be in a range
cos	Calculates the cosine of a real number
cosh	Calculates the hyperbolic cosine of a real number
distance	Calculates the pythagorean theorem
erf	Calculates the error function
erfc	Calculates the complement of the error function
exp	Calculates the exponential of a real number
exp1	Calculates the exponential and of a real number and subtracts 1
exp10	Calculates 10 raised to a real number
exp2	Calculates 2 raised to a real number
ExponentialRandom	Calculates a random number with exponential distribution
Factorial	Calculates the factorial of a real number
Gamma	Calculates the gamma of a real number
GammaP	Calculates the incomplete gamma function
GammaQ	Calculates the complement of the incomplete gamma function
GammaRandom*	Calculates a random number with gamma distribution
GaussianRandom	Calculates a random number

	with gaussian distribution
LegendrePolynomial	Calculates the Legendre polynomial function
log	Calculates the logarithm of a real number
log1	Calculates the logarithm of a real number and adds 1
log10	Calculates the logarithm base 10 of a real number
log2	Calculates the logarithm base 2 of a real number
LogGamma	Calculates the log gamma of a real number
max	Calculates the maximum of two real numbers
Maximum	Calculates the maximum of a given list of real numbers
Median	Calculates the median of a given list of real numbers
min	Calculates the minimum of two real numbers
Minimum	Calculates the minimum of a given list of real numbers
mod	Calculates the integer modulus for real numbers
Pi	Returns an approximation of π
PoissonRandom	Calculates a random number with poisson distribution
Random	Calculates a random number with uniform distribution
Remainder	Calculates the integer remainder for real numbers
Round	Rounds a real number to the nearest integer
Sgn	Calculates the sign of a real number
sin	Calculates the sine of a real number
sinh	Calculates the hyperbolic sine of a real number
SphericalBesselJ	Calculates the spherical Bessel J function
SphericalBesselY	Calculates the spherical Bessel Y function
sqrt	Calculates the square root of a real number

tan	Calculates the tangent of a real number
tanh	Calculates the hyperbolic tangent
toDeg	Returns the value of the argument(radians) in Degrees
toRad	Returns the value of the argument(degrees) in radians
Trunc	Truncates a real number to an integer
UniformRandom	Calculates a random number with uniform distribution

*Not yet implemented

Pre Defined Constants

Name	Summary
true	Evaluates to 1
false	Evaluates to 0
yes	Evaluates to 1
no	Evaluates to 0
on	Evaluates to 1
off	Evaluates to 0
pi	Evaluates to “pi” = 3.14…

Complex Numbers

Declaration

complexnumber z	Declares a complex number variable z set to (0,0)
cmplx z	cmplx is equivalent to complexnumber
cmplx z(1.0)	Declares z as a complex number and sets it equal to (1.0 + i0.0)
cmplx z(1.0,0.3)	Declares z as a complex number and sets it equal to

	(1.0 + i0.3)
`cmplx z(cis(pi/4))`	Declares z as a complex number and sets it equal to exp(i*pi/4) (cos(pi/4) + i*sin(pi/4))

Operators

Name	Summary
`!=`	Inequality operator for complex numbers
`*`	Multiply operator for complex numbers
`**`	Exponentation operator for complex numbers
`*=`	Multiply and assign operator for complex numbers
`+`	Addition operator for complex numbers
`+=`	Add and assign operator for complex numbers
`-`	Negation operator for a complex number
`-`	Subtraction operator for complex numbers
`-=`	Subtract and assign operator for complex numbers
`/`	Division operator for complex numbers
`/=`	Divide and assign operator for complex numbers
`=`	Assignment operator for complex numbers
`==`	Equality operator for complex numbers
`?`	Arithmetic operator for complex numbers

Functions

Name	Summary
`abs()`	Calculates the absolute value of a complex number

`cis()`	Calculates a unit vector in the complex plane cis(arg) = (cos(arg), sin(arg))
`complex()`	Creates a complex number from two real numbers
`conjugate()`	Calculates the conjugate of a complex number
`cos()`	Calculates the cosine of a complex number
`cosh()`	Calculates the hyperbolic cosine of a complex number
`exp()`	Calculates the exponential of a complex number
`imaginary()`	Returns the imaginary portion of a complex number as a real number
`log()`	Calculates the logarithm of a complex number
`modulus()`	Calculates the modulus of a complex number
`norm()`	Calculates the norm of a complex number
`Phase()`	Calculates the phase of a complex number
`Polar()`	Calculates the polar representation of a rectangular complex number
`real()`	Returns the real portion of a complex number
`Rect()`	Calculates the rectangular representation of a polar complex number
`sin()`	Calculates the sine of a complex number
`sinh()`	Calculates the hyperbolic sine of a complex number
`sqrt()`	Calculates the square root of a complex number
`tan()`	Calculates the tangent of a complex number
`tanh()`	Calculates the hyperbolic tangent of a complex number

Complex Number Member Functions

Functions

Name	Summary
set()	Sets the x,y pair of the complex number
real()	returns the real part of the complex number or sets the value of the real part if an argument is given.
imag()	returns the imaginary part of the complex number or sets the value of the imaginary part if an argument is given.
x()	returns the real part of the complex number or sets the value of the real part if an argument is given.
y()	returns the imaginary part of the complex number or sets the value of the imaginary part if an argument is given.
setX()	Equivalent to x(arg)
setY()	Equivalent to y(arg)
phase()	returns the phase in radians of the complex number
angle()	returns the phase in degrees of the complex number
modulus()	returns the modulus of the complex number
modsq()	returns the modulus square of the complex number
conjugate()	returns the complex conjugate of the complex number

Example:

```
ComplexNumber c(2,3)      // Declares and initializes complex c
number x = c.x()          // x = 2
number y = c.y()          // y = 3

c.x(10)      // Sets the real part to 10
c.y(4)       // Sets the imaginary part to 4
c.setX(10)   // Sets the real part to 10
c.setY(4)    // Sets the imaginary part to 4

c.set(4,6)    // Sets the complex number equal to (4,6)

cmplx d = c.conjugate()
```

```
number phase = d.phase()
```

Real Images

Declaration

`image img`	Declares a pointer to an image which must be created or assigned
`image img(ncols,nrows)`	Declares and creates a real image of size ncols by nrows Width=ncols , Height=nrows
`image img(512,512,exp(-iradius**2/64))`	Declares and creates a real image of size 512 by 512, assigning it to a Gaussian of sigma 8 (exp (- (r/8)**2)

Operators

Name	Summary
`*`	Multiply operator for real images
`**`	Exponentiation operator for real images
`*=`	Multiply and assign operator for real images
`+`	Addition operator for real images
`++`	Increment operator for a real images
`+=`	Add and assign operator for real images
`-`	Negation operator for a real images
`-`	Subtraction operator for real images
`-=`	Subtract and assign operator for real images
`/`	Division operator for real images

/=	Divide and assign operator for real images
<	Less than operator for real images
<=	Less than or equal operator for real images
=	Assignment operator for real images
==	Equality operator for real images
>	Greater than operator for real images
>=	Greater than or equal operator for real images
?	Arithmetic if operator for real images
[]	Image region expression

Library Functions

Name	Summary
abs	Returns a real image containing the absolute values of a real image
acos	Returns a real image containing the arccosine of a real image
acosh	Returns a real image containing the hyperbolic arccosine of a real image
asin	Returns a real image containing the arcsine of a real image
asinh	Returns a real image containing the hyperbolic arcsine of a real image
atanh	Returns a real image containing the hyperbolic arctangent of a real image
ceiling	Sets all values larger than a given value to the given value
clip	Sets all values smaller than a given value to the value and all values larger than a given value to the given value
cos	Returns a real image containing the hyperbolic cosine of a real image

cosh	Returns a real image containing the cosine of a real image
DotProduct	Calculates the dot product of two real image expressions
exp	Returns a real image containing the exponential of a real image
exp1	Returns a real image containing the exponential of a real image and subtracts 1
exp2	Returns a real image containing 2**image
exp10	Returns a real image containing 10**image
ExprSize	Sets the physical size of a real image expression
ExprSize	Sets the physical size of a real image expression
factorial	Returns the factorial of an image (values are rounded to integers)
floor	Sets all values smaller than a given value to the given value
log1	Returns an image of the log of an image after subtracting 1.
log10	Calculates log10 of an image
log2	Calculates log2 of an image
log	Calculates the natural logarithm of an image
max	Finds the maximum of a real image expression
max	Finds the maximum value and position for a real image expression
mean	Calculates the mean of a real image expression
MeanSquare	Calculates the mean square of a real image expression
median	Calculates the median of a real image expression
min	Finds the minimum value and position for a real image expression
min	Finds the minimum of a real image expression
norm	Returns an image of the norms of an image (xi-squared)

Polynomial	Calculates a polynomial expansion using a real image expression
Pow	Returns a real image containing image**x
pow2	Returns a real image containing 2**image
pow10	Returns a real image containing 10**image
product*	Calculates the product of a real image expression
RMS	Calculates the RMS of a real image expression
Round	Rounds all values to the nearest integer
sum	Calculates the sum of a real image expression
sigma	Returns the standard deviation of an image
sin	Returns a real image containing the sine of a real image
sinh	Returns a real image containing the hyperbolic sine of a real image
sqrt	Returns a real image containing the square root of a real image
sq	Returns a real image containing the square of a real image
square	Returns a real image containing the square of a real image
stdv	Returns the standard deviation of an image
tan	Returns a real image containing the tangent of a real image
tanh	Returns a real image containing the hyperbolic tangent of a real image
TimeBar”	Displays a timebar while evaluating real image expression
Trunc	Truncates all real values to the integer part
Variance	Returns the variance of the image
Vectorlength	Returns the square root of the sum of all pixels squared
Warp	Calculates bilinear

	interpolated value within a real image

*Not yet implemented

Complex Images

Declaration

compleximage img	Declares a “Pointer” to a complex image which must be created or assigned
compleximage img(ncols,nrows)	Declares and creates a complex image of size ncols by nrows Width=ncols , Height=nrows

However it is not necessary in most instances to declare an image to be complex. One can also declare it as type Image.
The construct…

```
Image img(512,512)
Cmplx z = complex(3,2)
img = z      // Will convert the Image from being real to complex
```

Operators

Name	Summary
*	Multiply operator for complex images
**	Exponentiation operator for complex images
*=	Multiply and assign operator for complex images
+	Addition operator for complex images
+=	Add and assign operator for complex images

`-`	Negation operator for a complex images
`-`	Subtraction operator for complex images
`-=`	Subtract and assign operator for complex images
`/`	Division operator for complex images
`/=`	Divide and assign operator for complex images
`=`	Assignment operator for complex images
`==`	Equality operator for complex images
`?`	Arithmetic if operator for complex images

Functions

Name	Summary
`ComplexConjugate`	Returns the complex conjugate of an image
`Conjugate`	Returns the complex conjugate of an image
`Real`	Returns the real part of an image
`Imaginary`	Returns the imaginary of an image
`Intensity`	Returns the modulus square of a complex image
`Phase`	Returns the phase of a complex image
`Modulus`	Returns the modulus (amplitude) of a complex image

Built in Image Expressions

Name	Summary
`icol`	When used in an expression involving an image, icol will refer to the index of the

	column in the image and there is an implied loop over all the elements of an image. Basically each pixel takes the value of the column number of the pixel.
irow	When used in an expression involving an image, irow will refer to the index of the row in the image and there is an implied loop over all the elements of an image. Each pixel takes the value of the row number of the pixel.
iplane	When used in an expression involving a 3D image, iplane will refer to the index of the depth in the 3D image and there is an implied loop over all the elements of an image. Each voxel has the value of the plane number of the voxel.
iradius	When used in an expression involving an image, iradius will refer to the value of sqrt((I-W/2)* (I-W/2)+(J-H/2)* (J-H/2)), where I and J are the column and row index of the image and W and H are the width and height of the image. There is an implied loop over all the elements of an image. Each pixel has the value of the radius of the pixel.
itheta	When used in an expression involving an image, itheta will refer to the value of atan((J-H/2)/(I-W/2)), where I and J are the column and row index of the image and W and H are the width and height of the image. There is an implied loop over all the elements of an image. Each pixel has the value of the angle with the x-axis of the pixel.
iwidth	When used in an expression involving an image, iwidth will refer to the width of the image. It's a constant.
iheight	When used in an expression

	involving an image, iheight will refer to the height of the image. It's a constant.
idepth	When used in an expression involving a 3D volume image, idepth will refer to the depth of the image. It's a constant.
ipoints	When used in an expression involving an image, ipoints will refer to the number of pixels in the image. It's a constant.

Image Stacks

Declaration

imagestack stack	Defines and Creates an empty image stack

Assignment

imagestack stack stack = existingStack	Defines the ImageStack Sets the stack equal to an existing image stack
imagestack stack stack = existing3DImage	Defines the ImageStack Sets the stack equal to an existing 3D image volume

Member functions

Name	Summary
AddImage(Image)	Adds an image to a stack
DeleteImage(Image)	Deletes an image from a stack
FFT(int num)	Performs a Fourier transform on an image on the stack
FFT	Performs a Fourier transform

	of every image on the stack
GetImage(int Num)	Returns an image from a stack
GetnumberOfImages()	returns the number of images in a stack
IFFT(int num)	Performs the inverse Fourier transform on an image in the stack
IFFT	Performs the inverse Fourier transform of every image on the stack
Save(String)	Saves an image stack as a MRC file

Volume Images

Declaration / Creation

Image3D img3	Declares a "Pointer" to a 3D Volume / 3D Image
Image3D img3(32,32,32)	Declares and creates an Image Volume of size 32 by 32 by 32
Image3D img3(32,32,32,exp(-iradius**2/8**2))	Declares and creates an Image Volume of size 32x32x32 and assigning it to a "spherical Gaussian" of sigma 8

Assignment

Image3D img3	Defines the 3D Image
img3 = existingImage3D	Sets the Image Volume from an existing 3D image volume
img3[x1:x2,y1:y2,z1:z2] = existingImage3D[xx1:xx2,yy1:yy2,zz1:zz2]	where (xx2-xx1) = (x2-x1) (yy2-yy1) = (y2-y1) (zz2-zz1) = (z2-z1)

Image3D img3	Defines the 3D Image
img3= existingStack	Sets the Image Volume from an existing image stack

Creation

Name	Summary
exprsize3	Function for creating a 3D Image Volume
Image3D name(width,height,depth) or Image3D name(width,height,depth,ImageExpression)	Creates the 3D Volume and assigns the volume to the image expression

example:

```
image3d img = exprsize3(256,256,256)        // Declares and creates a volume image
                                            // set to the initial value 0
image3d img1 = exprsize3(256,256,256,10)  // Declares and creates a volume image
                                            // set  to the initial value 10
image3d vol(256,256,256,exp(-iradius**2/20**2))
```

Member Functions

Name	Summary
BeginFill()	Starts a fill from projections
Depth()	Returns the depth (z dimension in pixels) of the volume image
Display()	Displays a 3D (volume) image
EndFill()	Ends a fill from projections
FFT()	Performs a 3D Fourier transform of a 3D (volume) image
FFT2()	Performs a 2D Fourier transform of each image (plane) of the 3D (volume) image
FillFromProjection*()	Filling the volume image from a 2D projection
GetImage(int z)	Returns a 2D image from a given position (z) in the volume image
GetName()	Returns the name of the image
GetSize(w,h,d)	Returns the width, height and depth of the volume image
GetVoxel(x,y,z)	Returns the value at position (x,y,z)
Height()	Returns the height (y

	dimension in pixels) of the volume image
IFFT()	Performs a 3D inverse Fourier transform of a 3D (volume) image
IFFT2()	Performs a 2D Fourier inverse transform of each image (plane) of the 3D (volume) image
Imaginary()	Replaces the volume image with its imaginary part
Modulus()	Transforms the image to the modulus
Phase()	Transforms the image to the phase
Real()	Replaces the volume image with its real part
Repeat(nx,ny,nz)	Repeat the volume image NX,NY,NZ times
RotateX(angle)	Rotate about x clockwise
RotateY(angle)	Rotate about y clockwise
RotateZ(angle)	Rotate about x clockwise
Save()	Saves the volume image as a MRC file
SetImage(i,image)	Sets a 2D image at a given position (z) in the volume image
SetName("name")	Sets the name of the 3D image
SetVoxel(x,y,z,value)	Sets the voxel value at position (x,y,z)
sq()	Replaces each pixel (voxel) with the square of its value
sqrt()	Replaces each pixel (voxel) with the squareroot of its value
Width()	Returns the width (x dimension in pixels) of the volume image

*Not yet implemented

Image Data Type

Declaration

```
image ss
compleximage css
```

Creating / initializing

Name	Summary
`Exprsize(width,height,..)`	Allocates and initializes an image
`realimage(width,height)`	Creates a real image of a given size
`newimage(width,height)`	Creates a real image of a given size
`createimage(width,height)`	Creates a real image of a given size
`createfloatimage(width,height)`	Creates a real image of a given size
`createcompleximage(width,height)`	Creates a complex image of a given size
`openimage()`	opens an existing image file

```
Example:
A0 = exprsize(512,512,icol)   Creates an image with label
                              a0 and
                              displays it. The image
                              contains a ramp where each
                              pixel has the value of the
                              column number.

Image ss = newimage(“real image”,512,512)
compleximage css = createcompleximage(“Complex TestImage”,
                              512,512)


Example:
image ss = openimage(“image.tif”)
```

