

pst-spirograph

v.0.51

A PSTricks package for drawing spirograph curves

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1 Introduction

pst-spirograph is a package to simulate the operation of a spirograph. A spirograph is a geometric drawing toy that produces mathematical roulette curves that are technically known as hypotrochoids and epitrochoids. The mathematician Bruno Abakanowicz invented the spirograph between 1881 and 1900.¹ It was used to calculate an area delimited by curves. A hypotrochoid is generated by a fixed point on a circle rolling inside a fixed circle.² It consists of a small toothed wheel rotating inside or outside a ring gear. The weighing tile wheel has nine drilled holes numbered from 0–8, through these small holes the tip of a pen or pencil can be put. This causes the small wheel to rotate one or more laps around the crown and draws a hypocycloid.

The wheel can also turn off a first fixed gear, it is thus possible to draw epicycloids. The command is written as

```
\psSpirograph [Options] (x,y)
\psSpirographB [Options] (x,y)
```

and can optionally be followed by the coordinates of the point where you wish to place the Spirograph: `\psSpirograph [Options] (x,y)` which by default is centered at the origin. The optional parameters, including default values are indicated as following:

1. Z1=20: number of teeth of the wheel 1, the crown;
2. Z2=10: number of teeth of the wheel 2;
3. m=0.5: relative size of the gear;
4. ap=20: pressure angle in degrees, it must be reduced if the number of teeth crown is large (if the path of the teeth will be incorrect), e.g. take Z1=120;
5. holenummer=0: active hole number;
6. polarangle=0: polar angle in degrees to position the center of the inner/outer gear; of the small wheel. It is a useful parameter for an animation, then it is the starting angle..
7. thetamax=360: the end value for the rotation of the second inside/outside gear;

There are two Boolean values for the organisation of the two circles:

- circles: to draw circles of contact (default is false).
- inner: the gear rotates inside of the crown (true — default) or outside (false).

In the drawing, the color selection wheel and the line of the curve is made with the following setting:

1. color1={ [rgb]{0.625 0.75 1}};
2. color2={ [rgb]{0.75 1 0.75}};
3. curvecolor=red ;
4. curvewidth=1pt: linewidth of the hypocycloid;
5. circlescolor=red .

The origin of the spirograph can be set by the coordinates (x, y) . If they are missing, $(0, 0)$ is assumed. By default, the wheels are not filled with color. The color inside the wheels must be set by the option `fillStyle=solid`.

The choice of color and line thickness contour of the wheels is made with usual PSTricks options: `linecolor` and `linewidth`. The transparency of the small wheel is adjusted with the `opacity` option of PSTricks.

The last parameter is the angle `thetamax=360`, which represents the rotation in degrees the center of the small wheel around the ring, so it is a parameter to adjust, depending on the planned route

¹ <http://en.wikipedia.org/wiki/Spirograph>

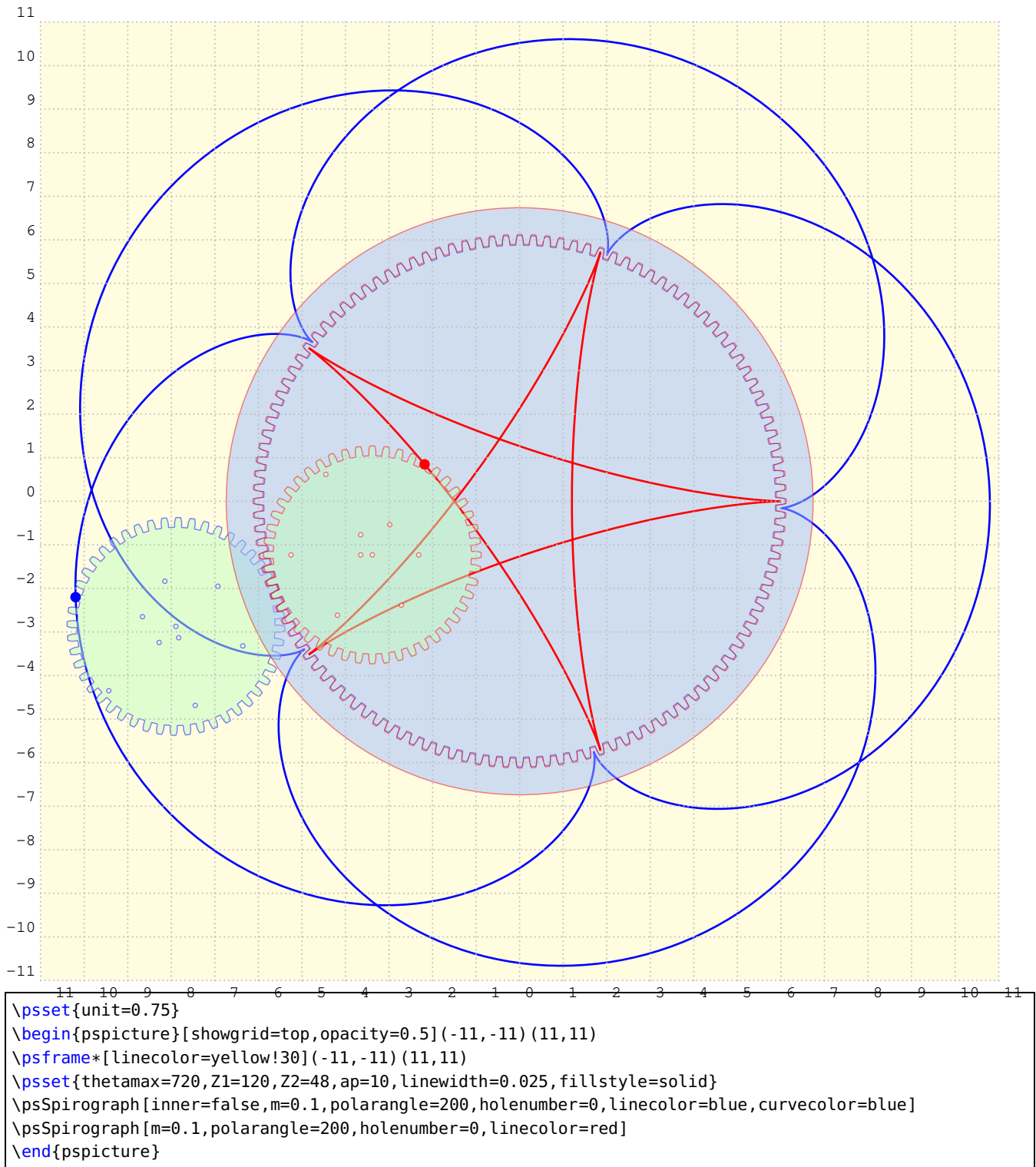
² <http://mathworld.wolfram.com/Spirograph.html>

