

# Fractals: pst-fractal v0.03

## Documentation

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### Abstract

The well known `pstricks` package offers excellent macros to insert more or less complex graphics into a document. `pstricks` itself is the base for several other additional packages, which are mostly named `pst-xxxx`, like `pst-fractal`.

This version uses the extended keyval package `xkeyval`, so be sure that you have installed this package together with the special one `pst-xkey` for PSTricks. The `xkeyval` package is available at [CTAN:/macros/latex/contrib/xkeyval/](http://CTAN:/macros/latex/contrib/xkeyval/). It is also important that after `pst-fractal` no package is loaded, which uses the old keyval interface.

The fractals are really big, which is the reason why this document is about 15 MByte.

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## 1 Julia and Mandelbrot sets

The syntax of the `psfractal` macro is simple

`\psfractal[settings](x0,y0)(x1,y1)`

All Arguments are optional, `psfractal` is the same as `\psfractal(-1,-1)(1,1)`.

The Julia and Mandelbrot sets are a graphical representation of the following sequence

$x$  is the real and  $y$  the imaginary part of the complex number  $z$ .  $C(x, y)$  is a complex constant and preset by  $(0, 0)$ .

$$z_{n+1}(x, y) = (z_n(x, y))^2 + C(x, y) \quad (1)$$

(2)

### 1.1 Julia sets

A Julia set is given with

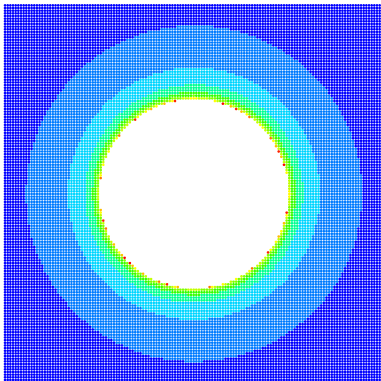
$$z_{n+1}(x, y) = (z_n(x, y))^2 + C(x, y) \quad (3)$$

$$z_0 = (x_0; y_0) \quad (4)$$

$(x_0; y_0)$  is the starting value.



```
\psfractal
```



```
1 \psfractal[xWidth=5cm,yWidth=5cm,
2   baseColor=white,
3   dIter=20](-2,-2)(2,2)
```

## 1.2 Mandelbrot sets

A Mandelbrot set is given with

$$z_{n+1}(x, y) = (z_n(x, y))^2 + C(x, y) \quad (5)$$

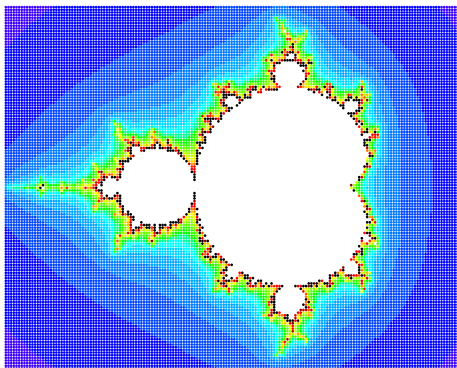
$$z_0 = (0; 0) \quad (6)$$

$$C(x, y) = (x_0; y_0) \quad (7)$$

$(x_0; y_0)$  is the starting value.



```
\psfractal[type=Mandel]
```



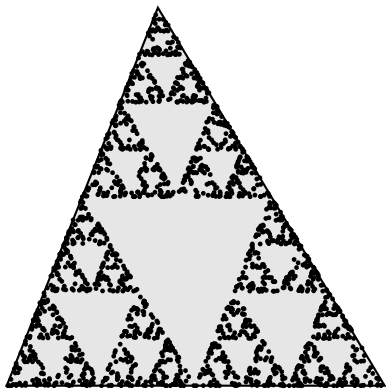
```
1 \psfractal[type=Mandel,
2   xWidth=6cm,yWidth=4.8cm,
3   baseColor=white,
4   dIter=10](-2,-1.2)(1,1.2)
```

## 1.3 Sierpinski triangle

The triangle must be given by three mandatory arguments:

```
\psSier[settings](x0,y0)(x1,y1)(x2,y2)
```

In difference to `psfractal` it doesn't reserve any space, this is the reason why it should be part of a `pspicture` environment.