Image Member Functions

Functions

Name	Summary
ac	Replaces a real image with its autocorrelation
acos	Replaces a real with its arccosine
acosh	Replaces a real with its

	hyperbolic arccosine
AdjustAngle	Adjusts the image so that it has an angle of 90 degrees. This is applicable for images returned from a simulation. In this case the image represents a periodic object and the angle of the unit cell may be different from 90 deg.
AdjustSampling	Adjusts the image so that it has equal sampling in x and y. This is applicable for images returned from a simulation. In this case the image represents a periodic object and the sampling along the a and b axes may be different.
Amplitude	Replaces a complex with its amplitude
AnnularHighpassFilter	Applies a high pass filter to an image
AnnularLowpassFilter	Applies a low pass filter to an image
ApplyAnnularMask	Applies an annular mask to an image
ApplyCircularMask	Applies a circular mask to an image
ApplyCosineMask	Applies a cosine mask to an image
ApplyHanningMask	Applies a Hanning mask to an image
ApplyMasksFromImage	Applies masks belonging to a different image onto itself
asin	Replaces the image with its arcsine
asinh	Replaces the image with its hyperbolic arcsine
atan	Replaces the image with its arctan
atan2	Replaces the image with its arctan
atanh	Replaces the image with its hyperbolic arctan
Autocorrelate	Replaces a real image with its autocorrelation (equivalent to ac)
bgs	Applies a Background Noise Subtraction Filter on a real image
cc	Replaces a complex image with its complex conjugate
ccd	Corrects for CCD detector bad

	pixels in a real image
ceiling	Sets all values greater than maxVal to maxVal
CenterOfMass	Returns the value of and position of the “Center of Mass”
clip	Sets all values greater smaller than minVal to minVal and all values greater than maxVal to maxVal
ConvertToRealSpaceStorage	Changes the data storage to regular real space storage (x,y)
ConvertToReciprocalSpaceStorage	Sets the storage to that of h,k in reciprocal space. (h=0,k=0) at position (0,0)
Complexconjugate	Replaces a complex image with its complex conjugate (equivalent to cc)
ComplexModulusSq	This replaces a complex image with the product of itself and its complex conjugate. It is the complex modulus square. Imaginary part is zero
Cmsq	Equivalent short for ComplexModulusSq
Conjugate	Replaces a complex image with its complex conjugate (equivalent to cc)
cos	Replaces a real with its cosine
cosh	Replaces a real with its hyperbolic cosine
Display	Displays the image
Displayonlogscale	Displays the image on a log scale
exp	Takes the exponential of an image
exp1	Takes the exponential of a real image and subtracts the value 1
exp10	Calculates the 10**image
exp2	Calculates the 2**image
factorial	Takes the factorial of each pixel of an image
fft	Takes the Fourier transform of an image
Fillfromprojection	Fills in a 2D image from 1D projections
Fliphorizontal	Flips an image horizontally (around the vertical axis)
Flipvertical	Flips an image vertically (around the horizontal axis)

floor	Sets all values smaller than minVal to minVal
GaussianLowpassFilter	Applies a Gaussian low pass filter
GaussianHighPassFilter	Applies a Gaussian high pass filter
GetCalibration	Returns the calibration of the image
GetCalibrationunit	Returns the calibration unit of the image
GetGamma	Returns the angle associated with the image
GetLattice	Returns the lattice (if defined) for the image
GetName	Return the name of the image
GetPeaklist	Returns the peaklist (if defined) for the image
GetPixel	Returns the pixel value for a given pixel
GetScale	Returns the scale/calibration
GetScaleX	Returns the scale/calibration in X
GetScaleY	Returns the scale/calibration in Y
GetSize	Returns the width and height of the image
HasLattice	Returns true(1)/false(0) if a lattice is defined on an image
HasPeaklist	Returns true(1)/false(0) if a peak list is defined on an image
Height	Returns the height (in pixels)
HighpassFilter	Applies a highpass filter to the image
Ifft	Replaces a complex image in reciprocal space with its inverse Fourier transform
Imaginary	Replaces a complex with its imaginary part
Intensity	Replaces an image with its modulus squared
Inverse	Sets the Image Values to 1/ Values
Invert	Sets the image equal to - Image
Laplacian	Takes the Laplacian of a real image
Log	Takes the natural log of a real image
Log1	Takes the natural log of a real image after adding the value 1

log10	Takes the log10 of a real image
log2	Takes the log2 of a real image
Max	Returns the maximum of a real image
Mean	Returns the mean of a real image
Min	Returns the minimum of a real image
Modulus	Replaces a complex image with its modulus
PadWithMean	Pads an image with its mean value to specified dimensions
PadWithZero	Pads an image with zero to specified dimensions
Phase	Replaces a complex image with its phase
pow	Replaces the image with image**factor
pow10	Replaces the image with 10**(image)
pow2	Replaces the image with 2**(image)
Powerspectrum	Calculates the Power Spectrum of an image
Ps	Calculates the Power Spectrum of an image
rccd	Corrects for CCD detector bad pixels in a real image (*ccd*)
Real	Replaces a complex image with its real part
Removeccddefects	Corrects for CCD detector bad pixels in a real image (*ccd*)
Repeat	Repeats an image by tiling
Resize	Resizes an image
RMS	Returns the RMS value of a real image
Rotate	Rotates the image by a given angle anti-clockwise
RotateLeft	Rotates anti-clockwise an image by 90 deg.
RotateRight	Rotates clockwise an image by 90 deg.
Round	Rounds all values to the nearest integer
SetBlackWhite	Sets the black and white display limits of an image
SetCalibration	Sets the calibration of an image
SetCalibrationUnit	Sets the calibration unit of an image
SetImageSpace	Sets the space (real/

	reciprocal) of an image
SetName	Sets the name of an image
SetPixel	Sets a specified pixel to a given value
SetScale	Sets the scale of an image
Sharpen	Applies a Sharpening Filter to a real image
Shift	Shifts the position (0,0) to a new position (x,y) in the image
ShiftCenter	Shifts the position (0,0) to the position (W/2,H/2) in the image
ShiftOrigin	Shifts the position (0,0) to the position (W/2,H/2) in the image
show	Displays an image
sigma	Returns the standard deviation of a real image
sin	Replaces a real image with its sine
sinh	Replaces a real image with its hyperbolic sine
Smooth	Applies a Smoothing Filter to a real image
sobel	Applies a Sobel Filter to a real image
sq	Takes the square of an image
sqrt	Takes the square root of a real image
square	Takes the square of an image
stdv	Returns the standard deviation of a real image
tan	Replaces a real with its tangent
tanh	Replaces a real with its hyperbolic tangent
thf	Applies a Threshold Filter to a real image
Transpose	Transposes an image
ThresholdFilter	Applies a Threshold Filter to a real image
Trunc	Truncates the values to its integer part
Update	Updates an image
Variance	Returns the variance of the image
wf	Applies a Wiener Filter to a real image
Width	Returns the width (pixels) of an image
WienerFilter	Applies a Wiener Filter to a real image

Example:

```
image img = exprsize(256,256,icol)
img.sin()
img.fft()
img.setname("test")
img.display()
```

Example:

```
// a# as in a0, a1, a10… are automatically assigned as
// images and are displayed by default
a10 = exprsize(256,256,sin(2*pi()*icol/8)*sin(2*pi()*irow/12))
a11 = a10
a11.fft()
a10.setname("test")
a11.setname("Fourier Transform of test")
a12 = a10[64,64,192,192]     // a12 is set to the top,left,bottom,right subregion of a10
```

Image Creation

Functions

Name	Summary
`ExprSize`	Allocates and initializes an image
`RealImage`	Creates a real image of a given size
`NewImage`	Creates a real image of a given size
`CreateImage`	Creates a real image of a given size
`CreateFloatImage`	Creates a real image of a given size
`CreateComplexImage`	Creates a complex image of a given size
`OpenImage`	opens an existing image file
`Image imag(width,height,…)`	Declares and creates an image of specified dimensions and optionally assigns it to an image-expression

```
Images can also be created and assigned from an array
numbers, a vector and a matrix

Matrix m(100,100)
Vector v(100)
number x[100]
..
..
Image i1,i2,i3
i1 = m // Creates an Image of size(100,100)
i2 = v // Creates an Image of size(100,1)
i3 = x // Creates an Image of size(100,1)

The images are filled with the content of m, v and x
If the images are already created, they must have the
dimensions of m, v and x
```

Image Management

Functions

Name	Summary
cexp	Returns a complex image from two images x and y (real part = cos(x)) (imaginary part = sin(x))
cis	Returns a complex image from two images x and y (real part = cos(x)) (imaginary part = sin(x))
CloseImage	Closes an existing image
Complex	Returns a complex image from two images x (real part) and y (imaginary part)
CreateComplexImage	Creates a complex image of a given size
CreateFloatImage	Creates a real image of a given size
CreateImage	Creates a new image of a given type
CreateImageFromDisplay	Creates an image from the information in a given window
CreateNewImage	Creates a new image of a given type
CreateRealImage	Creates a real image of a given size
CreateTableFromImage	Creates a table from an image

Delete	Deletes an image
DeleteImage	Deletes an image
DoesImageExist	Returns true/false if a given named image exists
Extract	Returns an image by extracting a region of an existing image
get2dSize	Returns width and height of an image
getCalibration	Returns the calibration of an image
getCalibrationUnit	Returns the calibration unit of an image
getCalibrationUnitString	Returns the calibration unit of an image
getFrontImage	Returns the front image
getHeight	Returns the height of an image
getMagnification	Returns the zoom factor of an image
getNamedImage	Returns the image with a given name
getNumberedImage	Returns the image with a label A#
getScale	Returns the scale of an image
getSize	Returns the width and height of an image
getUnitString	Returns the calibration unit of an image
getWidth	Returns the width of an image
getZoom	Returns the zoom factor of an image
NewImage	Creates a new image
Open	Opens a named image file
OpenImage	Opens a named image file
OpenWithDialog	Opens an image file using a file selector dialog
PrintImage	Prints a given image
RealImage	Creates a real image
Resize	Resizes an image
saveImage	Saves an image
setCalibration	Sets the calibration of an image
setCalibrationUnit	Sets the calibration unit of an image
setMagnification	Returns the scale of an image
setName	Returns the name of an image
setScale	Sets the scale of an image
setUnitString	Sets the calibration unit of an image
setZoom	Sets the zoom factor of an image

Image Processing

Functions

Name	Summary
Ac	Returns the autocorrelation of a real image
Align	Aligns two images
AlignImages	Aligns two images
AlignTwoImages	Aligns two images
AnnularHighPassFilter	Returns a new image of a high pass filtered image
AnnularLowPassFilter	Returns a new image of a low pass filtered image
ApplyAnnularMask	Returns an image resulting from the application of an annular mask to an image
ApplyCircularMask	Returns an image resulting from the application of an annular mask to an image
ApplyCosineMask	Returns an image resulting from the application of a circular cosine mask to an image
ApplyHanningMask	Returns an image resulting from the application of a circular hanning mask to an image
AutoCorrelate	Returns an image resulting from the auto-correlation of two images
AutoCorrelation	Returns an image resulting from the auto-correlation of two images
CC	Returns an image resulting from the cross-correlation of two images
Convolute	Returns an image resulting from the convolution of two images
Convolve	Returns an image resulting from the convolution of two images
Correlate	Returns an image resulting from the cross-correlation of two images

CrossCorrelate	Returns an image resulting from the cross-correlation of two images
CrossCorrelation	Returns an image resulting from the cross-correlation of two images
DotProduct	Returns the dot-product (inner product) of two images
FFT	Returns the Fourier transforms of an image
FindPattern	Returns the position dependent cross-correlation coefficient between an image and a pattern
FlipHorizontal	Returns an image resulting from mirroring an image around the vertical axis
FlipVertical	Returns an image resulting from mirroring an image around the horizontal axis
GaussianHighPassFilter	Returns an image resulting from the application of a Gaussian High Pass filter to an image
GaussianLowPassFilter	Returns an image resulting from the application of an Gaussian Low Pass filter to an image
HighPass	Returns an image resulting from the application of a Annular High Pass filter to an image
HighPassFilter	Returns an image resulting from the application of a Annular High Pass filter to an image
IFFT	Returns the inverse Fourier transforms of an image
Invert	Returns the inverse of an image
Laplacian	Returns the Laplacian of an image
Lowpass	Returns an image resulting from the application of an Annular Low Pass filter to an image
LowpassFilter	Returns an image resulting from the application of an Annular Low Pass filter to an image
Negate	Returns the inverse of an image
PhaseCorrelate	Returns the phase correlation between two images

PhaseCorrelation	Returns the phase correlation between two images
PowerSpectrum	Returns the Power Spectrum of an image
Ps	Returns the Power Spectrum of an image
RadialAverage	Returns the radial average of an image
RealFFT	Returns the Fourier transforms of an image
RemoveCCDdefects	Returns an image by adjusting for ccd defects of a recorded image
Repeat	Returns an image by repeating in x and y an existing image
Rotate	Returns an image resulting from rotating an image x degrees anti-clockwise
RotateLeft	Returns an image resulting from rotating an image 90 deg. Anti-clockwise
RotateRight	Returns an image resulting from rotating an image 90 deg. clockwise
Scale	Returns an image resulting from scaling an image
Sharpen	Returns an image resulting from applying a sharpening operation to an image
Shift	Returns an image resulting from shifting the origin of an exiting image
ShiftCenter	Returns an image resulting from shifting the origin of an exiting image
ShiftOrigin	Returns an image resulting from shifting the origin of an exiting image
Smooth	Returns an image resulting from applying a smoothing operation to an image
Sobel	Returns an image resulting from applying a Sobel operation to an image
TemplateMatch	Returns the position dependent cross-correlation coefficient between an image and a pattern
Wf	Returns an image resulting from applying a Wiener Filter to an image
WienerFilter	Returns an image resulting from applying a Wiener Filter to an image

Image Data Access

Functions

Name	Summary
`GetPixel`	Gets the pixel value for a given pixel
`GetPixelAmplitude`	Gets the pixel amplitude for a given pixel in a complex image
`GetPixelPhase`	Gets the pixel phase for a given pixel in a complex image
`SetPixel`	Sets the pixel value for a given pixel
`SetPixelAmplitude`	Sets the pixel amplitude for a given pixel in a complex image
`SetPixelPhase`	Sets the pixel phase for a given pixel in a complex image
`[col,row]`	Indexing into an Image pixel
`Image dmg(256,256)`	
`img[10,10] = value`	Sets the pixel at [10,10] to value

Peak Determination

Functions

Name	Summary
`AddPeakList`	Add a peaklist to an image. The peaklist gets merged with any other peaklists for the image.
`CreateVectorMap`	Creates a vector map from two images (displacements)

FindMaxima	Finds the maxima in an image
FindMinima	Finds the minima in an image
FindPeaks	Finds the peaks in an image
FitDoublePeaks	Fits a peak list to a set of overlapping Gaussian peaks (two peaks are close)
FitExponentials	Fits the peaks in a peak list to Exponential peaks.
FitGaussians	Fits the peaks in a peak list to Gaussian peaks.
FitParabolas	Fits the peaks in a peak list to Parabolic peaks.
FitPeaks	Fits the peaks in a peak list to Gaussian peaks (other shapes available)
GetPeakList	Returns the peak list defined for an image
HasPeakList	Return true/false if the image has/has not an associated peak list
ReadPeakList	Returns a peaklist (image) from a peak list file (tab-delimited text file)
SavePeaks	Save the peaks in a peak list to a file.
SavePeaksWithDialog	Save the peaks in a peak list to a file
SetPeakList	Creates a peaklist for an image replacing any existing peaklist.
VectorMap	Creates a vector map from two sets of displacements

Lattice Determination

Functions

Name	Summary
FitLattice	Fits an existing lattice to a Peaklist
GetLattice	Gets the lattice defined on an image
HasLattice	Return true/false if the image has/has not a lattice defined

Vector

Operators

`*`	The normal arithmetic operators apply on vectors of equal size
`/`	
`-`	
`+`	
`*=`	
`/=`	
`-=`	
`+=`	

Declaration

`Vector v`	Declares a vector, not yet created and assigned
`Vector c(10)`	Declares and creates a vector of size 10 (10 elements) initialized to 0
`ComplexVector v`	Declares a complex vector, not yet created and assigned
`ComplexVector c(10)`	Declares and creates a complex vector of size 10 (10 elements) initialized to (0,0)

Member functions	Summary
`angle()`	Replaces each element of the complex vector with the angle (atan2(y/x)) in degrees
`at(i)`	Returns the value of the element of the vector at the position ‘i’

`conjugate()`	Replaces the complex vector with its complex conjugate
`create(len)`	Creates the vector of size len
`imag()`	Replaces the complex vector with the imaginary component
`length()`	Returns the Square root of the sum of the squares
`modulus()`	Replaces the complex vector with a real vector containing the modulus of the complex elements
`modsq()`	Replaces the complex vector with a real vector containing the modulus square of the complex elements
`Phase()`	Replaces each element of the complex vector with the angle (atan(y/x)) in radians
`Print()`	Prints out all the values of the vector
`Real()`	Replaces the complex vector with a real vector containing the real part of the complex elements
`Resize(len)`	Resizes the vector to 'len' number of elements
`Set(ndx,value)`	Sets the element of the vector at index 'ndx' to the value 'value'
`Size()`	Returns the number of elements in the vector
`Sort(order=0)`	Sorts the vector in ascending(0) (default) or descending(1) order
Creating an Image from a Vector	
`Vector V(100)`	
…	
`Image imag = V`	Creates an Image of size V.size(),1

Image Display

Functions

Name	Summary
Display	Shows/Displays an image
DisplayAsTable	Displays the image as a table of numbers
DisplayAt	Displays the image in a window at the given position
DisplayOnLogscale	Displays the image on a log scale
GetSurveyMode	Gets the method of survey technique for setting black and white values
GetSurveyTechnique	Gets the method of survey technique for setting black and white values
GetWindowPosition	Returns the window position of an image
GetWindowSize	Returns the window size for a displayed image
SetDisplayType	Sets the type of display for an image
SetSurveyMode	Sets the method of survey technique for setting black and white values
SetSurveyTechnique	Sets the method of survey technique for setting black and white values
SetWindowPosition	Sets the window position of an image
SetWindowSize	Sets the window size for a displayed image
Show	Equivalent to Display
ShowImage	Equivalent to Display
UpdateImage	Updates the display for a modified image

Image Selections

Functions

Name	Summary
ExpandSelection	Expands a given selection
GetSelection	Gets the rectangle of the

	selection
SetSelection	Sets the rectangle of the selection

Annotations

Functions

Name	Summary
AnnotationType	Returns the type of a given annotation
CountAnnotations	Returns the number of annotations on the image
CreateArrowAnnotation	Creates an arrow annotation
CreateBoxAnnotation	Creates a rectangular annotation
CreateDoubleArrowAnnotation	Creates a double arrow annotation
CreateLineAnnotation	Creates a line annotation
CreateOvalAnnotation	Creates an oval annotation
CreateTextAnnotation	Creates an text annotation
DeleteAnnotation	Deletes a given annotation
DeselectAnnotation	Deselects an annotation
GetAnnotationRect	Gets the bounding rectangle of a given annotation
GetNthAnnotationID	Gets the ID of an annotation
IsAnnotationSelected	Determines if an annotation is selected
MoveAnnotation	Moves the annotation to a given position
OffsetAnnotation	Offsets the annotation with specified integer offsets
SelectAnnotation	Selects the specified annotation
SetAnnotationBackground*	Sets the background of an annotation
SetAnnotationColor	Sets the Color of an annotation
SetAnnotationFace*	Sets the text face of an annotation
SetAnnotationFont	Sets the text font of an annotation
SetAnnotationJustification*	Sets the text justification of an annotation
SetAnnotationRect	Sets the bounding rectangle

	of an annotation
SetAnnotationSize	Sets the size of an annotation
ShiftAnnotation	Shifts the position of an annotation. Equivalent to MoveAnnotation
ValidAnnotation	Is the annotation valid

*Not yet implemented

Strings

Operators

Name	Summary
!=	Inequality operator for strings
+	Concatenate a string and a real number
+	Concatenate a string and a complex number
+	Concatenate a complex number and a string
+	Concatenate a real number and a string
+	Concatenate a string and a string
==	Equality operator for strings

Functions

Name	Summary
Asc*	Returns numeric value in ascii
Chr*	Returns ascii equivalent of a number as a string
Left*	Returns the leftmost portion of a string
Len*	Returns the length of a string
mid*	Returns the middle portion of a string
right*	Returns the rightmost portion of a string

val*	Converts a string to a real number

*Not yet implemented

Persistent Notes (mostly not implemented)

Name	Summary
DeletePersistentNote*	Deletes persistent note
GetPersistentComplexNumberNote	Gets the value of a persistent complex number note
GetPersistentNoteState*	Gets persistent note state
GetPersistentNumberNote	Gets the value of a persistent number note
GetPersistentRectNote	Gets the value of a persistent rect note
GetPersistentRGBNumberNote*	Gets the value of a persistent RGB number note
GetPersistentStringNote*	Gets the value of a persistent string note
GetPersistentStringNote*	Gets the value of a persistent string note
SetPersistentComplexNumberNote	Sets the value of a persistent complex number note
SetPersistentKeywordNote*	Adds a persistent keyword note
SetPersistentNoteState*	Sets persistent note state
SetPersistentNumberNote	Sets the value of a persistent number note
SetPersistentRectNote	Sets the value of a persistent rect note
SetPersistentRGBNumberNote*	Sets the value of a persistent RGB number note
SetPersistentStringNote*	Sets the value of a persistent string note

*Not yet implemented

Number Conversions

Name	Summary
BaseN*	Convert a number to an arbitrary base string
BaseN*	Convert a number to an arbitrary base string with a fixed length
Binary*	Convert a number to a binary string with a fixed length
Binary*	Convert a number to a binary string
Decimal*	Convert a number to a decimal string
Decimal*	Convert a number to a decimal string with a fixed length
Hex*	Convert a number to a hex string with a fixed length
Hex*	Convert a number to a hex string
Octal*	Convert a number to an octal string with a fixed length
Octal*	Convert a number to an octal string

*Not yet implemented

Dialogs

Name	Summary
ContinueCancelDialog	Puts up a dialog with the option to cancel or continue the script
ErrorDialog	Puts up a dialog with an error string
GetNumber	Prompts for a number to input
GetTwoImages	Prompts for two images to select
GetTwoImagesWithPrompt	Prompts for two images to

	select
OkCancelDialog	Puts up a dialog with the option to cancel or continue the script
OkDialog	Puts up a dialog with the option to accept or not a choice
TwoButtonDialog	Puts up a dialog with two buttons to choose from

Input/Output

Name	Summary
OpenLogWindow	Opens the log/output window for scripts
OpenResultsWindow	Opens the log/output window for scripts (for DM compatibility)
Print	Prints (writes) an expression to the output window. By default adds a new line character at the end
Result	Prints (writes) an expression to the output window. DM compatible

Movies

Name	Summary
AddImageToMovie	Adds an image to a movie
AddWindowToMovie	Adds a window (containing an image) to a movie
CloseMovie	Closes the movie
CreateNewMovie	Creates a new movie with a given name

Example:

```
image img = exprsize(256,256,icol)
```

```
number i
createnewmovie("movie")
for(i=0; i < 256; i++) {
        addimagetomovie(img)
        img.shift(1,0) ;
}
closemovie()
```

Miscellaneous

Name	Summary
Catch	catch an exception thrown after a *try* statement
CloseProgressWindow*	*Not Yet Implemented*
CommandDown	Returns true/false depending on if the Command (Apple) key is down or not
DateStamp	Not Yet Implemented
Delay	Delay execution of the script x number of 1/60th of a second
DoEvents	Checks for input from the keyboard
Exit	Exit from the script
GetKey	Returns the key currently pressed
Help	Gets help on a given function
OpenAndSetProgressWindow*	*Not Yet Implemented*
OptionDown	Returns true/false depending on if the Option key is down or not
ShiftDown	Returns true/false depending on if the Shift key is down or not
SpaceDown	Returns true/false depending on if the Space bar is down or not
Throw	Throw an exception
ThrowString	Throw an exception with a string
Try	Try to execute the following bracketed statements. Check for an exception by using the *catch* statement

*Not yet implemented

Electron Microscopy Simulation Script Functions

General Calculation Functions

Name	Summary
`CalculateAtomicScatteringFactors`	Calculates the atomic scattering factors for a given atomic element and places them in a file
`CalculatExitWave`	Calculates the exit wave for the simulation currently open
`CalculateImage`	Calculates the image for the simulation currently open
`CalculatePotential`	Calculates the potential for the simulation currently open
`CalculateImageFromWave`	Calculates an image from a complex exit wave, given a microscope
`CalculateLinearImageFromWave`	Calculates a linear image from a complex exit wave, given a microscope
`ApplyFocusPlate`	Applies a focus plate (focus given in an image) to a complex wavefunction
`ShiftImageFocus`	Shifts the focus of a given complex wavefunction
`PropagateWave`	Calculates a 3D Complex Volume Image containing the electron wavefunction at each slice in the multislice calculation up to a given thickness

Microscope Data Type

Declaration

```
Microscope mic
```

Initializing

Name	Summary

`Microscope mic`	Defines a default microscope
`=`	Equates a microscope to another microscope

Example:

```
Microscope mic
mic.setvoltage(300)
```

Example:

`Simulation ss`	
`ss = GetSimulation()`	Get the Current Simulation See data type below
`ss = GetSimulation(String)`	Get the named Simulation
`Microscope mic`	Sets a default Microscope
`mic = ss.GetMicroscope()`	Assigns to simulation Microscope

Microscope Class Member Functions

Name	Summary
GetAperture	Returns the Aperture of the objective lens in 1/Å
GetApertureH	Returns the horizontal Center of Objective Lens Aperture in units of h of reciprocal space
GetApertureHK	Returns the Center of Objective Lens Aperture in units of h and k of reciprocal space
GetApertureK	Returns the Vertical Center of Objective Lens Aperture in units of k of reciprocal space
GetCs	Returns the Cs in mm of the objective lens
GetCs5	Returns the Cs5 in mm of the objective lens
GetDelta	Returns the Cs in mm of the objective lens
GetDivergence	Returns the Cs in mm of the objective lens
GetFocus	Returns the focus in Å of the objective lens
GetFocusSpread	Returns the spread in focus

	in Å of the objective lens
GetVoltage	Returns the Cs in mm of the objective lens
Print()	Prints out a summary of the microscope parameters
SetAperture	Sets the Aperture of the objective lens in 1/Å
SetApertureH	Sets the horizontal Center of Objective Lens Aperture in units of h of reciprocal space
SetApertureHK	Sets the Center of Objective Lens Aperture in units of h and k of reciprocal space
SetApertureK	Sets the Vertical Center of Objective Lens Aperture in units of k of reciprocal space
SetCs	Sets the Cs in mm of the objective lens
SetCs5	Sets the Cs5 in mm of the objective lens
SetDelta	Sets the Cs in mm of the objective lens
SetDivergence	Sets the Cs in mm of the objective lens
SetFocus	Sets the focus in Å of the objective lens
SetFocusSpread	Sets the spread in focus in Å of the objective lens
SetVoltage	Sets the Cs in mm of the objective lens

Simulation Data Type

Declaration

```
Simulation ss
```

Initializing

Name	Summary
GetSimulation	Gets the current simulation
OpenSimulation	Sets the current simulation from an existing structure file

```
Example:
simulation ss
ss = GetSimulation()          Gets current simulation
ss = GetSimulation("bcsco")   Gets the open "bcsco"
                              simulation
```

```
Example:
simulation ss = opensimulation("bcsco.at")
```

Simulation Class Member Functions

Name	Summary
CalculateAll	(Re)Calculates the Potential(s), Exit Wave(s) and Image(s).
Calculate3DPotential	Calculates the 3D potential for the unit cell of the current simulation
CalculateExitWave	Calculates the Exit Wave
CalculateImage	Calculates the Image
CalculatePotential	Calculates the Potential
CreateFrequencyImage	Returns a square image of a simulated object in reciprocal space.
CreateImage	Returns a square image from a given calculated image of given size and sampling
DisplayExitWave	Displays a given calculated exit wave for the simulation
DisplayExitWaveModulus	Displays the modulus of the exit wave
DisplayExitWavePhase	Displays the phase of the exit wave for the simulation
DisplayImage	Displays a given image for the simulation
DisplayPotential	Displays the calculated potential for the simulation
Focus	Sets the focus of the simulation
GetAperture	Returns the outer objective lens aperture (1/Å)
GetApertureAngle	Returns the outer objective lens aperture in mradians
GetApertureCenter	Returns the center of the objective lens aperture
GetApertureCenterHK	Returns the center of the objective lens aperture in (H,K) of the reciprocal space

	of the unit cell
GetCs	Returns the Spherical Aberration Cs in mm
GetCs5	Returns the 5th order Spherical Aberration Cs5 in mm
GetDeltaFocus	Returns the increment in focus for the calculation
GetDeltaThickness	Returns the increment in thickness for the calculation
GetDivergence	Returns the convergence angle (mrad) for the calculation
GetEndFocus	Returns the ending value for focus
GetEndThickness	Returns the ending value for thickness
GetExitWave	Returns an image containing a given number of unit cells of the exit wave of the calculation
GetExitWaveModulus	Returns an image containing a given number of unit cells of the modulus of the exit wave
GetExitWavePhase	Returns an image containing a given number of unit cells of the phase of the exit wave
GetFocus	Returns the focus (Å) for the calculation
GetFocusSpread	Returns the focus Spread (Å) for the calculation
GetImage	Returns an image containing the a given number of unit cells of calculated simulated image
GetInnerAperture	Returns the inner objective lens aperture (1/Å)
GetOpticAxis	Returns the center of the optic axis in tilt angle (mrad) and azimuthal angle (degrees)
GetOpticAxisHK	Returns the center of the optic axis in (H,K) of the reciprocal space of the unit cell
GetOuterAperture	Returns the outer objective lens aperture (1/Å)
GetPhaseShift	Returns the phase shift for the phase plate in units of π
GetPhaseShiftRadius	Returns the radius for the phase plate in units of 1/Å
GetPhaseShiftRadius2	Returns the outer radius for the phase plate in units of 1/Å. Beams are blocked

	between PhaseShiftRadius and PhaseShiftRadius2 if they are different
GetPotential	Returns an image containing a given number of unit cells of the calculated potential
GetStartFocus	Returns the starting focus (Å) for a thru-focus series
GetStartThickness	Returns the starting thickness (Å) for a thru-thickness series
GetThickness	Returns the thickness (Å) for the simulation
GetTilt	Returns the tilt angle of the specimen in mrad and the azimuthal angle of specimen tilt with respect to the horizontal axis in degrees
GetTiltAngle	Returns the tilt angle of the specimen in mrad
GetTiltDirection	Returns the azimuthal angle of specimen tilt with respect to the horizontal axis in degrees
GetTiltH	Gets the h value of the center of laue circle (specimen tilt)
GetTiltHK	Gets the h,k values of the center of laue circle (specimen tilt)
GetTiltK	Gets the k value of the center of laue circle (specimen tilt)
GetVibration	Gets the vibration of the “specimen” along x and y
GetVibrationX	Gets the vibration of the “specimen” along x
GetVibrationY	Gets the vibration of the “specimen” along y
GetVoltage	Returns the voltage of the microscope for the simulation (kV)
LoadExitWave	Loads a 1 by 1 unit cell of the Exit Wave as calculated and returns it as an image
LoadExitWaveModulus	Loads a 1 by 1 unit cell of the Exit Wave modulus as calculated and returns it as an image
LoadExitWavePhase	Loads a 1 by 1 unit cell of the Exit Wave Phase as calculated and returns it as an image
LoadImage	Loads a 1 by 1 unit cell of

	the Image as calculated and returns it as an image
LoadPotential	Loads a 1 by 1 unit cell of the Potential as calculated and returns it as an image
PropagateWave	Calculates a 3D Complex Volume Image containing the electron wavefunction at each slice in the multislice calculation up to a given thickness
SetAperture	Sets the outer objective lens aperture (1/Å)
SetApertureAngle	Sets the outer objective lens aperture in mradians
SetApertureCenter	Sets the center of the objective lens aperture
SetApertureHK	Sets the center of the objective lens aperture in (H,K) of the reciprocal space of the unit cell
SetCs	Sets the Spherical Aberration Cs in mm
SetCs5	Sets the 5th order Spherical Aberration Cs5 in mm
SetDeltaFocus	Sets the Incremental focus (Å) for a thru-focus series
SetDeltaThickness	Sets the incremental thickness (Å) for a thru-thickness series
SetDivergence	Sets the convergence angle (mrad) for the calculation
SetEndFocus	Sets the ending value for focus [Å] in a thru-focus series
SetEndThickness	Sets the ending value for thickness [Å] in a thru-thickness series
SetFocus	Sets the focus (Å) for the calculation
SetFocusSpread	Sets the focus Spread (Å) for the calculation
SetInnerAperture	Sets the inner objective lens aperture (1/Å)
SetOpticAxis	Sets the center of the optic axis in tilt angle (mrad) and azimuthal angle (degrees)
SetOpticAxisHK	Sets the center of the optic axis in (H,K) of the reciprocal space of the unit cell
SetOuterAperture	Sets the outer objective lens aperture (1/Å)

SetPhaseShift	Sets the phase shift for the phase plate in units of π
GetPhaseShiftRadius	Sets the radius for the phase plate in units of 1/Å
GetPhaseShiftRadius2	Sets the outer radius for the phase plate in units of 1/Å. Beams are blocked between PhaseShiftRadius and PhaseShiftRadius2 if they are different
SetStartFocus	Sets the starting focus (Å) for a thru-focus series
SetStartThickness	Sets the starting thickness for a thru-thickness series
SetThickness	Sets the thickness (Å) for the calculation
SetTiltAngle	Sets the tilt angle of the specimen in mrad
SetTiltDirection	Sets the azimuthal angle of specimen tilt with respect to the horizontal axis in degrees
SetTiltH	Sets the h value of the center of laue circle (specimen tilt)
SetTiltHK	Sets the h,k values of the center of laue circle (specimen tilt)
SetTiltK	Sets the k value of the center of laue circle (specimen tilt)
SetVibration	Sets the vibration of the "specimen" along x and y
SetVibrationX	Sets the vibration of the "specimen" along x
SetVibrationY	Gets the vibration of the "specimen" along y
SetVoltage	Sets the voltage of the microscope for the simulation (kV)
Thickness	Returns the thickness for the calculation

Example:

```
Simulation ss = getsimulation()
Number cs = 0.5  // Cs in mm
Number voltage = 300      // voltage in kV
ss.setcs(cs)
ss.setvoltage(voltage)

// Assume that the potential has already been calculated
// as our changes only require the exit wave(s) (change in wavelength)
// and the image(s) to be recalculated

ss.showpotential(1,5,5)

ss.calculateexitwave()
ss.calculateimage()

// Display the exit wave. The first of whatever number calculated
// 5 by 5 unit cell
image xw = ss.getexitwave(1,5,5)  //
xw.phase()
xw.setname("Phase of exit wave")
xw.show()

// Show the image. The first of whatever number calculated
// 5 by 5 unit cell
image img = ss.getimage(1,5,5)
img.setname("Calculated Image")
img.show()
```

Example:

```
Simulation ss = getsimulation()             // Get current simulation
image3d test                                // Declare a 3D volume image
ss.calculate3dpotential(test)               // Calculate the 3D potential
test.display()                              // into test and display
                                            // Image sections are traversed
                                            // using the arrow keys
```

Example:

```
Simulation ss = getsimulation()             // Get current simulation
image tt = ss.loadimage()                   // Load the image
tt.fft()                                    // Fourier transform
image dp = ss.createfrequencyimage(tt)      // Create image of fourier transform
                                            // with default size 512
dp.show()                                   // Show the frequency image

tt = ss.loadexitwave()                      // Do the same for the diffraction
                                            // pattern
tt.fft()
image dp2 = ss.createfrequencyimage(tt)
dp2.show()
```

Alphabetical description of general script functions and class member functions

abs

SUMMARY	Calculates the absolute value of a real/complex number or the absolute values of a real/complex image
SYNTAX	`number abs( number )`
SYNTAX	`number abs( complexnumber )`
SYNTAX	`image abs( image )`
SYNTAX	`image abs( compleximage )`
SYNTAX	`void image.abs()` Image member function
DESCRIPTION	Calculates the absolute value of a complex number or image. (also known as the modulus of a complex number) Calculates the absolute value(s) of a real number of real image

ac

SUMMARY	Calculates the autocorrelation function of a real image
SYNTAX	`image ac( image )`
SYNTAX	`void image.ac()` Image member function

acos

SUMMARY	Calculates the arccosine of a real number or a real image
SYNTAX	`number acos( number )`
SYNTAX	`image acos( image )`
SYNTAX	`void image.acos()` Image member function

acosh

SUMMARY	Calculates the hyperbolic arccosine of a real number or a real image
SYNTAX	number acosh(number)
SYNTAX	image acosh(image)
SYNTAX	void image.acosh() Image member function

AddImage

SUMMARY	Adds an image to an image stack
SYNTAX	void imagestack.addimage(image) Image stack member function

AddImageToMovie

SUMMARY	Adds an image to an existing open movie
SYNTAX	void AddImageToMovie (image)
DESCRIPTION	Adds an image to an existing open movie.

AddPeakList

SUMMARY	Add a peaklist to an image merging with an existing peaklist (if any).
SYNTAX	void AddPeakList(image theImage, image peaklist)
DESCRIPTION	After reading in a peaklist from a file or getting the peaklist from an image, this peaklist can be added to an existing image. The peaklist merges with any existing peaklist associated with the image. The dimensions of the image to be associated the peaklist must be of the same dimensions as the image from which the peaklist originated for this to make sense.

AddWindowToMovie

SUMMARY	Adds an image to an existing open movie

SYNTAX void AddWindowToMovie (image)

DESCRIPTION Adds a window (referenced by a displayed image) to an existing open movie.

AdjustAngle

SUMMARY Adjusts the angle of the image if different from 90

SYNTAX void image.AdjustAngle() Image member function

DESCRIPTION Adjusts the image so that it has an angle of 90 degrees. This is applicable for images returned from a simulation. In this case the image represents a periodic object and the angle of the unit cell may be different from 90 deg.

AdjustSampling

SUMMARY Adds an image to an image stack

SYNTAX void image.AdjustSampling(image) Image member function

DESCRIPTION Adjusts the image so that it has equal sampling in x and y. This is applicable for images returned from a simulation. In this case the image represents a periodic object and the sampling along the a and b axes may be different.

AiryAi

SUMMARY Calculates the Airy Ai function

SYNTAX number AiryAi(number)

DESCRIPTION *Not Implemented

AiryBi

SUMMARY Calculates the Airy Bi function

SYNTAX number AiryBi(number)

DESCRIPTION

Align

SUMMARY	Aligns two images
SYNTAX	complexnumber align(image x, image y [, number method] [, number freqCutoff [, number focusShift] [,number voltage])
DESCRIPTION	Aligns image y with image x using either crosscorrelation or phasecorrelation. Only argument 1 and 2 are required. The others are optional. Default values are method = 0 (crosscorrelation = 0, phasecorrelation =1), freqCutoff = 0.3*maxFrequency, focusShift = 0[Å], voltage = 300 [kV] Returns the shift used to translate image y in a complex number

AlignImages

SUMMARY	Aligns two images
SYNTAX	AlignImages (image x, image y [, number method] [, number freqCutoff [, number focusShift] [,number voltage])
DESCRIPTION	Equivalent to *Align* . Aligns image y with image x using either crosscorrelation or phasecorrelation. Only argument 1 and 2 are required. The others are optional. Default values are method = 0 (crosscorrelation = 0, phasecorrelation =1), freqCutoff = 0.3*maxFrequency, focusShift = 0[Å], voltage = 300 [kV]

AlignTwoImages

SUMMARY	Aligns two images
SYNTAX	complexnumber AlignTwoImages(image x, image y [, number method] [, number freqCutoff [, number focusShift] [,number voltage])
DESCRIPTION	Equivalent to *Align*. Aligns image y with image x using either crosscorrelation or phasecorrelation. Only argument 1 and 2 are required. The others are optional. Default values are method = 0 (crosscorrelation = 0, phasecorrelation =1), freqCutoff = 0.3*maxFrequency, focusShift = 0[Å],

voltage = 300 [kV]   Returns the shift used to translate image y in a complex number

Amplitude

SUMMARY	Returns the modulus of a complex number/image/ image3D as a real number/image
SYNTAX	number amplitude(complexnumber)
SYNTAX	image amplitude(compleximage)
SYNTAX	void image.amplitude() // Class Member Function
SYNTAX	void image3D.amplitude()// Class Member Function

AnalyzeDiffractogram*

SUMMARY	Analyzes a diffractogram
SYNTAX	void AnalyzeDiffractogram(image , numbervariable defocus, numbervariable direction, numbervariable err)
DESCRIPTION	*Not Implemented -- Analyze diffractogram in image. Returned defocus, astigmatism, and err are in nm

Angle

SUMMARY	Returns the phase of a complex number in degrees
SYNTAX	number complexnumber.angle()

AnnotationType

SUMMARY	Returns the type of an annotation
SYNTAX	number AnnotationType (image , number annotationID)
DESCRIPTION	Returns the type of the annotation specified in the given image with the given index.