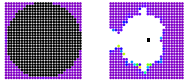


```
1 \begin{pspicture}(5,5)
2   \psSier(0,0)(2,5)(5,0)
3 \end{pspicture}
```

## 2 The options

### 2.1 type

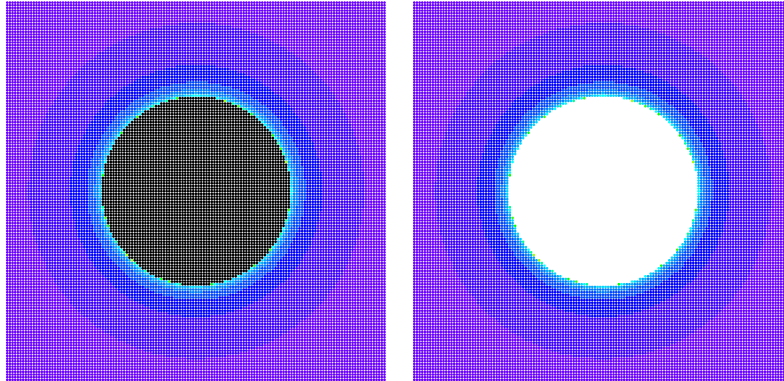
Can be of "Julia" (default) or "Mandel".



```
\psfractal\quad \psfractal[type=Mandel]
```

### 2.2 baseColor

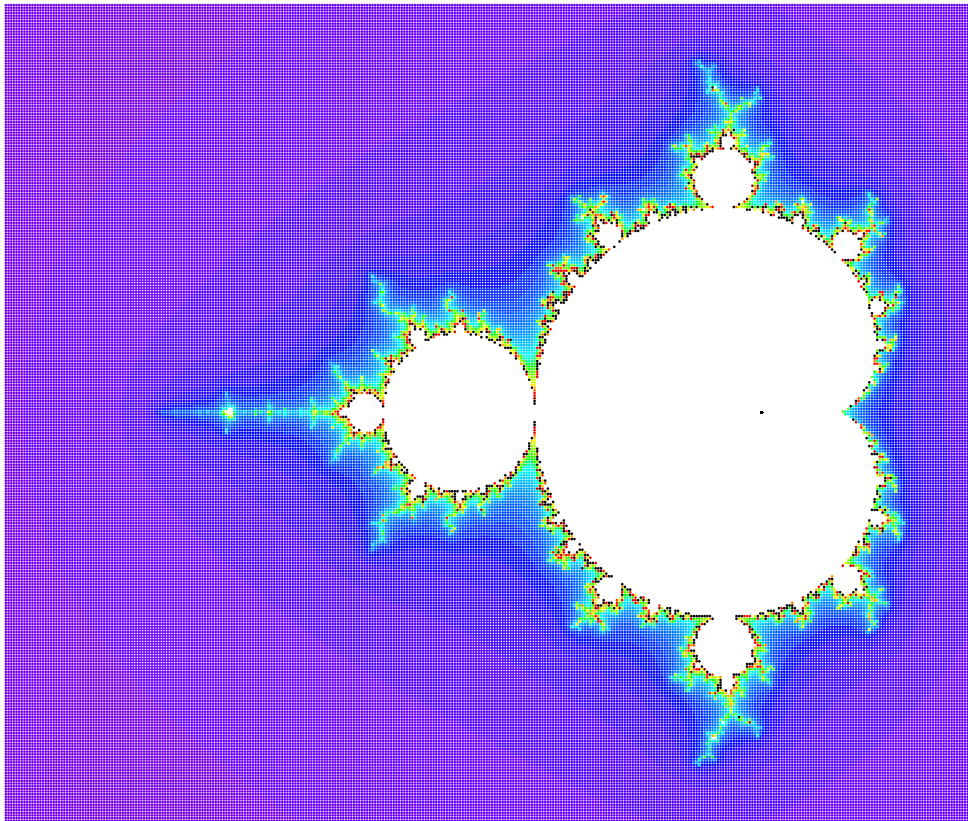
The color for the convergent part.



```
1 \psfractal[xWidth=5cm,yWidth=5cm,dIter=10](-2,-2)(2,2)\quad
2 \psfractal[xWidth=5cm,yWidth=5cm,baseColor=white,dIter=10](-2,-2)(2,2)
```

### 2.3 xWidth and yWidth

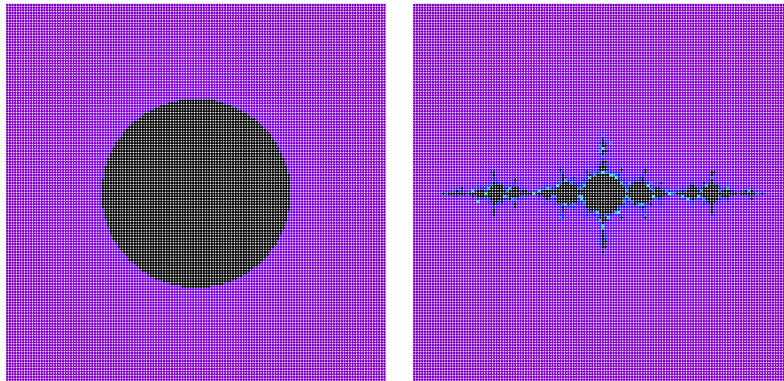
These values define the physical width of the fractal.



```
\psfractal[type=Mandel,xWidth=12.8cm,yWidth=10.8cm,dIter=5](-2.5,-1.3)(0.7,1.3)
```