AnnularHighpassFilter

SUMMARY	Applies a high pass filter to an image
SYNTAX	image AnnularHighPassFilter(image , number cutoff [, number edgewidth])
SYNTAX	void image.AnnularHighPassFilter(number cutoff [, number edgewidth]) // Image member function If the image is calibrated in Å, the cutoff is in 1/Å
DESCRIPTION	edgewidth by default is set to 0 and represents a soft edge

AnnularLowpassFilter

SUMMARY	Applies a low pass filter to an image
SYNTAX	image AnnularLowPassFilter(image , number cutoff [, number edgewidth])
SYNTAX	void image.AnnularLowPassFilter(number cutoff [, number edgewidth]) // Image member function If the image is calibrated in Å, the cutoff is in 1/Å
DESCRIPTION	edgewidth by default is set to 0 and represents a soft edge

ApplyAnnularMask

SUMMARY	Applies an annular mask to an image
SYNTAX	image ApplyAnnularMask(image , number r1, number r2 [, number edgewidth] [, number isopaque])
SYNTAX	void image.ApplyAnnularMask(number r1, number r2 [, number edgewidth] [, number isopaque]) // Image member function If the image is calibrated in Å, the values r1 and r2 are in 1/Å

DESCRIPTION	Annular mask of inner radius r1 and outer radius r2. By default the width of the edge = 0 and by default isopaque = false

ApplyCircularMask

SUMMARY	Returns an image resulting from the application of an annular mask to an image
SYNTAX	void ApplyCircularMask (image , number r, [, number edgewidth] [, number isopaque]) // In place operation If the image is calibrated in Å, the values r is in 1/Å
SYNTAX	void image.ApplyCircularMask ([number edgewidth] [, number isopaque]) // In place operation
DESCRIPTION	Circular mask of radius r. By default the width of the edge = 0 and by default isopaque = false

ApplyCosineMask

SUMMARY	Returns an image resulting from the application of a circular cosine mask to an image
SYNTAX	void ApplyCosineMask(image) // In place operation
SYNTAX	void image.ApplyCosineMask() // Member function

ApplyFocusPlate

SUMMARY	Returns an image resulting from the application of a arbitrary focus plate to a complex image or wave function
SYNTAX	ComplexImage ApplyFocusPlate(compleximage source, image focus [, number voltage = 300] [, number sampling = 0.2])
SYNTAX	void ApplyFocusPlate(image focus [, number voltage = 300] [, number sampling = 0.2]) // Image member function
DESCRIPTION	The focus variation (or constant) is given in the image focus. The complex image is propagated over the distance focus (which can vary as a function of

position). By default the voltage is 300kV. If the source is calibrated in Ångstrom or nanometer, the sampling is taken from the source. Otherwise the default is 0.2 Å/pixel and must be set if different.

ApplyHanningMask

SUMMARY	Returns an image resulting from the application of a circular hanning mask to an image
SYNTAX	`void ApplyHanningMask( image) // In place operation`
SYNTAX	`void image.ApplyHanningMask() // Member function`

asin

SUMMARY	Calculates the arcsine of a real number or a real image
SYNTAX	`number asin( number )`
SYNTAX	`image asin( image )`
SYNTAX	`void image.asin()` Image member function

asinh

SUMMARY	Calculates the hyperbolic arcsine of a real number or a real image
SYNTAX	`number asinh( number )`
SYNTAX	`image asinh( image )`
SYNTAX	`void image.asinh()` Image member function

atan2

SUMMARY	Calculates the arctangent of y/x for real numbers, real images of a complex image
SYNTAX	`number atan2( number x, number y) // atan(y/x)`

SYNTAX	image atan2(image x, image y)
SYNTAX	void image.atan2() Image member function

atanh

SUMMARY	Calculates the hyperbolic arctangent of a real number or a real image
SYNTAX	number atanh(number)
SYNTAX	image atanh(image)
SYNTAX	void image.atanh() Image member function

Autocorrelate

SUMMARY	Calculates the autocorrelation function of a real image
SYNTAX	image autocorrelate(image)
SYNTAX	void image.autocorrelation() Image member function

BeginFill**

SUMMARY	Starts a fill from projections
SYNTAX	void image.beginfill() // image class member function
SYNTAX	void image3D.beginfill() // image3d class member function
DESCRIPTION	BeginFill and EndFill must bracket the filling from projections.

BesselI

SUMMARY	Calculates the general Bessel I function
SYNTAX	number BesselI(number, number)
DESCRIPTION	

BesselJ

SUMMARY	Calculates the general Bessel J function
SYNTAX	`number BesselJ( number, number )`
DESCRIPTION	

BesselK

SUMMARY	Calculates the general Bessel K function
SYNTAX	`number BesselK( number, number )`
DESCRIPTION	

BesselY

SUMMARY	Calculates the general Bessel Y function
SYNTAX	`number BesselY( number, number )`
DESCRIPTION	

Beta

SUMMARY	Calculates the beta function
SYNTAX	`number Beta ( number, number )`
DESCRIPTION	

bgs

SUMMARY	Applies a Background Noise Subtraction Filter on a real image
SYNTAX	`void image.bgs()`
DESCRIPTION	Attempts to subtract out an amorphous background from an image containing crystalline material. In general the WienerFilter is a safer filter from a statistical point.

BinomialCoefficient

SUMMARY	Calculates the binomial coefficient
SYNTAX	number BinomialCoefficient (number, number)
DESCRIPTION	

BinomialRandom*

SUMMARY	Calculates a random number with binomial distribution
SYNTAX	number BinomialRandom (number, number)
DESCRIPTION	*Not Implemented

cc

SUMMARY	Returns an image resulting from the cross-correlation of two images
SYNTAX	image cc(image x, image y)

ccd

SUMMARY	Corrects for CCD detector bad pixels in a real image
SYNTAX	image ccd(image)
SYNTAX	void image.ccd()
DESCRIPTION	Attempts to locate pixels that correspond to bad pixels in the CCD camera. The pixel values fall out of the normal range and are substituted by mean values of the neighborhood

ceiling

SUMMARY	Limits all values of a real image to a given maximum value

SYNTAX	image ceiling(image , number)
SYNTAX	void image.ceiling(number) Image member function

cis

SUMMARY	Calculates a unit vector in the complex plane
SYNTAX	compleximage cis(image x, image y)
DESCRIPTION	Returns the complex image (cos(x) , sin(x))

clip

SUMMARY	Limits all values of a real image to given minimum and maximum values
SYNTAX	image clip(image , number min, number max)
SYNTAX	void image.clip(number min, number max) Image member function

CloseMovie

SUMMARY	Closes an open movie
SYNTAX	void CloseMovie ()

complex

SUMMARY	Creates a complex number/image from two real numbers/images
SYNTAX	complexnumber complex(number x, number y) // x +iy
SYNTAX	compleximage complex(image x, image y) // x + iy

complexconjugate

SUMMARY	Returns the complex conjugate of a complex number/ image

SYNTAX	complexnumber complexconjugate (complexnumber)
SYNTAX	compleximage complexconjugate (compleximage)

ComplexModulusSq / cmsq

SUMMARY	Returns the complex modulus square of a complex image.
SYNTAX	compleximage ComplexModulusSq(compleximage)
SYNTAX	void image.ComplexModulusSq() // Member Function
SYNTAX	void image.cmsq() // Member Function
DESCRIPTION	This replaces a complex image with the product of itself and its complex conjugate. It is the complex modulus square. Imaginary part is zero

conjugate

SUMMARY	Returns the complex conjugate of a complex number/ image
SYNTAX	complexnumber conjugate(complexnumber)
SYNTAX	compleximage conjugate(compleximage)
SYNTAX	void image.conjugate(number) Image member function
SYNTAX	number complexnumber.conjugate() complex number member function

ContinueCancelDialog

SUMMARY	Continue cancel dialog
SYNTAX	Boolean ContinueCancelDialog(String prompt)
DESCRIPTION	Puts up a dialog with both a Continue button and Cancel button. Returns true for Continue and false for Cancel.

Convolve

SUMMARY	Returns the convolution of two images
SYNTAX	image convolve(image x, image y)
DESCRIPTION	Equivalent to Convolute

Convolute

SUMMARY	Returns the convolution function of two images
SYNTAX	image convolve(image x, image y)
DESCRIPTION	Equivalent to Convolve

Correlate

SUMMARY	Returns the correlation function of two images
SYNTAX	image correlate(image x, image y)
DESCRIPTION	

cos

SUMMARY	Calculates the cosine of a real number or a real image	
SYNTAX	number cos(number)	
SYNTAX	image cos(image)	
SYNTAX	void image.cos()	Image member function

cosh

SUMMARY	Calculates the hyperbolic cosine of a real number or a real image
SYNTAX	number cosh(number)
SYNTAX	image cosh(image)

SYNTAX	void image.cosh() Image member function

CountAnnotations

SUMMARY	Returns the number of annotations in an image
SYNTAX	Number CountAnnotations(Image)
DESCRIPTION	Returns the number of annotations contained in the image as a number.

CreateArrowAnnotation

SUMMARY	Creates an arrow annotation
SYNTAX	Number CreateArrowAnnotation(Image, Number top, Number left, Number bottom, Number right)
DESCRIPTION	Creates an arrow annotation in the given image with the given endpoints. Returns the ID to the new annotation as a number.

CreateDoubleArrowAnnotation

SUMMARY	Creates a double arrow annotation
SYNTAX	Number CreateDoubleArrowAnnotation(Image, Number top, Number left, Number bottom, Number right)
DESCRIPTION	Creates a double arrow annotation in the given image with the given endpoints. Returns the ID to the new annotation as a number.

CreateComplexImage

SUMMARY	Creates a complex image of a given size
SYNTAX	image CreateComplexImage(string name, number width, number height)
DESCRIPTION	Returns a Complex image with the given name and dimensions

CreateFloatImage

SUMMARY	Creates a real image of a given size
SYNTAX	image CreateFloatImage(string name, number width, number height)
SYNTAX	image CreateFloatImage(number width, number height)
DESCRIPTION	Returns a real image with the given name and dimensions. Equivalent to “CreateImage”, “RealImage” and “NewImage”

CreateImage

SUMMARY	Creates a real image of a given size
SYNTAX	image CreateImage(string name, number width, number height)
SYNTAX	image CreateImage(number width, number height)
DESCRIPTION	Returns a real image with the given name and dimensions. Equivalent to “CreateFloatImage”, “RealImage” and “NewImage”

CreateLineAnnotation

SUMMARY	Creates a line annotation
SYNTAX	Number CreateLineAnnotation(Image, Number top, Number left, Number bottom, Number right)
DESCRIPTION	Creates a line annotation in the given image with the given endpoints. Returns the ID to the new annotation as a number.

CreateNewMovie

SUMMARY	Creates and opens a movie
SYNTAX	void CreateNewMovie (string movieName)

CreateOvalAnnotation

SUMMARY	Creates an oval annotation
SYNTAX	`Number CreateOvalAnnotation( Image, Number top, Number left, Number bottom, Number right )`
DESCRIPTION	Creates an oval annotation in the given image with the given coordinates. Returns the ID to the new annotation as a number.

CreateTableFromImage

SUMMARY	Displays the image as a table of numbers
SYNTAX	`void CreateTableFromImage (image)`
DESCRIPTION	Will create a table representing the content of an image. Equivalent to “DisplayAsTable”

CreateTextAnnotation

SUMMARY	Creates a text annotation
SYNTAX	`Number CreateTextAnnotation( Image, Number top, Number left, String text )`
DESCRIPTION	Creates a text annotation in the given image in the box specified by the coordinates. Returns the ID to the new annotation as a number.

CreateVectorMap

SUMMARY	Creates a vector map from two images
SYNTAX	`void CreateVectorMap(image x, image y [, number samplingX ] [, number samplingY] [, number scale])`
DESCRIPTION	Creates and displays a vector map from two images x and y which correspond to the x and y components of the vectors. Vectors will be created every samplingX (default=16) pixels and samplingY (default=16) pixels. Vectors are drawn with the magnification factor: scale (default=10)

CrossCorrelate

SUMMARY	Returns the correlation function of two images
SYNTAX	`image crosscorrelate(image x, image y)`
DESCRIPTION	Equivalent to cc, correlate and crossscorrelation

CrossCorrelation

SUMMARY	Returns the correlation function of two images
SYNTAX	`image crosscorrelate(image x, image y)`
DESCRIPTION	Equivalent to cc, correlate and crossscorrelate

CrossProduct

SUMMARY	Calculates the cross product
SYNTAX	`RealImage CrossProduct( RealImage a, RealImage b )`
DESCRIPTION	Calculates the cross product of two 3 element images.

DateStamp

SUMMARY	Returns date and time
SYNTAX	`String DateStamp( void )`
DESCRIPTION	Returns a string representing the current date and time.

Delay

SUMMARY	Delay execution of the script x number of 1/60th of a second
SYNTAX	`void Delay ( number )`

DeleteAnnotation

SUMMARY	Deletes an annotation
SYNTAX	`void DeleteAnnotation( Image, Number annotationID )`
DESCRIPTION	Deletes the annotation specified by the annotation ID in the given image.

DeleteImage

SUMMARY	Deletes an image. Deletes an image in an image stack
SYNTAX	`void DeleteImage( image )`
SYNTAX	`void imagestack.deleteimage(image)` Image member function

DeselectAnnotation

SUMMARY	Deselects an annotation
SYNTAX	`void DeselectAnnotation( Image, Number annotationID )`
DESCRIPTION	Deselects the annotation specified by the annotation ID in the given image.

Display

SUMMARY	Displays an image
SYNTAX	`void Display(image)`
SYNTAX	`void image.Display()          // Class member`
SYNTAX	`void image3D.Display()        // Class member`
SYNTAX	`void imagestack.Display()     // Class member`

DisplayAsTable

SUMMARY	Displays the image as a table of numbers
SYNTAX	void DisplayAsTable(image)
DESCRIPTION	Will create a table representation of the image. Currently the image does not change its representation as in DM, but rather creates a separate table. Equivalent to “CreateTableFromImage”

DisplayAt

SUMMARY	Displays the image in a window at the given position
SYNTAX	void DisplayAt(image, number x, number y)
DESCRIPTION	x and y are the top left coordinates of the window

DisplayOnLogScale

SUMMARY	Determines if an image is to be displayed on a log scale
SYNTAX	void DisplayOnLogScale(image, number log)
SYNTAX	void image.DisplayOnLogScale(number log) // Class Member
DESCRIPTION	Sets if the image is to be displayed on a logscale “log” set to 1 (true) or 0 (false)

distance

SUMMARY	Calculates the pythagorean theorem
SYNTAX	number distance(number x, number y)
DESCRIPTION	Returns sqrt(x*x + y*y).

Doevents

SUMMARY	Checks for input from the keyboard. Useful to check for interrupts in a loop or for control

SYNTAX void Doevents ()

DotProduct

SUMMARY Calculates the inner product (dot-product) between to real images (vectors)

SYNTAX number dotproduct(image img1, image img2)

EndFill**

SUMMARY Ends a fill from projections

SYNTAX

DESCRIPTION

erf

SUMMARY Calculates the error function

SYNTAX number erf(number)

DESCRIPTION

erfc

SUMMARY Calculates the complement of the error function

SYNTAX number erfc(number)

DESCRIPTION

ErrorDialog

SUMMARY Puts up a dialog with an error number

SYNTAX void ErrorDialog(number)

Exit

SUMMARY	Exit from the script
SYNTAX	`void Exit ()`

exp

SUMMARY	Calculates the exponential of a real/complex number or a real/complex image
SYNTAX	`number exp( number )`
SYNTAX	`complexnumber exp( complexnumber )`
SYNTAX	`image exp( image )`
SYNTAX	`compleximage exp( compleximage )`
SYNTAX	`void image.exp()` Image member function

exp1

SUMMARY	Calculates the exponential of a real number or a real image and subtracts 1
SYNTAX	`number exp1( number )`
SYNTAX	`image exp1( image )`
SYNTAX	`void image.exp1()` Image member function

exp2

SUMMARY	Calculates 2 raised to the power of a real number or a real image
SYNTAX	`number exp2( number )`
SYNTAX	`image exp2( image )`
SYNTAX	`void image.exp2()` Image member function

exp10

SUMMARY	Calculates 10 raised to the power of a real number or a real image
SYNTAX	`number exp10( number )`
SYNTAX	`image exp10( image )`
SYNTAX	`void image.exp10()` Image member function

ExpandSelection

SUMMARY	Expands the selection of an image
SYNTAX	`void ExpandSelection( Image )`
DESCRIPTION	Expands the selection in the given image to fit the entire image.

ExponentialRandom

SUMMARY	Calculates a random number with exponential distribution
SYNTAX	`number ExponentialRandom()`
DESCRIPTION	

exprsize

SUMMARY	Allocates an image of a given size and optionally assigns it to an expression
SYNTAX	`image exprsize( number width, number height )`
SYNTAX	`compleximage exprsize( number width, number height )`
SYNTAX	`image exprsize( number width, number height,realimageexpression )`
SYNTAX	`compleximage exprsize( number width, number height,realimageexpression )`

exprsize3

SUMMARY	Allocates a volume (3D) image of a given size and optionally assigns it to an expression
SYNTAX	image exprsize3(number width, number height, number height)
SYNTAX	compleximage exprsize3(number width, number height , number height)
SYNTAX	image exprsize(number width, number height, number height ,realimageexpression)
SYNTAX	compleximage exprsize(number width, number height, number height ,realimageexpression)

extract

SUMMARY	Returns an image from a region of another image
SYNTAX	image extract(image, number centerX, number centerY , number width, number height)

factorial

SUMMARY	Calculates the factorial of a real number or a real image
SYNTAX	number factorial(number)
SYNTAX	image factorial(image)
SYNTAX	void image.factorial() Image member function
DESCRIPTION	The values are rounded to the nearest integer. The factorial of values less than 1 are returned as 0

FFT

SUMMARY	Takes the forward Fourier transform of an image, a volume image or an image within an imagestack or the entire imagestack
SYNTAX	image fft(image)
SYNTAX	image3D fft(image3D)

SYNTAX	void image.fft()	Image member function
SYNTAX	void image3D.fft()	Image member function
SYNTAX	void imagestack.fft(number)	Image member function
SYNTAX	void imagestack.fft()	Image member function

DESCRIPTION

FillFromProjection**

SUMMARY Fills in a 2D image from 1D projections

SYNTAX

DESCRIPTION

FindMaxima

SUMMARY Finds the minima in an image

SYNTAX void FindMaxima(Image, [number minValueForPeak], [number minPeakDistance], [number cmRadius], [number distanceFromEdgde])

SYNTAX void image.FindMaxima([number minValueForPeak] , [number minPeakDistance], [number cmRadius], [number distanceFromEdgde])

DESCRIPTION Look for maxima in the image. minValueForPeak is the smallest value in the image to be considered to be a peak. CmRadius is the center of mass radius used for defining the peak. minPeakDistance is the smallest distance allowed between peaks. distanceFromEdgde is the closest proximity to the edge of the image that is searched for peaks. Default values if not specified are: minValueForPeak = imageMax - 0.2*imageRange, minPeakDistance = 0, cmRadius = 0 , distanceFromEdgde = 0

FindMinima

SUMMARY Finds the minima in an image

SYNTAX void FindMinima (Image, [number maxValueForPeak], [number minPeakDistance], [number cmRadius], [number distanceFromEdgde])

SYNTAX	void image.FindMinima([number maxValueForPeak] , [number minPeakDistance], [number cmRadius], [number distanceFromEdgde])
DESCRIPTION	Look for minima in the image. maxValueForPeak is the largest value in the image to be considered to be a peak. CmRadius is the center of mass radius used for defining the peak. minPeakDistance is the smallest distance allowed between peaks. distanceFromEdgde is the closest proximity to the edge of the image that is searched for peaks. Default values if not specified are: maxValueForPeak = imageMin + 0.2*imageRange, minPeakDistance = 0, cmRadius = 0 , distanceFromEdgde = 0

FindPattern

SUMMARY	Returns the position dependent cross-correlation coefficient between an image and a pattern for each position of the pattern within the image
SYNTAX	image FindPattern(image sourceImage [. Image template] [,number normalize])
DESCRIPTION	This function performs a cross correlation between the sourceimage and the template for each possible position of the template within the image. If the sourceImage has a selection, the template needs not be specified as the selection is used as the template. The argument normalize is set to true/ false (default = false) to set if the source and template are normalized to zero mean before the cross correlation is taken. Equivalent to "TemplateMatch"

FindPeaks

SUMMARY	Finds peaks in an image
SYNTAX	void FindPeaks(Image, [number minValueForPeak], [number minPeakDistance], [number cmRadius], [number distanceFromEdgde])
SYNTAX	void image.FindPeaks([number minValueForPeak] , [number minPeakDistance], [number cmRadius], [number distanceFromEdgde])
DESCRIPTION	Look for maxima in the image. minValueForPeak is the smallest value in the image to be considered to be a

peak. CmRadius is the center of mass radius used for defining the peak. minPeakDistance is the smallest distance allowed between peaks. distanceFromEdgde is the closest proximity to the edge of the image that is searched for peaks. Default values if not specified are: minValueForPeak = imageMax - 0.2*imageRange, minPeakDistance = 0, cmRadius = 0 , distanceFromEdgde = 0

FitDoublePeaks

SUMMARY	Fits a peak list to a set of double peaks (two peaks are close)
SYNTAX	void FitDoublePeaks(image [number maxPeakSeparation] [, number outputTable])
DESCRIPTION	Fits the peaks found in an image to a set of Gaussian peaks. Peaks within a given distance maxPeakSeparation (default = 10 pixels) are considered to be closely spaced Gaussian peaks. Optionally the parameters for the peaks can be output as a table (outputTable = false by default). The peaks in the image peaklist are updated to reflect the Gaussian fit.

FitExponentials

SUMMARY	Fits the peaks in a peak list to Exponential peaks
SYNTAX	void FitExponentials(image [, number output = 0] [,number pixelsAcrossPeak = 26] [,number minNumberofPixelsInPeak = 100])
DESCRIPTION	Fits the peaks found in an image to a set of Exponential peaks. Optionally the parameters for the peaks can be output as a table [1] or written to the log window[2]. pixelsAcrossPeak is an estimate of the numbers of pixels across the entire peak. minNumberofPixelsInPeak represents a minimum number of pixels that must be in a peak. The peaks in the image peaklist are updated to reflect the fit.

FitGaussians

SUMMARY	Fits the peaks in a peak list to Gaussian peaks

SYNTAX	void FitGaussians(image [, number output = 0] [,number pixelsAcrossPeak = 26] [,number minNumberofPixelsInPeak = 100])
DESCRIPTION	Fits the peaks found in an image to a set of Gaussian peaks. Optionally the parameters for the peaks can be output as a table [1] or written to the log window[2]. pixelsAcrossPeak is an estimate of the numbers of pixels across the entire peak. minNumberofPixelsInPeak represents a minimum number of pixels that must be in a peak. The peaks in the image peaklist are updated to reflect the fit.

FitLattice

SUMMARY	Fits an existing lattice to a peaklist
SYNTAX	void FitLattice(image [, number maxDeviation])
DESCRIPTION	The lattice defined on the image will be refined to minimize the sum squared distance from the lattice to the peaks in the peak list. Only peaks lying within the distance maxDeviation (fraction of a lattice vector) will be used in the fitting routine.

FitParabolas

SUMMARY	Fits the peaks in a peak list to Parabolic peaks
SYNTAX	void FitParabolas(image [, number output = 0] [,number pixelsAcrossPeak = 26] [,number minNumberofPixelsInPeak = 100])
DESCRIPTION	Fits the peaks found in an image to a set of Parabolic peaks. Optionally the parameters for the peaks can be output as a table [1] or written to the log window[2]. pixelsAcrossPeak is an estimate of the numbers of pixels across the entire peak. minNumberofPixelsInPeak represents a minimum number of pixels that must be in a peak. The peaks in the image peaklist are updated to reflect the fit.

FitPeaks

SUMMARY	Fits the peaks in a peak list to Gaussian/ Exponential peaks

SYNTAX	`void FitPeaks(image [, number output = 0] [, number peakShape = 0 ] [,number pixelsAcrossPeak = 26] [,number minNumberofPixelsInPeak = 100] )`
DESCRIPTION	Fits the peaks found in an image to a set of Gaussian peaks. Optionally the parameters for the peaks can be output as a table [1] or written to the log window[2]. peakShape (0=Gaussian), (1=Exponential). pixelsAcrossPeak is an estimate of the numbers of pixels across the entire peak. minNumberofPixelsInPeak represents a minimum number of pixels that must be in a peak. The peaks in the image peaklist are updated to reflect the fit.

FlipHorizontal

SUMMARY	Flips an image horizontally (around the vertical axis)
SYNTAX	`void FlipHorizontal( image)`
SYNTAX	`void image.FlipHorizontal()  // Class member`

FlipVertical

SUMMARY	Flips an image vertically (around the horizontal axis)
SYNTAX	`void FlipVertical( image)`
SYNTAX	`void image.FlipVertical()     // Class member`

floor

SUMMARY	Limits all values of a real image to a given minimum value
SYNTAX	`image floor( image , number)`
SYNTAX	`void image.floor(number)      Image member function`
DESCRIPTION	Sets all values < minVal to minVal

Gamma

SUMMARY	Calculates the gamma of a real number
SYNTAX	number Gamma(number)
DESCRIPTION	

GammaP

SUMMARY	Calculates the incomplete gamma function
SYNTAX	number GammaP(number , number)
DESCRIPTION	

GammaQ

SUMMARY	Calculates the complement of the incomplete gamma function
SYNTAX	number GammaQ(number , number)
DESCRIPTION	

GammaRandom*

SUMMARY	Calculates a random number with gamma distribution
SYNTAX	number GammaRandom()
DESCRIPTION	*Not Implemented

GaussianLowPassFilter

SUMMARY	Applies a Gaussian low pass filter
SYNTAX	image GaussianLowPassFilter(image, number sigma)
DESCRIPTION	Applies a Gaussian low pass filter of sigma in the units of calibration unit of the image

GaussianHighPassFilter

SUMMARY	Applies a Gaussian high pass filter
SYNTAX	`image GaussianHighPassFilter (image, number sigma)`
DESCRIPTION	Applies a Gaussian High pass filter of sigma in the units of calibration unit of the image

GaussianRandom*

SUMMARY	Calculates a random number with gaussian distribution
SYNTAX	`number GaussianRandom()`
DESCRIPTION	

GetAnnotationRect

SUMMARY	Gets the rectangle of the annotation
SYNTAX	`void GetAnnotationRect( Image, Number annotationID, NumberVariable top, NumberVariable left, NumberVariable bottom, NumberVariable right )`

GetCalibration

SUMMARY	Returns the calibration of the image
SYNTAX	`void GetCalibration( image, numbervariable scalex, numbervariable scaley)`
SYNTAX	`void GetCalibration( image, numbervariable scale)`
SYNTAX	`number GetCalibration( image)`
SYNTAX	`number image.GetCalibration() // Image Class Member Function`
DESCRIPTION	In general the scale return for a single number is the value stored in scaleX, which is normally the same as scaleY

GetCalibrationUnit

SUMMARY	Returns the calibration unit of the image
SYNTAX	number GetCalibrationUnit(image)
SYNTAX	String image.GetCalibrationUnit () // Image Class Member Function
DESCRIPTION	The non-class function returns a number. The index numbers for the calibration units are: 0 – Pixels, 1 – Å, 2 – nanometer, 3 – 1/Pixels, 4 – 1/Å, 5 – 1/nm. The class member function returns a string representation of the unit

GetHeight

SUMMARY	Returns the height in pixels of an image
SYNTAX	number GetHeight(image)

GetImage

SUMMARY	Returns a 2D image from a given position (z) in a volume image
SYNTAX	image image3D.GetImage(number whichImage)
DESCRIPTION	Returns an image which is a copy of the image at the given depth in the volume image. The range for whichImage is 0 – (Depth-1)

GetKey

SUMMARY	Returns key
SYNTAX	Number GetKey(void)
DESCRIPTION	Returns the key that was last pressed as a number.

GetLattice

SUMMARY	Returns the lattice (if defined) for the image
SYNTAX	`image GetLattice( image)`
SYNTAX	`image image.GetLattice()`
DESCRIPTION	The lattice is returned in a 2 by 3 image. OriginX is Lattice(0,0). OriginY is Lattice(1,0). UX is Lattice(0,1). UY is Lattice(1,1). VX is Lattice(0,2). VY is Lattice(1,2).

GetName

SUMMARY	Return the name of the image
SYNTAX	`string GetName( image)`
SYNTAX	`void GetName( image, stringvariable name)`
SYNTAX	`string image.GetName() // Image Class member function`

GetNamedImage

SUMMARY	Return the image with a given name
SYNTAX	`image GetNamedImage(string name)`
SYNTAX	`void GetNamedImage(image , string name)`

GetNumber

SUMMARY	Prompt for a number using an OkCancelDialog. Returns 0 (False) if cancel is pressed. 1 (True) otherwise.
SYNTAX	`number GetNumber ( string prompt, NumberVariable val)`
SYNTAX	`number GetNumber ( string prompt, number default, NumberVariable val)`

GetNumberedImage

SUMMARY	Return the image with a given name
SYNTAX	image GetNumberedImage (number num)
SYNTAX	void GetNumberedImage (image destImage, number num)
DESCRIPTION	Returns the image with the label/tag A# as in A0, A1, A2 etc…

GetNthAnnotationID

SUMMARY	Get the ID of an annotation
SYNTAX	Number GetNthAnnotationID(Image, Number index)
DESCRIPTION	Returns the ID of the index'th annotation in the image.

GetPeakList

SUMMARY	Returns the peaklist (if defined) for the image
SYNTAX	image GetPeakList(image)
SYNTAX	image image.GetPeakList() // class member
DESCRIPTION	Reaturns the peak list in the form of an image of size 3 by numberPeaks. Column 0 – xposition, Column 1 – yposition, Column 2 - peakValue

GetPixel

SUMMARY	Returns the pixel value for a given pixel
SYNTAX	number GetPixel(image, number x, number y)
SYNTAX	complexnumber GetPixel(compleximage, number x, number y)
SYNTAX	number image.GetPixel(number x, number y)
SYNTAX	complexnumber compleximage.GetPixel(number x, number y)

GetPixelAmplitude

SUMMARY	Returns the pixel amplitude for a given pixel in a complex image
SYNTAX	number GetPixelAmplitude(compleximage, number x, number y))

GetPixelPhase

SUMMARY	Returns the pixel phase for a given pixel in a complex image
SYNTAX	number GetPixelPhase(compleximage, number x, number y))

GetScale

SUMMARY	Returns the scale/calibration of an image
SYNTAX	void GetScale(image, numbervariable scalex, numbervariable scaley)
SYNTAX	void GetScale(image, numbervariable scale)
SYNTAX	number GetScale(image)
SYNTAX	number image.GetScale() // Image Class Member Function
DESCRIPTION	In general the scale return for a single number is the value stored in scaleX, which is normally the same as scaleY

GetSelection

SUMMARY	Gets the selection rectangle of an image
SYNTAX	Boolean GetSelection(Image, NumberVariable top, NumberVariable left, NumberVariable bottom, NumberVariable right)
DESCRIPTION	Sets the given coordinate variables to the coordinates of the current selection in the given image. If the image has no selection, the coordinates are set to the size of the image. Returns true if there was a selection, false if not.

GetSize

SUMMARY	Returns the size of an image
SYNTAX	`void GetSize(image, numbervariable width, numbervariable height)`
SYNTAX	`void image.GetSize(numbervariable width, numbervariable height) // Class member function`
SYNTAX	`void image3D.GetSize(numbervariable width, numbervariable height, numbervariable depth) // Class member function`

GetSurveyMode

SUMMARY	Gets the method of survey technique for setting black and white values
SYNTAX	`Number  mode = GetSurveyMode( Image )`
DESCRIPTION	mode = 0 CrossHair . mode = 1 Entire Image, Equivalent to GetSurveyTechnique

GetSurveyTechnique

SUMMARY	Sets the method of survey technique for setting black and white values
SYNTAX	`Number  mode = GetSurveyTechnique ( Image )`
DESCRIPTION	mode = 0 CrossHair . mode = 1 Entire Image, Equivalent to GetSurveyMode

GetTwoImages

SUMMARY	Two image dialog
SYNTAX	`Boolean GetTwoImages( String title, ImageVariable image1, ImageVariable image2 )`

DESCRIPTION	Puts up an Ok-Cancel dialog box and allows the user to choose two images. Returns true for Ok and false for Cancel.

GetTwoImagesWithPrompt

SUMMARY	Two image dialog with prompt
SYNTAX	Boolean GetTwoImagesWithPrompt(String prompt, String title, ImageVariable image1, ImageVariable image2)
DESCRIPTION	Puts up an Ok-Cancel dialog box and allows the user to choose two images. Returns true for Ok and false for Cancel.

GetVoxel

SUMMARY	Gets the voxel value at position (x,y,z)
SYNTAX	number image3D.GetVoxel(number x,number y,number z)
SYNTAX	complexnumber compleximage3D.GetVoxel(number x,number y,number z)

GetWidth

SUMMARY	Returns the width in pixels of an image
SYNTAX	number GetWidth(image)

GetWindowPosition

SUMMARY	Returns the window position of an image
SYNTAX	void GetWindowPosition(image numbervariable left, numbervariable top)

GetWindowSize

SUMMARY	Returns the window size for a displayed image
SYNTAX	void GetWindowSize (image numbervariable width, numbervariable height)

HasLattice

SUMMARY	Returns true/false if a lattice is defined on an image
SYNTAX	number HasLattice(image)
SYNTAX	number image.HasLattice() // class member

HasPeaklist

SUMMARY	Returns true/false if a peak list is defined on an image
SYNTAX	number HasPeaklist(image)
SYNTAX	number image.HasPeaklist() // class member

Height

SUMMARY	Returns the height (in pixels) of an image
SYNTAX	number image.height() // Image Member Function
SYNTAX	number image3D.height() // Image3D Member Function

Highpass

SUMMARY	Returns an image resulting from the application of a Annular High Pass filter to an image
SYNTAX	image Highpass(image , number cutoff [, number edgewidth])
DESCRIPTION	Equivalent to AnnularHighPassFilter. edgewidth by default is set to 0 and represents a soft edge

Highpassfilter

SUMMARY	Returns an image resulting from the application of a Annular High Pass filter to an image
SYNTAX	image Highpassfilter(image , number cutoff [, number edgewidth])
DESCRIPTION	Equivalent to AnnularHighPassFilter. edgewidth by default is set to 0 and represents a soft edge

HorizontalProjection

SUMMARY	Returns an image resulting projecting the pixels (summed) onto the horizontal (x) axis
SYNTAX	image HorizontalProjection(image)

IFFT

SUMMARY	Takes the inverse Fourier transform of a complex image, a complex volume image or a complex image within an imagestack or the entire imagestack	
SYNTAX	image ifft(compleximage)	
SYNTAX	image3D ifft(image3D)	
SYNTAX	void image.ifft()	Image member function
SYNTAX	void image3D.ifft()	Image member function
SYNTAX	void imagestack.ifft(number)	Image member function
SYNTAX	void imagestack.ifft()	Image member function

imaginary / imag

SUMMARY	Returns the imaginary portion of a complex number/ image as a real number/image
SYNTAX	number imaginary(complexnumber)
SYNTAX	image imaginary(compleximage)

SYNTAX	void image.imaginary() Image member function
SYNTAX	number complexnumber.imag() complex number member function

intensity

SUMMARY	Returns the modulus square of a complex number/image as a real number/image
SYNTAX	number intensity(complexnumber)
SYNTAX	image intensity(compleximage)
SYNTAX	void image.intensity() Image member function

Inverse

SUMMARY	Inverts an image
SYNTAX	void image.Inverse() // Member function

Invert

SUMMARY	Inverts an image
SYNTAX	image Inverse (image)
SYNTAX	void image.Inverse() // Member function

IsAnnotationSelected

SUMMARY	Checks if an annotation is selected
SYNTAX	Boolean IsAnnotationSelected(Image, Number annotationID)
DESCRIPTION	Returns true if the annotation specified by the annotation ID in the given image is selected; returns true otherwise.