## 2.4 $cx$ and $cy$

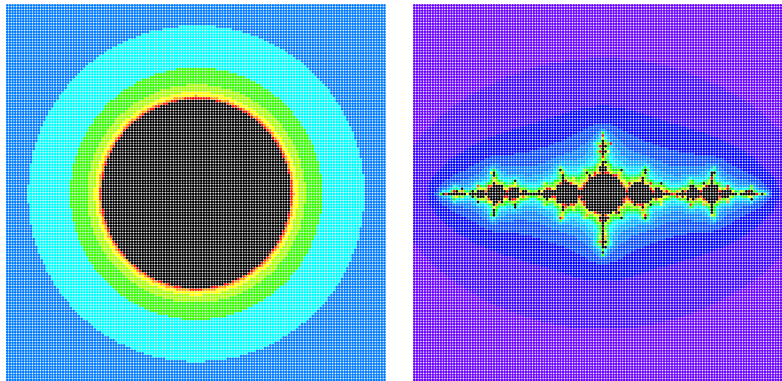
Define the starting value for the complex constant number  $C$ .



```
\psset{xWidth=5cm,yWidth=5cm}
\psfractal[dIter=2](-2,-2)(2,2)\quad \psfractal[dIter=2,cx=-1.3,cy=0](-2,-2)(2,2)
```

## 2.5 dIter

The color is set by wavelength to RGB conversion of the iteration number, where `dIter` is the step, predefined by 1. The wavelength is given by the value of `iter` added by 400.



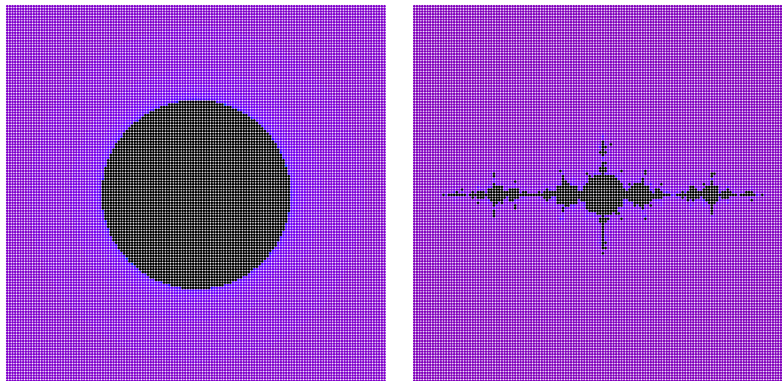
```

1 \psset{xWidth=5cm,yWidth=5cm}
2 \psfractal[dIter=30](-2,-2)(2,2)\quad \psfractal[dIter=10,cx=-1.3,cy=0](-2,-2)(2,2)

```

## 2.6 maxIter

`maxIter` is the number of the maximum iteration until it leaves the loop. It is predefined by 255, but internally multiplied by `dIter`.



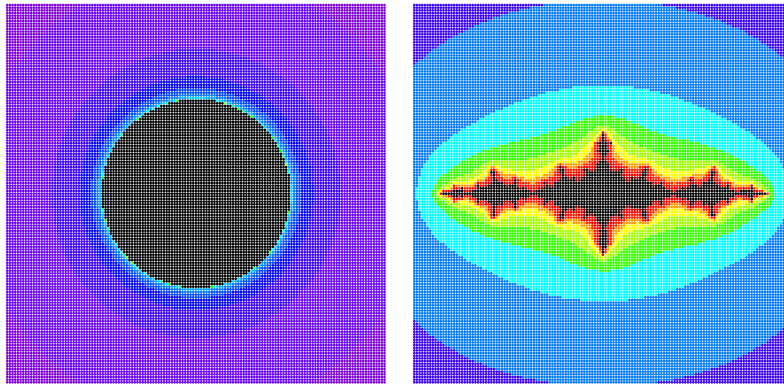
```

1 \psset{xWidth=5cm,yWidth=5cm}
2 \psfractal[maxIter=50,dIter=3](-2,-2)(2,2)\quad
3 \psfractal[maxIter=30,cx=-1.3,cy=0](-2,-2)(2,2)

```

## 2.7 maxRadius

if the square of distance of  $z_n$  to the origin of the complex coordinate system is greater as `maxRadius` then the algorithm leaves the loop and sets the point. `maxRadius` should always be the square of the "real" value, it is preset by 100.