Laplacian

SUMMARY	Takes the Laplacian of a real image
SYNTAX	`image Laplacian(image )`
SYNTAX	`void image.Laplacian() // Member function`

LegendrePolynomial

SUMMARY	Calculates the Legendre polynomial function
SYNTAX	`number LegendrePolynomial(number, number, number)`
DESCRIPTION	

log

SUMMARY	Calculates the natural logarithm of a real number or a real image
SYNTAX	`number log( number )`
SYNTAX	`image log( image )`
SYNTAX	`void image.log()` Image member function

log1

SUMMARY	Calculates the logarithm of a real number or a real image after first adding 1
SYNTAX	`number log1( number )`
SYNTAX	`image log1( image )`
SYNTAX	`void image.log1()` Image member function
DESCRIPTION	First the argument is changed by adding 1 (useful when the image contains 0’s) and then the logarithm is taken

log2

SUMMARY	Calculates the logarithm base 2 of a real number or a real image

SYNTAX	`number log2( number )`
SYNTAX	`image log2( image )`
SYNTAX	`void image.log2()` Image member function

log10

SUMMARY	Calculates the logarithm base 10 of a real number or a real image
SYNTAX	`number log10( number )`
SYNTAX	`image log10( image )`
SYNTAX	`void image.log10()` Image member function

Lowpass

SUMMARY	Returns an image resulting from the application of an Annular Low Pass filter to an image
SYNTAX	`image AnnularLowPassFilter( image , number cutoff [, number edgewidth ] )`
DESCRIPTION	Equivalent to AnnularLowPassFilter. edgewidth by default is set to 0 and represents a soft edge

Lowpassfilter

SUMMARY	Returns an image resulting from the application of an Annular Low Pass filter to an image
SYNTAX	`image Lowpassfilter( image , number cutoff [, number edgewidth ] )`
DESCRIPTION	Equivalent to AnnularLowPassFilter. edgewidth by default is set to 0 and represents a soft edge

MatrixDeterminant*

SUMMARY	Returns the determinant of a matrix
SYNTAX	`number MatrixDeterminant ( image )`
DESCRIPTION	*Not Implemented

MatrixInverse*

SUMMARY	Inverts a real matrix
SYNTAX	image MatrixInverse (image)
DESCRIPTION	*Not Implemented

MatrixMultiply

SUMMARY	Does a matrix multiplication of two real images
SYNTAX	image MatrixMultiply (image, image)

MatrixPrint*

SUMMARY	Prints out the values of a matrix / image
SYNTAX	void MatrixPrint(image)
DESCRIPTION	*Not Implemented

MatrixTranspose

SUMMARY	Transposes the matrix representation of a real image
SYNTAX	image MatrixTranspose (image)

max

SUMMARY	Returns the maximum value of a real image. Can also return the positions of the maximum. Calculate the min of two real number expressions or two images
SYNTAX	number max(image)
SYNTAX	number max(image, number xpos, number ypos)
SYNTAX	number max(number, number)
SYNTAX	void max(number, number , numbervariable result)
SYNTAX	image max(image, image)

SYNTAX	void max(image, image, imagevariable result)
SYNTAX	number image.max() Image member function
SYNTAX	number image.max(number xpos, number ypos) Image member function

Maximum*

SUMMARY	Calculates the maximum of a given list of real numbers
SYNTAX	number minimum (number, number, ...) up to a maximum of 16 arguments
DESCRIPTION	*Not yet implemented

mean

SUMMARY	Returns the mean value of a real image.
SYNTAX	number max(image)
SYNTAX	number image.mean() Image member function

meansquare

SUMMARY	Returns the mean square value of a real image.
SYNTAX	number meansquare(image)
SYNTAX	number image.meansquare() Image member function

median

SUMMARY	Returns the median value of a real image or a list of numbers.
SYNTAX	number median(image)
SYNTAX	number median(number x1, number x2, number x3…) up to a maximum of 16 arguments

min

SUMMARY	Returns the minimum value of a real image. Can also return the positions of the minimum. Calculate the min of two real number expressions or two images
SYNTAX	number min(image)
SYNTAX	number min(image, number xpos, number ypos)
SYNTAX	number min(number, number)
SYNTAX	void min(number, number, numbervariable result)
SYNTAX	image min(image, image)
SYNTAX	void min(image, image, imagevariable result)
SYNTAX	number image.min() Image member function
SYNTAX	number image.min(number xpos, number ypos) Image member function

Minimum*

SUMMARY	Calculates the minimum of a given list of real numbers
SYNTAX	number minimum (number, number, ...) up to a maximum of 16 arguments
DESCRIPTION	*Not yet implemented

modsq

SUMMARY	Returns the modulus squareof a complex number
SYNTAX	number complexnumber.modsq() // complex number member function

modulus

SUMMARY	Returns the modulus of a complex number/image/image3D as a real number/image
SYNTAX	number modulus(complexnumber)
SYNTAX	image modulus(compleximage)

SYNTAX	`number complexnumber.modulus() // complex number member function`
SYNTAX	`void image.modulus() // Class Member Function`
SYNTAX	`void image3D.modulus()// Class Member Function`

MoveAnnotation

SUMMARY	Moves an annotation
SYNTAX	`void MoveAnnotation( Image, Number annotationID, Number top, Number left, Number bottom, Number right )`
DESCRIPTION	Moves the annotation specified by annotation ID in the given image to the specified coordinates.

Negate

SUMMARY	Returns the inverse of an image
SYNTAX	`image Negate(image)`

NewImage

SUMMARY	Creates a real image of a given size
SYNTAX	`image NewImage(string title, number width, number height)`
SYNTAX	`image NewImage(number width, number height)`

norm

SUMMARY	Calculates the norm of a real/complex number or a real/complex image.
SYNTAX	`number norm( number )`
SYNTAX	`number norm( complexnumber )`
SYNTAX	`realimage norm( image )`
SYNTAX	`realimage norm( compleximage )`

SYNTAX	void image.norm() Image member function
DESCRIPTION	The norm of the real number is its square. The norm of a complex number is its modulus square.

OffsetAnnotation

SUMMARY	Offsets an annotation
SYNTAX	void OffsetAnnotation(Image, Number annotationID, Number deltax, Number deltay)
DESCRIPTION	Offsets the annotation specified by annotation ID in the given image by the specified offsets.

OkDialog

SUMMARY	Ok dialog
SYNTAX	void OkDialog(String prompt)
DESCRIPTION	Puts up a dialog with an Ok button

OpenAndSetProgressWindow

SUMMARY	Opens and sets the progress window
SYNTAX	void OpenAndSetProgressWindow(String line1, String line2, String line3)

OpenImage

SUMMARY	Creates an image from an existing image file
SYNTAX	image open(string filename)
SYNTAX	void open(string filename, number width, number height [number type = 7 (real)] [, number byteOffset = 0] [, number swapBytes = 0])
DESCRIPTION	Opens an existing image. If the image is fully specified by its internal structure and is supported, only the filename is needed as long as the path is set properly beforehand. If the image

file contains raw image data, then image width, height and optionally type, offset and swapbytes are needed.

OpenLogWindow

SUMMARY	Opens the output window
SYNTAX	void OpenLogWindow (void)

OpenResultsWindow

SUMMARY	Opens the results window
SYNTAX	void OpenResultsWindow(void)
DESCRIPTION	Equivalent to OpenLogWindow. DM compatibility function

OpenWithDialog

SUMMARY	Creates an image from an existing image file chosen through a file dialog
SYNTAX	image OpenWithDialog()

OptionDown

SUMMARY	Returns true/false depending on if the Option key is down or not
SYNTAX	Boolean OptionDown(void)
DESCRIPTION	Returns 1 if the option key is down and 0 otherwise.

PadWithMean

SUMMARY	Pads an image with its mean value to specified dimensions

SYNTAX void image.PadWithMean(number newWidth, number newHeight) // class member

PadWithZero

SUMMARY Pads an image with zero to specified dimensions

SYNTAX void image.PadWithZero(number newWidth, number newHeight) // class member

Pi

SUMMARY Returns an approximation of π One can also just write Pi which is a predefined constant

SYNTAX number pi()

phase

SUMMARY Returns the phase of a complex number/image/image3D as a real number/image

SYNTAX number phase(complexnumber)

SYNTAX image phase(compleximage)

SYNTAX number complexnumber.phase() // complex number member function

SYNTAX void image.phase()   // Image member function

SYNTAX void image3D.phase()   // Image3D member function

PhaseCorrelate

SUMMARY Returns the phase correlation between two images

SYNTAX image PhaseCorrelate (image x, image y [, number freqCutoff])

DESCRIPTION Calculate the phase correlation between two images but using frequencies up to a maximum frequency cut off “freqCutoff” default freqCutoff = 0.3*maxFrequency

PhaseCorrelation

SUMMARY	Returns the phase correlation between two images
SYNTAX	image PhaseCorrelation(image x, image y [, number freqCutoff])
DESCRIPTION	Calculate the phase correlation between two images but using frequencies up to a maximum frequency cut off “freqCutoff” default freqCutoff = 0.3*maxFrequency

PoissonRandom*

SUMMARY	Calculates a random number with poisson distribution
SYNTAX	number PoissonRandom()
DESCRIPTION	

Polar

SUMMARY	Calculates the polar representation of a rectangular complex number/image
SYNTAX	complexnumber polar(complexnumber)
SYNTAX	complexnumber polar(compleximage)
SYNTAX	void image.polar() Image member function
DESCRIPTION	Amplitude stored in real part. Phase stored in imaginary part

Polynomial*

SUMMARY	Calculates a polynomial expansion using a real image expression
DESCRIPTION	*Currently not implemented

pow

SUMMARY	Calculates the exponential of a real/complex number or a real/complex image
SYNTAX	`number pow( number x, number y)    // x**y`
SYNTAX	`image exp( image x, number y )     // x**y`
SYNTAX	`void image.pow(number x)` Image member function

pow2

SUMMARY	Calculates 2 raised to the power of a real number or a real image
SYNTAX	`number pow2( number )`
SYNTAX	`image pow2( image )`
SYNTAX	`void image.pow2()` Image member function

pow10

SUMMARY	Calculates 10 raised to the power of a real number or a real image
SYNTAX	`number pow10( number )`
SYNTAX	`image pow10( image )`
SYNTAX	`void image.pow10()` Image member function

PowerSpectrum

SUMMARY	Calculates the power spectrum of a real image
SYNTAX	`image PowerSpectrum( image )`
SYNTAX	`void image.PowerSpectrum() // Image Member Function`

product*

SUMMARY	Calculates the product of a real/complex image expression
SYNTAX	Number product(RealImageExpression)
SYNTAX	ComplexNumber product(ComplexImageExpression)
DESCRIPTION	*Currently not implemented

PropagateWave

SUMMARY	Calculates a 3D complex volume containing the wave function at each slice for the current simulation up to a given thickness.
SYNTAX	Image3D PropagateWave(number thickness)
SYNTAX	Image3D simulation.PropagateWave(number thickness) // member function of the simulation object
DESCRIPTION	Implemented as both a standalone function for an open simulation or as a member function of the class simulation.

ps

SUMMARY	Calculates the power spectrum of a real image
SYNTAX	image ps(image)
SYNTAX	void image.ps() // Image Member Function

RadialAverage

SUMMARY	Returns the radial average of an image
SYNTAX	image RadialAverage(image sourceImage [, number mode])
DESCRIPTION	Creates a new image of type mode that is a representation of the radial average of sourceImage. The optional argument mode represents: Mode = 1D , Mode = 1 2D Split Plane , Mode = 2 2D

ReadPeakList

SUMMARY	Returns the peak list from a file
SYNTAX	image ReadPeakList(string filename)
DESCRIPTION	Returns the peak list in an image by reading a file containg the list of peaks (saved by the program as a tab-delimited text file). The peaklist can then be associated with an existing image through the SetPeakList function.

real

SUMMARY	Returns the real part of a complex number/image as a real number/image
SYNTAX	number real(complexnumber)
SYNTAX	image real(compleximage)
SYNTAX	number complexnumber.real() // complex number member function
SYNTAX	void image.real() // Image member function

RealImage

SUMMARY	Creates a real image of a given size
SYNTAX	image RealImage(string title, number numBytes, number width, number height)
SYNTAX	image RealImage(number width, number height)
DESCRIPTION	Creates a real floating point image. Only 4 byte real numbers are supported

RealFFT

SUMMARY	Takes the forward Fourier transform of an image
SYNTAX	image Realfft(image)

DESCRIPTION	This does not compute a packed Fourier transform as in DM, but is present so that there is an equivalent syntax to DM scripting

Remainder

SUMMARY	Calculates the integer remainder for real numbers or real images
SYNTAX	number remainder(number)
SYNTAX	image remainder(image)
DESCRIPTION	

Rect

SUMMARY	Calculates the rectangular representation of a polar complex number/image
SYNTAX	complexnumber rect(complexnumber)
SYNTAX	complexnumber rect(compleximage)
SYNTAX	void image.rect() Image member function

RemoveCCDDefects

SUMMARY	Corrects for CCD detector bad pixels in a real image (*ccd*)
SYNTAX	image RemoveCCDDefects(image)
SYNTAX	void image.RemoveCCDDefects() //Member function
DESCRIPTION	Equivalent to “ccd”

repeat

SUMMARY	Repeats an image/image3D in the 2 or 3 dimensions
SYNTAX	image repeat(image, number nx, number ny)
SYNTAX	void image.repeat(number nx, number ny) Image member function

SYNTAX	void image3D.repeat(number nx, number ny, number nz) Image3D member function

Resize

SUMMARY	Resizes an image
SYNTAX	image Resize(image , number width, number height)
SYNTAX	void image.Resize(number width, number height)
DESCRIPTION	Resizes the image using interpolation

RMS

SUMMARY	Calculates the root mean square value of a real image
SYNTAX	number rms(image)
SYNTAX	number image.rms() Image member function

Rotate

SUMMARY	Rotates a 2D image clockwise by a given angle
SYNTAX	image rotate(image, number angle)
SYNTAX	void image.rotate(number angle)

RotateLeft

SUMMARY	Rotates an image anti-clockwise an image by 90 deg.
SYNTAX	image rotateleft(image, number angle)
SYNTAX	void image.rotateleft(number angle)

RotateRight

SUMMARY	Rotates an image clockwise an image by 90 deg.
SYNTAX	image rotateright(image, number angle)

SYNTAX	`void image. rotateright(number angle )`

RotateX

SUMMARY	Rotates a volume image (image3D) clockwise about x
SYNTAX	`void image3D.rotatex(number angle )`

RotateY

SUMMARY	Rotates a volume image (image3D) clockwise about y
SYNTAX	`void image3D.rotatey(number angle )`

RotateZ

SUMMARY	Rotates a volume image (image3D) clockwise about z
SYNTAX	`void image3D.rotatez(number angle )`

round

SUMMARY	rounds to the nearest integer a real number or a real image
SYNTAX	`number round( number )`
SYNTAX	`image round( image )`
SYNTAX	`void image.round()` Image member function

SaveImage

SUMMARY	Save the image
SYNTAX	`void SaveImage (image theImage, string fileName [, number type] )`
DESCRIPTION	Saves the peak data to a given file, as the specified file type. Default type = current type. Type = 1 (ascii file), type = 2 (binary) , type = 3 (tiff)

SavePeaks

SUMMARY Save the peaks in a peak list to a file

SYNTAX
```
void SavePeaks(image theImage, string fileName [,
number type] )
```

DESCRIPTION Saves the peak data to a given file, as the specified file type. Type = 1 (default, text file), type = 2 – Tempas file

SavePeaksWithDialog

SUMMARY Save the peaks in a peak list to a file after prompting for filename and location

SYNTAX
```
void SavePeaks(image theImage[, number type])
```

DESCRIPTION Saves the peak data to a given file, as the specified file type. Type = 1 (default, text file), type = 2 – Tempas file

SelectAnnotation

SUMMARY Selects an annotation

SYNTAX
```
void SelectAnnotation( Image, Number annotationID )
```

DESCRIPTION Selects the annotation specified by the annotation ID in the given image.

Set

SUMMARY Sets the real and imaginary part of a complex number

SYNTAX
```
void complexnumber.set(number x,number y) // complex
number member function
```

SetAnnotationBackground*

SUMMARY Sets the background of an annotation

SYNTAX	void SetAnnotationBackground(Image, Number annotationID, Number background)

SetAnnotationColor

SUMMARY	Sets the RGB Color of the Annotation
SYNTAX	void SetAnnotationColor(Image, Number annotationID, Number red, Number green, Number blue)

SetAnnotationFace*

SUMMARY	Sets the text face of an annotation
SYNTAX	Sets the type face of the annotation specified by the annotation ID in the given image.

SetAnnotationFont

SUMMARY	Sets the text justification of an annotation
SYNTAX	void SetAnnotationJustification(Image, Number annotationID, Number justification)
DESCRIPTION	Sets the justification of the text annotation specified by the annotation ID in the given image.

SetAnnotationJustification*

SUMMARY	Sets the text justification of an annotation
SYNTAX	void SetAnnotationJustification(Image, Number annotationID, Number justification)

SetAnnotationRect

SUMMARY	Sets the rect of an annotation

SYNTAX	void SetAnnotationRect(Image, Number annotationID, Number top, Number left, Number bottom, Number right)
DESCRIPTION	Moves the annotation specified by annotation ID in the given image to the specified coordinates.

SetAnnotationSize

SUMMARY	Sets the text size of an annotation
SYNTAX	void SetAnnotationSize(Image, Number annotationID, Number textSize)
DESCRIPTION	Sets the size of text of the annotation specified by the annotation ID in the given image.

SetBlackWhite

SUMMARY	Sets the black and white display limits of an image
SYNTAX	void image.SetBlackWhite(number black, number white) // Member function
DESCRIPTION	Sets the limits for what is to be displayed as black and white. Values <= black are all displayed as black. Values >= white are all displayed as white.

SetCalibration

SUMMARY	Sets the calibration and possibly calibration unit of an image
SYNTAX	void SetCalibration(image , number calibration)
SYNTAX	void SetCalibration(image , number calibration, number calibrationunit)
DESCRIPTION	The index numbers for the calibration units are: 0 – Pixels, 1 – Å, 2 – nanometer, 3 – 1/Pixels, 4 – 1/Å, 5 – 1/nm

SetCalibrationUnit

SUMMARY	Sets the calibration unit of an image
SYNTAX	`void SetCalibrationUnit( image , number calibrationunit)`
DESCRIPTION	The index numbers for the calibration units are: 0 = Pixels, 1 = Å, 2 = nanometer, 3 = 1/Pixels, 4 = 1/Å, 5 = 1/nm

SetImage

SUMMARY	Sets a 2D image at a given position (z) in the volume image
SYNTAX	`void image3D.SetImage(image, number whichposition)  // Member function`
DESCRIPTION	Copies an existing image into the depth “whichposition” (0 – (depth-1)) in a volume image

SetDisplayType

SUMMARY	Sets the type of display of an image
SYNTAX	`SetDisplayType(image img, number type)`
	`SetDisplayType(Image, string type) type = “raster”,”surface”,”rgb”,”line”,”table”,”argand”,”complex”. String is case insensitive`
SYNTAX	`void image.SetDisplayType(number type // Member function`
	`void image.SetDisplayType(string type) type = “raster”,”surface”,”rgb”,”line”,”table”,”argand”,”complex”. String is case insensitive`
DESCRIPTION	types : 1=Raster Image , 2=Surface Plot , 3=RGB, 4 Line Plot , 5-Table , Types 3 is not implemented

SetImageSpace

SUMMARY	Sets the space (real/reciprocal) of an image
SYNTAX	`void image.SetImageSpace(number space) // Member function`

SYNTAX	void image3D.SetImageSpace(string space) // Member function

DESCRIPTION	space = 0 Real space , space = 1 Reciprocal Space
	
	space = “real”, space = “reciprocal”

SetLimits

SUMMARY	Sets the black and white display limits of an image
SYNTAX	SetLimits(image, number black, number white)
SYNTAX	void image.SetLimits (number black, number white) // Member function Equivalent to the member function SetBlackWhite
DESCRIPTION	Sets the limits for what is to be displayed as black and white. Values <= black are all displayed as black. Values >= white are all displayed as white.

SetName

SUMMARY	Sets the name of an image
SYNTAX	void SetName(image , string)
SYNTAX	void image.SetName(string) // Image Member Function

SetPeakList

SUMMARY	Associated an image with an existing peaklist.
SYNTAX	void SetPeakList(image theImage, image peaklist)
DESCRIPTION	After reading in a peaklist from a file or getting the peaklist from an image, this peaklist can be associated with a desired existing image. The dimensions of the image to be associated the peaklist must be of the same dimensions as the image from which the peaklist originated for this to make sense.

SetPixel

SUMMARY	Sets a specified pixel to a given value
SYNTAX	`void SetPixel(image , number x, number y, number val)`
SYNTAX	`void SetPixel(compleximage ,number x, number y, number val)`
SYNTAX	`void SetPixel(compleximage ,number x, number y, complexnumber val)`
SYNTAX	`void image.SetPixel(number x, number y, number val) // Member function`
SYNTAX	`void compleximage.SetPixel(number x, number y, number val) // Member function`
SYNTAX	`void compleximage.SetPixel(number x, number y, complexnumber val) // Member function`

SetPixelAmplitude*

SUMMARY	Sets the pixel amplitude for a given pixel in a complex image
SYNTAX	`void SetPixelAmplitude( image, number x, number y, number amplitude )`
SYNTAX	`void image.SetPixelAmplitude(number x, number y, number amplitude)` Image member function
DESCRIPTION	

SetPixelPhase

SUMMARY	Sets the pixel phase for a given pixel in a complex image
SYNTAX	`void SetPixelPhase(image, number x, number y, number phase)`
SYNTAX	`void image.SetPixelPhase(number x, number y, number phase)` Image member function
DESCRIPTION	

SetSelection

SUMMARY	Sets the selection rectangle of an image
SYNTAX	`void SetSelection( Image, Number top, Number left, Number bottom, Number right )`
DESCRIPTION	Sets the selection of the given image to the coordinates.

SetScale

SUMMARY	Sets the scale/calibration of an image
SYNTAX	`void SetScale( image , number scale)`
SYNTAX	`void SetScale( image , number scaleX, number scaleY)`
DESCRIPTION	Sets the x and y scale, the number of units per pixel in x and y

SetSurveyMode

SUMMARY	Sets the method of survey technique for setting black and white values
SYNTAX	`void SetSurveyMode( Image, Number mode )`
DESCRIPTION	mode = 0 CrossHair . mode = 1 Entire Image, Equivalent to SetSurveyTechnique

SetSurveyTechnique

SUMMARY	Sets the method of survey technique for setting black and white values
SYNTAX	`void SetSurveyTechnique( Image, Number mode )`
DESCRIPTION	mode = 0 CrossHair . mode = 1 Entire Image, Equivalent to SetSurveyMode

SetVoxel

SUMMARY	Sets the voxel value at position (x,y,z)

SYNTAX	`image3D.SetVoxel(number x, number y, number z, number value)`
SYNTAX	`compleximage3D.SetVoxel(number x, number y, number z, complexnumber value)`

SetWindowPosition

SUMMARY	Sets the window position of an image
SYNTAX	`void SetWindowPosition(image, number left, number top)`
DESCRIPTION	

SetWindowSize

SUMMARY	Sets the window size for a displayed image
SYNTAX	`void SetWindowSize(image, number width, number height)`

Sharpen

SUMMARY	Applies a Sharpening Filter to a real image
SYNTAX	`void Sharpen( image ) // In place operation`
DESCRIPTION	Does a sharpening operation on real image in place

Shift

SUMMARY	Shifts the position (0,0) to a new position (sx,sy) in the image
SYNTAX	`image Shift( image, number sx, number sy)`
SYNTAX	`void Shift( image)  // sx = W/2 , sy = H/2   In place operation`
SYNTAX	`void image.Shift(number sx, number sy)`

ShiftAnnotation

SUMMARY	Shifts the position of an annotation
SYNTAX	`void SetAnnotationRect( Image, Number annotationID, Number shiftX, Number shiftY)`

ShiftCenter

SUMMARY	Shifts the position (0,0) to the position (W/2,H/2) in the image
SYNTAX	`void ShiftCenter( Image)      // In place operation`
SYNTAX	`void Image.ShiftCenter()      // Member function`
DESCRIPTION	Shifts each dimension of an image by half. For two dimensional images it will swap quadrants.

ShiftDown

SUMMARY	Returns true/false depending on if the Shift key is down or not
SYNTAX	`Boolean ShiftDown( void )`
DESCRIPTION	Returns 1 if the shift key is down and 0 otherwise.

ShiftImageFocus

SUMMARY	Propagates a complex image or wave function by a distance focus
SYNTAX	`void ShiftImageFocus( compleximage source, number focus [, number voltage = 300] [ , number sampling = 0.2])`
DESCRIPTION	The focus variation (or constant) is given in the image focus. The complex image is propagated over the distance focus. By default the voltage is 300kV. If the source is calibrated in Ångstrom or nanometer, the sampling is taken from the source. Otherwise the default is 0.2 Å/pixel and must be set if different.

ShiftOrigin

SUMMARY	Shifts the position (0,0) to the position (sx,sy) in the image
SYNTAX	image ShiftOrigin(Image, number sx, number sy)
SYNTAX	void ShiftOrigin(Image) // sx = W/2 , sy = H/2 (in place)
SYNTAX	void image.ShiftOrigin(number sx, number sy)

show

SUMMARY	Displays an image. Equivalent to Display
SYNTAX	void Show(image)
SYNTAX	void image.Show() // Member function
SYNTAX	void image3D.Show() // Member function
DESCRIPTION	Equivalent to Display

ShowImage

SUMMARY	Displays an image.
SYNTAX	void ShowImage(image)
SYNTAX	void image.ShowImage() // Member function
DESCRIPTION	Equivalent to Display

sgn

SUMMARY	Calculates the sign of a real number
SYNTAX	RealNumberExpression sgn(RealNumberExpression)
DESCRIPTION	Returns 1 if the number is equal or greater than 0 otherwise returns -1

sigma

SUMMARY	Calculates the standard deviation of a real image
SYNTAX	`number sigma( image )`
SYNTAX	`number image.sigma()` Image member function

sin

SUMMARY	Calculates the sine of a real number or a real image
SYNTAX	`number sin( number )`
SYNTAX	`image sin( image )`
SYNTAX	`void image.sin()` Image member function

sinh

SUMMARY	Calculates the hyperbolic sine of a real number or a real image
SYNTAX	`number sinh( number )`
SYNTAX	`image sinh( image )`
SYNTAX	`void image.sinh()` Image member function

Smooth

SUMMARY	Applies a Smoothing Filter to a real image
SYNTAX	`image Smooth(image)`
SYNTAX	`void image.Smooth()` // Member function

Sobel

SUMMARY	Applies a Sobel Filter to a real image
SYNTAX	`image sobel(image)`
SYNTAX	`void image.sobel()` // Member function

SpaceDown

SUMMARY	Returns true/false depending on if the Space bar is down or not
SYNTAX	`Boolean SpaceDown( void )`
DESCRIPTION	Returns 1 if the space key is down and 0 otherwise.

SphericalBesselJ

SUMMARY	Calculates the spherical Bessel J function
SYNTAX	`number SphericalBesselJ( number, number )`
DESCRIPTION	

SphericalBesselY

SUMMARY	Calculates the general Bessel Y function
SYNTAX	`number SphericalBesselY( number, number )`
DESCRIPTION	

sqrt

SUMMARY	Calculates the square root of a real number or a real image	
SYNTAX	`number sqrt( number )`	
SYNTAX	`image sqrt( image )`	
SYNTAX	`void image.sqrt()`	Image member function

sq

SUMMARY	Calculates the square of a real number or a real image
SYNTAX	`number sq( number )`

SYNTAX	image sq(image)	
SYNTAX	void image.sq()	Image member function

square

SUMMARY	Calculates the square of a real number or a real image	
SYNTAX	number square(number)	
SYNTAX	image square(image)	
SYNTAX	void image.square()	Image member function

stdv

SUMMARY	Calculates the standard deviation of a real image	
SYNTAX	number stdv(image)	
SYNTAX	number image.stdv()	Image member function

sum

SUMMARY	Calculates the sum of a real image	
SYNTAX	number sum(image)	
SYNTAX	number image.sum()	Image member function

tan

SUMMARY	Calculates the tangent of a real number or a real image	
SYNTAX	number tan(number)	
SYNTAX	image tan(image)	
SYNTAX	void image.tan()	Image member function

tanh

SUMMARY	Calculates the hyperbolic sine of a real number or a real image
SYNTAX	number tanh(number)
SYNTAX	image tanh(image)
SYNTAX	void image.tanh() Image member function

Templatematch

SUMMARY	Returns the position dependent cross-correlation coefficient between an image and a pattern for each position of the pattern within the image
SYNTAX	image TemplateMatch(image sourceImage [. Image template] [,number normalize])
DESCRIPTION	This function performs a cross correlation between the sourceimage and the template for each possible position of the template within the image. If the sourceImage has a selection, the template needs not be specified as the selection is used as the template. The argument normalize is set to true/ false (default = false) to set if the source and template are normalized to zero mean before the cross correlation is taken. Equivalent to “FindPattern”

TimeBar*

SUMMARY	Displays a timebar while evaluating real image expression
SYNTAX	RealImageExpression TimeBar(String title, RealImageExpression expression)
DESCRIPTION	*Not Implemented - Puts up a timebar with the string as a title for the real expression.

thf

SUMMARY	Applies a Threshold Filter to a real image
SYNTAX	void image.thf() // Class Member function

DESCRIPTION	Equivalent to ThresholdFilter

throw

SUMMARY	throws an exception that can be caught by a try statement
SYNTAX	`throw( number)`
SYNTAX	`throw( string)`

throwstring

SUMMARY	throws an exception that can be caught by a try statement
SYNTAX	`throwstring(string )`

ThresholdFilter

SUMMARY	Applies a Threshold Filter to a real image
SYNTAX	`void image.ThresholdFilter() // Class Member function`
DESCRIPTION	

Transpose

SUMMARY	Transposes an image
SYNTAX	`image Transpose(image)`
SYNTAX	`void image.Transpose() // Class Member function`

trunc

SUMMARY	Truncates a real number to an integer or a real image to integer values
SYNTAX	`number trunc( number )`

SYNTAX	`image trunc( image )`
SYNTAX	`void image.trunc()           Image member function`

TwoButtonDialog

SUMMARY	Two button dialog
SYNTAX	`Boolean TwoButtonDialog( String prompt, String, rejectLabel, String acceptLabel )`
DESCRIPTION	Puts up a two button dialog with the accepting and rejecting buttons labeled according to the parameters 'acceptLabel' and 'rejectLabel'. Returns true for accept and false for reject.

UniformRandom*

SUMMARY	Calculates a random number with uniform distribution
SYNTAX	`number UniformRandom()`
DESCRIPTION	

update

SUMMARY	Updates an image that has been modified
SYNTAX	`void image.update()     // Image member function`
DESCRIPTION	To ensure that an image that has been modified gets its display representation and other statistics reset

UpdateImage

SUMMARY	Updates an image that has been modified
SYNTAX	`void UpdateImage(image)`
DESCRIPTION	To ensure that an image that has been modified gets its display representation and other statistics reset

ValidAnnotation

SUMMARY	Checks if specified annotation exists
SYNTAX	Boolean ValidAnnotation(Image, Number annotationID)
DESCRIPTION	Returns true if the annotation specified by the annotation ID in the given image is valid; returns false otherwise.

variance

SUMMARY	Returns the variance of a real image
SYNTAX	number variance(image)
SYNTAX	number image.variance() Image member function

Vectorlength

SUMMARY	Returns the Length of a real image as a vector
SYNTAX	number VectorLength(image)
SYNTAX	number image.VectorLength() Image member function
DESCRIPTION	Returns the square root of the sum of the squares

VectorMap

SUMMARY	Creates a vector map from two images
SYNTAX	void VectorMap(image x, image y [, number samplingX] [, number samplingY] [, number scale])
DESCRIPTION	Creates and displays a vector map from two images x and y which correspond to the x and y components of the vectors. Vectors will be created every samplingX (default=16) pixels and samplingY (default=16) pixels. Vectors are drawn with the magnification factor: scale (default=10)

VerticalProjection

SUMMARY	Returns an image resulting projecting the pixels (summed) onto the vertical (y) axis
SYNTAX	image VerticalProjection(image)

Warp

SUMMARY	Calculates bilinear interpolated value within a real image
SYNTAX	image warp(RealImage source, RealImageExpression sourceX, RealImageExpression sourceY)
DESCRIPTION	Transforms the source into a new image based on a transformation of the x and y values

wf

SUMMARY	Returns an image resulting from applying a Wiener Filter to an image
SYNTAX	image wf(image)
SYNTAX	void image.wf() // Image Member Function
DESCRIPTION	Attempts to reduce random noise in the image of a crystalline object. Equivalent to “wienerfilter”

width

SUMMARY	Returns the width of an image
SYNTAX	number image.width() // Image Member Function
SYNTAX	number image3D.width() // Image3D Member Function

WienerFilter

SUMMARY	Returns an image resulting from applying a Wiener Filter to an image
SYNTAX	image WienerFilter(image)

SYNTAX	`void image.wienerfilter()  // Image Member Function`
DESCRIPTION	Attempts to reduce random noise in the image of a crystalline object. Equivalent to "wf"

x

SUMMARY	Returns or sets the real part of a complex number
SYNTAX	`number complexnumber.x() // returns the real part`
SYNTAX	`voi complexnumber.x(number) // sets the real part`

y

SUMMARY	Returns or sets the imaginary part of a complex number
SYNTAX	`number complexnumber.y() // returns the imaginary part`
SYNTAX	`void complexnumber.y(number) // sets the imaginary part`

Alphabetical description of simulation script functions

Non Member Functions

CalculateAtomicScatteringFactors

SUMMARY	Calculates the atomic scattering factors for a given atomic element and places them in a file
SYNTAX	`void CalculateAtomicScatteringFactors(number Z [, number debyeWaller ] [, number voltage ] [, number gMax] [, number deltaG] )`

DESCRIPTION	Calculates the full Atomic Scatering Factors for the element with atomic number Z for all [h,k,l] out to gMax. Default values are: debyeWaller = 0.5 , voltage = 300 kV , gMax = 4.0 1/Å , deltaG – 0.1 1/Å

CalculateExitWave

SUMMARY	Calculates the Exit WaveFunction(s) for the current simulation. Optionally can use a starting wave different from a uniform plane wave of value 1 everywhere.

SYNTAX	`void CalculateExitWave ()`
	
	or
	
	`CalculateExitWave(ComplexImage entranceWave)`

CalculateImage

SUMMARY	Calculates the simulated Images(s) for the current simulation
SYNTAX	`void CalculateImage()`

CalculatePotential

SUMMARY	Calculates the 2D Projected Potential(s) for the current simulation
SYNTAX	`void CalculatePotential()`

PropagateWave

SUMMARY	Calculates a 3D complex volume containing the wave function at each slice for the current simulation up to a given thickness.
SYNTAX	`Image3D PropagateWave(number thickness)`
DESCRIPTION	Implemented as both a standalone function for an open simulation or as a member function of the class simulation.

Simulation Class Member Functions

The syntax simulation.functionname() would be used as in the following example
Example:

```
simulation sim = getsimulation()
sumber focus = sim.getfocus()
print(focus)
```

Any brackets [] within the functions argument list represents optional arguments which have default values if not specified. If any optional argument needs to be specified, all othe optional arguments preceding it must be specified.

Calculate3DPotential

SUMMARY	Calculates the 3D potential for the unit cell of the current simulation
SYNTAX	`void simulation.Calculate3Dpotential (image3D potential)`
SYNTAX	`Image3d potential=simulation.Calculate3Dpotential()`
DESCRIPTION	Calculates the full 3D potential for the specimen unit cell out to 2*gmax for all [h,k,l]. Stores the 3D complex potential in the volume image “potential” which can be displayed using the command “potential.display()” The volume image is created in the process.

CalculateExitWave

SUMMARY	Calculates the Exit WaveFunction(s) for the current simulation
SYNTAX	`void simulation.CalculateExitWave ()`

CalculateImage

SUMMARY	Calculates the simulated Images(s) for the current simulation
SYNTAX	`void simulation.CalculateImage()`

CalculatePotential

SUMMARY	Calculates the 2D Projected Potential(s) for the current simulation
SYNTAX	void simulation.CalculatePotential()

CreateFrequencyImage

SUMMARY	Returns a square image of a simulated object in reciprocal space
SYNTAX	image simulation.CreateFrequencyImage (image [, number imageSize] [, number divergenceAngle] [, number gMax] [, number minIntensity] [, number h, number k, number l])
DESCRIPTION	Creates and returns a square image of size *imageSize*imageSize* of the specified image representing the Fourier transform of one of the calculated types in the simulation (potential, exit wave, image) using a sampling given by the value of gMax (sampling = imageSize/(2*gMax)). The minimum intensity in the pattern (the valye of black) is 10**(- minIntensity). Gaussian peaks of sigma given by the divergenceAngle are placed on the diffraction spots. Default values are: imageSize = 512, gMax = gMax for the current simulation, divergenceAngle is the value for the microscope for the simulation. MinIntensity = 6. The optional values h,k,l are the indicies of the desired reflection along the positive x-axis in the diffraction pattern image.