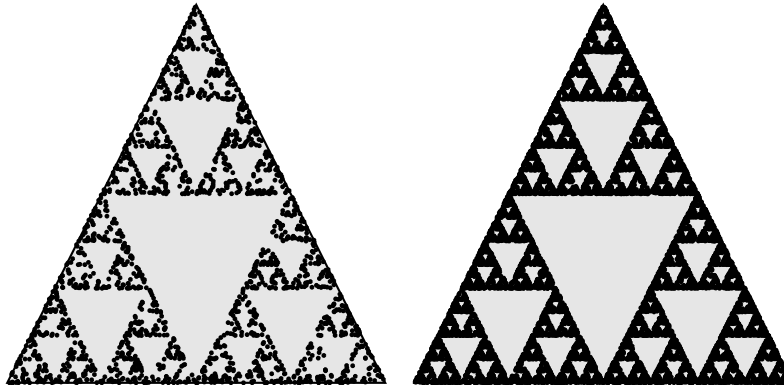
```

1 \psset{xWidth=5cm,yWidth=5cm}
2 \psfractal[maxRadius=30,dIter=10](-2,-2)(2,2)\quad
3 \psfractal[maxRadius=30,dIter=30,cx=-1.3,cy=0](-2,-2)(2,2)

```

## 2.8 `plotpoints`

This option is only valid for the Sierpinski triangle and preset by 2000.



```

1 \begin{pspicture}(5,5)
2   \psSier(0,0)(2.5,5)(5,0)
3 \end{pspicture}\quad
4 \begin{pspicture}(5,5)
5   \psSier[plotpoints=10000](0,0)(2.5,5)(5,0)
6 \end{pspicture}

```

## 3 PDF output

`pst-fractal` is based on the popular `pstricks` package and writes pure PostScript code<sup>[4]</sup>, so it is not possible to run  $\text{\TeX}$  files with `pdfL $\text{\TeX}$`  when there are `pstricks` macros in the document. If you still need a PDF output use one of the following possibilities:

- package `pdftricks.sty`<sup>[7]</sup>

- the for Linux free available program VTeX/Lnx<sup>1</sup>
- build the PDF with ps2pdf (dvi→ps→pdf)
- use the pst-pdf package.<sup>2</sup>

You do not need to load pstricks.sty, it will be done by pst-fractal by default.

## 4 FAQ

- The fractal is not correct placed.

Be sure that you view your output with a dvi viewer which can show PostScript code, like kdvi but not xdvi. It is better to run dvips and then view the ps-file with gv.

- Unknown PostScript command:

Be sure that you have the "newest" pstricks-add.tex file

```
\def\fileversion{2.85}
\def\filedate{2007/04/01}
```

## 5 Credits

### References

- [1] Denis Girou and Manuel Luque. *PST-lens - PostScript macros for Generic TeX*. <http://ftp.dante.de/tex-archive/graphics/pstricks/contrib/pst-lens/>, 2001.
- [2] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The L<sup>A</sup>T<sub>E</sub>X Graphics Companion*. Addison-Wesley Publishing Company, Reading, Mass., 2. edition, 2004.
- [3] Laura E. Jackson and Herbert Voß. Die Plot-Funktionen von pst-plot. *Die T<sub>E</sub>Xnische Komödie*, 2/02:27–34, June 2002.
- [4] Nikolai G. Kollock. *PostScript richtig eingesetzt: vom Konzept zum praktischen Einsatz*. IWT, Vaterstetten, 1989.
- [5] Manuel Luque. *Vue en 3D*. <http://members.aol.com/Mluque5130/vue3d16112002.zip>, 2002.
- [6] Herbert Voß. Die mathematischen Funktionen von Postscript. *Die T<sub>E</sub>Xnische Komödie*, 1/02:40–47, March 2002.

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<sup>1</sup><http://www.micropress-inc.com/linux/>

<sup>2</sup><http://www.ctan.org/CTAN/macros/latex/contrib/pst-pdf/>

- [7] Herbert Voss. *PSTricks Support for pdf*. <http://PSTricks.de/pdf/pdfoutput.phtml>, 2002.
- [8] Herbert Voß. *L<sup>A</sup>T<sub>E</sub>X in Mathematik und Naturwissenschaften*. Franzis-Verlag, Poing, 2006.
- [9] Herbert Voß. *PSTricks – Grafik für T<sub>E</sub>X und L<sup>A</sup>T<sub>E</sub>X*. DANTE – Lehmanns, Heidelberg/Hamburg, 4. edition, 2007.
- [10] Michael Wiedmann and Peter Karp. *References for T<sub>E</sub>X and Friends*. <http://www.miwie.org/tex-refs/>, 2003.
- [11] Timothy Van Zandt. *PSTricks - PostScript macros for Generic TeX*. <http://www.tug.org/application/PSTricks>, 1993.