CreateImage

SUMMARY	Returns a square image from a given calculated image of given size and sampling
SYNTAX	image simulation.CreateImage(image [, number imageSize] [, number sampling])
DESCRIPTION	Creates and returns a square image of size *imageSize*imageSize* of the specified image representing one of the calculated types in the simulation (potential, exit wave, image) using a sampling of *sampling*. Default values are: whichImage = 1 , imageSize = 512 , sampling = 0.1Å

DisplayExitWave

SUMMARY	Displays a calculated exit wave
SYNTAX	void simulation.DisplayExitWave([number whichExitWave] [, number nX] [, number nY] [, number zoom])
DESCRIPTION	Creates and displays the specified exit wave for nX by nY unit cells, using a zoom factor. The image will be resampled to make dx and dy the same and to make the angle 90 degrees if necessary. Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

DisplayExitWaveModulus

SUMMARY	Displays the modulus of a calculated exit wave
SYNTAX	void simulation.DisplayExitWaveModulus([number whichExitWave] [, number nX] [, number nY] [, number zoom])
DESCRIPTION	Creates and displays the modulus of the specified exit wave for nX by nY unit cells, using a zoom factor. The image will be resampled to make dx and dy the same and to make the angle 90 degrees if necessary. Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

DisplayExitWavePhase

SUMMARY	Displays the phase of a calculated exit wave
SYNTAX	void simulation.DisplayExitWavePhase([number whichExitWave] [, number nX] [, number nY] [, number zoom])
DESCRIPTION	Creates and displays the phase of the specified exit wave for nX by nY unit cells, using a zoom factor. The image will be resampled to make dx and dy the same and to make the angle 90 degrees if necessary. Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

DisplayImage

SUMMARY	Displays a calculated image
SYNTAX	`void simulation.DisplayImage( [number whichImage ] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and displays the specified image for nX by nY unit cells, using a zoom factor. The image will be resampled to make dx and dy the same and to make the angle 90 degrees if necessary. Defaults are: whichImage = 1, nX = 1, nY = 1, zoom = 1

DisplayPotential

SUMMARY	Displays a calculated 2D projected potential
SYNTAX	`void simulation.DisplayPotential( [number whichPotential ] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and displays the specified exit wave for nX by nY unit cells, using a zoom factor. The image will be resampled to make dx and dy the same and to make the angle 90 degrees if necessary. Defaults are: whichPotential = 1, nX = 1, nY = 1, zoom = 1

Focus

SUMMARY	Sets the focus of the simulation
SYNTAX	`void simulation.Focus(number focus)`
DESCRIPTION	Sets the focus [Å] for the current simulation

GetAperture

SUMMARY	Returns the radius of the outer objective lens aperture (1/Å)
SYNTAX	`number simulation.GetAperture()`
DESCRIPTION	Equivalent to GetOuterAperture

GetApertureAngle

SUMMARY	Returns the angle of the outer objective lens aperture (mrad)
SYNTAX	`number simulation.GetApertureAngle()`

GetApertureCenter

SUMMARY	Returns the center of the objective lens aperture in “tilt” angle (mrad) and azimuthal angle (degrees)
SYNTAX	`number simulation.GetApertureCenter( number theta, number phi)`

GetApertureCenterHK

SUMMARY	Returns the center of the objective lens aperture in (H,K) of the reciprocal space of the unit cell
SYNTAX	`void simulation.GetApertureCenterHK( number cH, number cK)`

GetCs

SUMMARY	Returns the Spherical Aberration Cs in mm le of the outer objective lens aperture (mrad)
SYNTAX	`number simulation.GetCs()`

GetCs5

SUMMARY	Returns the 5th order Spherical Aberration Cs5 in mm
SYNTAX	`number simulation.GetCs5()`

GetDeltaFocus

SUMMARY	Returns the increment in focus [Å] for a simulation of a thru-focus series
SYNTAX	`number simulation.GetDeltaFocus()`

GetDeltaThickness

SUMMARY	Returns the increment in thickness [Å] for a thru-thickness calculation
SYNTAX	`number simulation.GetDeltaThickness()`

GetDivergence

SUMMARY	Returns the convergence angle (mrad) for the calculation
SYNTAX	`number simulation.GetDivergence()`

GetEndFocus

SUMMARY	Returns the last focus [Å] for a simulation of a thru-focus series
SYNTAX	`number simulation.GetEndFocus()`

GetEndThickness

SUMMARY	Returns the last thickness [Å] for a thru-thickness calculation
SYNTAX	`number simulation.GetEndThickness()`

GetExitWave

SUMMARY	Returns an image containing the exit wave of the calculation
SYNTAX	`image simulation.GetExitWave( [number whichExitWave] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and returns an image of the specified exit wave for nX by nY unit cells, using a zoom factor, Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

GetExitWaveModulus

SUMMARY	Returns an image containing the modulus of the exit wave
SYNTAX	`image simulation.GetExitWaveModulus( [number whichExitWave] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and returns an image of the specified exit wave modulus for nX by nY unit cells, using a zoom factor, Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

GetExitWavePhase

SUMMARY	Returns an image containing the phase of the exit wave
SYNTAX	`image simulation.GetExitWavePhase( [number whichExitWave])`
DESCRIPTION	Creates and returns an image of the specified exit wave phase for nX by nY unit cells, using a zoom factor, Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

GetFocus

SUMMARY	Returns the focus [Å] for the simulation
SYNTAX	`number simulation.GetFocus()`

GetFocusSpread

SUMMARY	Returns the focus [Å] for the simulation
SYNTAX	`number simulation.GetFocusSpread()`
DESCRIPTION	The focus spread refers to the effect of the chromatic aberration of the objective lens and contributes to the damping of the contrast transfer function

GetImage

SUMMARY	Returns an image containing the calculated simulated image
SYNTAX	image simulation.GetImage([number whichImage] [, number nX] [, number nY] [, number zoom])
DESCRIPTION	Creates and returns an image of the specified simulated image for nX by nY unit cells, using a zoom factor, Defaults are: whichImage = 1, nX = 1, nY = 1, zoom = 1

GetInnerAperture

SUMMARY	Returns the inner radius of the objective lens aperture (1/Å)
SYNTAX	number simulation.GetInnerAperture()

GetOpticAxis

SUMMARY	Returns the center of the optic axis in tilt angle (mrad) and azimuthal angle (degrees)
SYNTAX	number simulation.GetApertureCenter(number theta, number phi)

GetOpticAxisHK

SUMMARY	Returns the center of the optic axis in (H,K) of the reciprocal space of the unit cell
SYNTAX	void simulation.GetOpticAxisHK(number cH, number cK)

GetOuterAperture

SUMMARY	Returns the radius of the outer objective lens aperture (1/Å)
SYNTAX	number simulation.GetOuterAperture()
DESCRIPTION	Equivalent to GetAperture

GetPhaseShift

SUMMARY	Returns the phase shift for the phase plate in units of π
SYNTAX	`number simulation.GetPhaseShift()`

GetPhaseShiftRadius

SUMMARY	Returns the radius for the phase plate in units of 1/Å
SYNTAX	`number simulation.GetPhaseShiftRadius()`

GetPhaseShiftRadius2

SUMMARY	Returns the outer radius for the phase plate in units of 1/Å
SYNTAX	`number simulation.GetPhaseShiftRadius2()`

GetPotential

SUMMARY	Returns an image containing the calculated 2D projected potential
SYNTAX	`image simulation.GetPotential( [number whichPotential] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and returns an image of the specified potential for nX by nY unit cells, using a zoom factor, Defaults are: whichPotential = 1, nX = 1, nY = 1, zoom = 1

GetStartFocus

SUMMARY	Returns the starting focus (Å) for a thru-focus series
SYNTAX	`number simulation.GetStartFocus()`

GetStartThickness

SUMMARY	Returns the starting thickness (Å) for a thru-thickness series
SYNTAX	`number simulation.GetStartThickness()`

GetThickness

SUMMARY	Returns the thickness (Å) for the simulation
SYNTAX	`number simulation.GetThickness()`

GetTilt

SUMMARY	Returns the tilt angle of the specimen in mrad and the azimuthal angle of specimen tilt with respect to the horizontal axis in degrees
SYNTAX	`void simulation.GetTilt(number theta, number phi)`

GetTiltAngle

SUMMARY	Returns the tilt angle of the specimen in mrad
SYNTAX	`number simulation.GetTiltAngle()`

GetTiltDirection

SUMMARY	Returns the azimuthal angle of specimen tilt with respect to the horizontal axis in degrees
SYNTAX	`number simulation.GetTiltDirection()`

GetTiltH

SUMMARY	Gets the h value of the center of laue circle (specimen tilt)
SYNTAX	`number simulation. GetTiltH()`

GetTiltHK

SUMMARY Returns the center of Laue circle in (H,K) of the reciprocal space of the unit cell

SYNTAX `void simulation.GetTiltHK( number cH, number cK)`

GetTiltK

SUMMARY Gets the k value of the center of laue circle (specimen tilt)

SYNTAX `number simulation.GetTiltK()`

GetVibration

SUMMARY Gets the vibration of the “specimen” along x and y

SYNTAX `void simulation.GetVibration(number variable vX, numberVariable vY)`

GetVibrationX

SUMMARY Gets the vibration of the “specimen” along x

SYNTAX `number simulation.GetVibrationX()`

GetVibrationY

SUMMARY Gets the vibration of the “specimen” along y

SYNTAX `number simulation.GetVibrationY()`

GetVoltage

SUMMARY Returns the voltage of the microscope for the simulation (kV)

SYNTAX `number simulation.GetVoltage()`

LoadExitWave

SUMMARY — Returns an image containing the exit wave of the calculation

SYNTAX — `image simulation.LoadExitWave( [number whichExitWave])`

DESCRIPTION — Returns the specified exit wave as an image. Default value for which exit wave if not specified is 1. The image will have the sampling of the simulation and the angle of the unit cell.

LoadExitWaveModulus

SUMMARY — Returns an image containing the modulus of the exit wave

SYNTAX — `image simulation.LoadExitWaveModulus( [number whichExitWave] )`

DESCRIPTION — Returns the specified exit wave modulus as an image. Default value for which exit wave if not specified is 1. The image will have the sampling of the simulation and the angle of the unit cell.

LoadExitWavePhase

SUMMARY — Returns an image containing the phase of the exit wave

SYNTAX — `image simulation.LoadExitWavePhase( [number whichExitWave])`

DESCRIPTION — Returns the specified exit wave phase. Default value for which exit wave if not specified is 1. The exit wave phase image will have the sampling of the simulation and the angle of the unit cell.

LoadImage

SUMMARY — Returns an image containing the calculated simulated image

SYNTAX — `image simulation.LoadImage( [number whichImage])`

DESCRIPTION — Returns the specified image. Default value for which image if not specified is 1. The image will have the sampling of the simulation and the angle of the unit cell.

LoadPotential

SUMMARY — Returns an image containing the calculated 2D projected potential

SYNTAX — `image simulation.LoadPotential( [number whichPotential] )`

DESCRIPTION — Returns the specified potential as an image. Default value for which potential if not specified is 1. The image will have the sampling of the simulation and the angle of the unit cell.

PropagateWave

SUMMARY — Calculates a 3D complex volume containing the wave function at each slice for the current simulation up to a given thickness.

SYNTAX — `Image3D simulation.PropagateWave(number thickness)`

DESCRIPTION — Returns a 3D complex volume containing the wave function up to a given thickness. In order to see the wave, the volume image must be displayed in the script, such as `Image3D wave = simulation.PropagateWave(200) ; wave.show() ;`

SetAperture

SUMMARY — Sets the outer objective lens aperture (1/Å)

SYNTAX — `void simulation.SetAperture( number )`

SetApertureAngle

SUMMARY — Sets the outer objective lens aperture in mradians

SYNTAX — `void simulation.SetApertureAngle( number )`

SetApertureCenter

SUMMARY	Sets the center of the objective lens aperture
SYNTAX	`void simulation.SetApertureCenter( number theta, number phi)`

SetApertureHK

SUMMARY	Sets the center of the objective lens aperture in (H,K) of the reciprocal space of the unit cell
SYNTAX	`void simulation.SetApertureHK(number cH,Number cK )`

SetCs

SUMMARY	Sets the Spherical Aberration Cs in mm
SYNTAX	`void simulation.SetCs( number )`

SetCs5

SUMMARY	Sets the 5th order Spherical Aberration Cs5 in mm
SYNTAX	`void simulation.SetCs5( number )`

SetDeltaFocus

SUMMARY	Sets the Incremental focus (Å) for a thru-focus series
SYNTAX	`void simulation.SetDeltaFocus( number )`

SetDeltaThickness

SUMMARY	Sets the incremental thickness (Å) for a thru-thickness series
SYNTAX	`void simulation.SetDeltaThickness( number )`

SetDivergence

SUMMARY Sets the convergence angle (mrad) for the calculation

SYNTAX void simulation.SetDivergence(number)

SetEndFocus

SUMMARY Sets the ending value for focus [Å] in a thru-focus series

SYNTAX void simulation.SetEndFocus(number)

SetEndThickness

SUMMARY Sets the ending value for thickness [Å] in a thru-thickness series

SYNTAX void simulation.SetEndFocus(number)

SetFocus

SUMMARY Sets the focus (Å) for the calculation

SYNTAX void simulation.SetFocus(number)

SetFocusSpread

SUMMARY Sets the focus Spread (Å) associated with the chromatic aberration of the objective lens for the calculation

SYNTAX void simulation.SetFocusSpread(number)

SetInnerAperture

SUMMARY Sets the inner objective lens aperture (1/Å)

SYNTAX void simulation.SetInnerAperture(number)

SetOpticAxis

SUMMARY	Sets the center of the optic axis in tilt angle (mrad) and azimuthal angle (degrees)
SYNTAX	`void simulation.SetOpticAxis( number theta , number phi)`

SetOpticAxisHK

SUMMARY	Sets the center of the optic axis in (H,K) of the reciprocal space of the unit cell real
SYNTAX	`void simulation.SetOpticAxisHK( number cH, number cK)`

SetOuterAperture

SUMMARY	Sets the outer objective lens aperture (1/Å)
SYNTAX	`void simulation.SetOuterAperture( number )`

SetPhaseShift

SUMMARY	Sets the phase shift for the phase plate in units of π
SYNTAX	`void simulation.SetPhaseShift( number )`

SetPhaseShiftRadius

SUMMARY	Sets the radius for the phase plate in units of 1/Å
SYNTAX	`void simulation.SetPhaseShiftRadius( number )`

SetPhaseShiftRadius2

SUMMARY	Sets the outer radius for the phase plate in units of 1/Å

SYNTAX	void simulation.SetPhaseShiftRadius(number)
DESCRIPTION	If the second radius is set greater than the PhaseShiftRadius, the beams are blocked between PhaseShiftRadius and PhaseShiftRadius2

SetStartFocus

SUMMARY	Sets the starting focus (Å) for a thru-focus series
SYNTAX	void simulation.SetStartFocus(number)

SetStartThickness

SUMMARY	Sets the starting thickness for a thru-thickness series
SYNTAX	void simulation.SetStartThickness(number)

SetThickness

SUMMARY	Sets the thickness (Å) for the calculation
SYNTAX	void simulation.SetThickness(number)

SetTiltAngle

SUMMARY	Sets the tilt angle of the specimen in mrad
SYNTAX	void simulation.SetTiltAngle(number)

SetTiltDirection

SUMMARY	Sets the azimuthal angle of specimen tilt with respect to the horizontal axis in degrees
SYNTAX	void simulation.SetTiltDirection(number)

SetTiltH

SUMMARY	Sets the h value of the center of laue circle (specimen tilt)
SYNTAX	`void simulation.SetTiltH( number )`

SetTiltHK

SUMMARY	Sets the h,k values of the center of laue circle (specimen tilt)
SYNTAX	`void simulation.SetTiltHK( number h,number k)`

SetTiltK

SUMMARY	Sets the k value of the center of laue circle (specimen tilt)
SYNTAX	`void simulation.SetTiltK( number )`

SetVibration

SUMMARY	Sets the vibration of the “specimen” along x and y
SYNTAX	`void simulation.SetVibration( number vibX, number vibY)`

SetVibrationX

SUMMARY	Sets the vibration of the “specimen” along x
SYNTAX	`void simulation.SetVibrationX( number )`

SetVibrationY

SUMMARY	Sets the vibration of the “specimen” along y
SYNTAX	`void simulation.SetVibrationY( number )`

SetVoltage

SUMMARY	Sets the voltage of the microscope for the simulation (kV)
SYNTAX	`void simulation.SetVoltage( number )`

ShowExitWave

SUMMARY	Displays a calculated exit wave
SYNTAX	`void simulation.ShowExitWave( [number whichExitWave] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and displays the specified exit wave for nX by nY unit cells, using a zoom factor, Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

ShowExitWaveModulus

SUMMARY	Displays the modulus of a calculated exit wave
SYNTAX	`void simulation.ShowExitWaveModulus( [number whichExitWave] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and displays the modulus of the specified exit wave for nX by nY unit cells, using a zoom factor, Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

ShowExitWavePhase

SUMMARY	Displays the phase of a calculated exit wave
SYNTAX	`void simulation.ShowExitWavePhase( [number whichExitWave ] [, number nX ] [, number nY ] [, number zoom ] )`
DESCRIPTION	Creates and displays the phase of the specified exit wave for nX by nY unit cells, using a zoom factor, Defaults are: whichExitWave = 1, nX = 1, nY = 1, zoom = 1

ShowImage

SUMMARY	Displays a calculated image
SYNTAX	void simulation.ShowImage([number whichImage] [, number nX] [, number nY] [, number zoom])
DESCRIPTION	Creates and displays the specified image for nX by nY unit cells, using a zoom factor, Defaults are: whichImage = 1, nX = 1, nY = 1, zoom = 1

ShowPotential

SUMMARY	Displays a calculated 2D projected potential
SYNTAX	void simulation.ShowPotential([number whichPotential] [, number nX] [, number nY] [, number zoom])
DESCRIPTION	Creates and displays the specified exit wave for nX by nY unit cells, using a zoom factor, Defaults are: whichPotential = 1, nX = 1, nY = 1, zoom = 1

Example:

```
// Precession Tilt series
// This is summing over the power-spectrum of the exit wave function
// by spinning the beam in a circle. The beam tilt is theta (30 mrad).
// The increment in the azimuthal angle is dphi (6 degrees)
// A table of HKL values for different thicknesses is shown
// For illustration purposes, a precession image is also calculated



number theta = 30                    // The tilt angle in mrad
number phi = 0                       // Tilt angle (degrees) with respect to a-axis
number dphi = 6                      // increments in tilt angle (degrees)

simulation sim = getsimulation()     // Get the simulation

// We are making sure that everything has been calculated and is current
sim.calculateall()

image xw = sim.loadexitwave()        // Declare and load the exit wave
image im = sim. loadimage()          // Declare and load the image
image sumim = im ; sumim = 0 ;       // Declare the sum for the images and zero
image sumps = xw ; sumps = 0 ;       // Declare the sum for the powerspectrum
                                     // and zero

OpenResultsWindow()

for(number thickness = 10; thickness <= 100; thickness += 10) {
    sim.setthickness(thickness)
    number i = 0                          // declare and  initialize our counter
    for(phi = 0 ; phi < 360; phi += dphi) {   // loop over the azimuthal angle
        sim.settilt(theta,phi)            // set the tilt of the specimen
                                          // this is equivalent to the tilting the beam
        sim.calculateexitwave()           // Calculate the new exit wave
        sim.calculateimage()              // Calculate the new image
        sumim += sim. loadimage()         // Add the image to the sum
        xw = sim. loadexitwave()          // Load the exit wave
        xw.fft()                          // Fourier transform to get the frequency
                                          // complex coefficients
        xw *= conjugate(xw)               // Set the complex PowerSpectrum
                                          // If we had  used xw.ps() to get the
                                          // power spectrum we would have had a real
                                          // image in “real” space
        sumps += xw                       // Add the powerspectrum to the sum
        i++                               // Keep track of the count
        print("phi = "+phi)               // Just to know where we are in the loop
    }
    sumim /= i                            // Divide by the number of terms in the sum

    // Create a rectangular image of size 1024 by 1024 of sampling 0.1 Å (default)
    image precessionImage = sim.createimage(sumim,1024)

    precessionImage.setname("Image Precession")
    precessionImage.show()                // Show the summed images



    sumps /= i                            // Divide by the number of terms in the sum
    sumps.sqrt()                          // To compare with the Scattering factors

    // Create a rectangular image of size 1024 by 1024 out to gMax = 4 1/Å
    // with a convergence angle of 0.2 mrad
    image precessionPS = sim.createfrequencyimage(sumps,1024,0.2,4)
    precessionPS.setname("Power Spectrum Precession Thickness "+ sim.getthickness())

    precessionPS.show()                   // Show the summed power spectrum
    sumps.setname("thickness " + sim.getthickness())
    sim.createhkltable(sumps)
}
```