of the hypocycloid.

2 Parameter

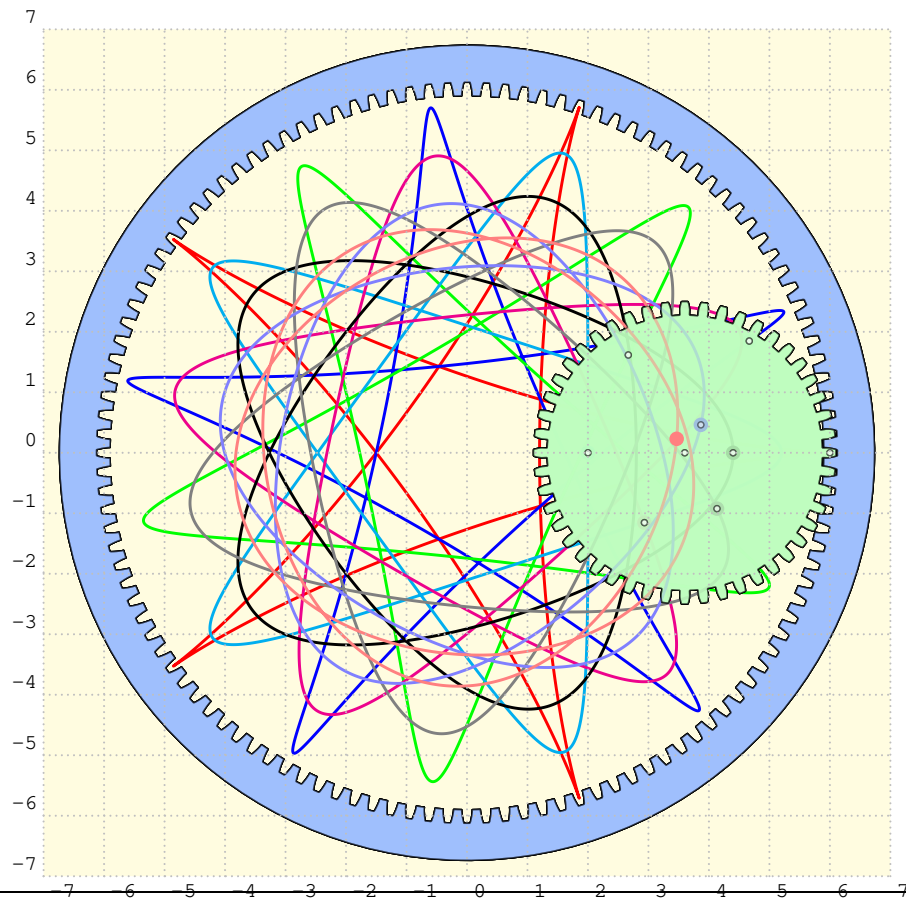
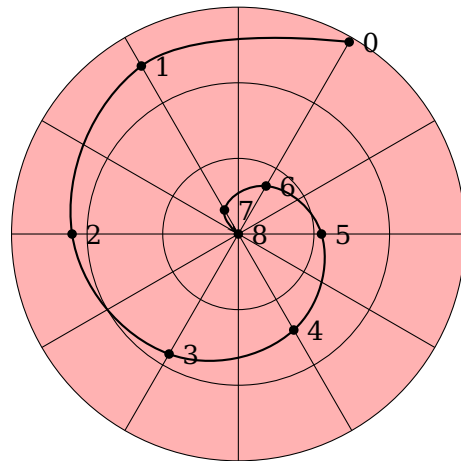
2.1 Relative size

The relative size of the two gears can be set by the optional argument m , which can take every possible value.



2.2 Pencil position

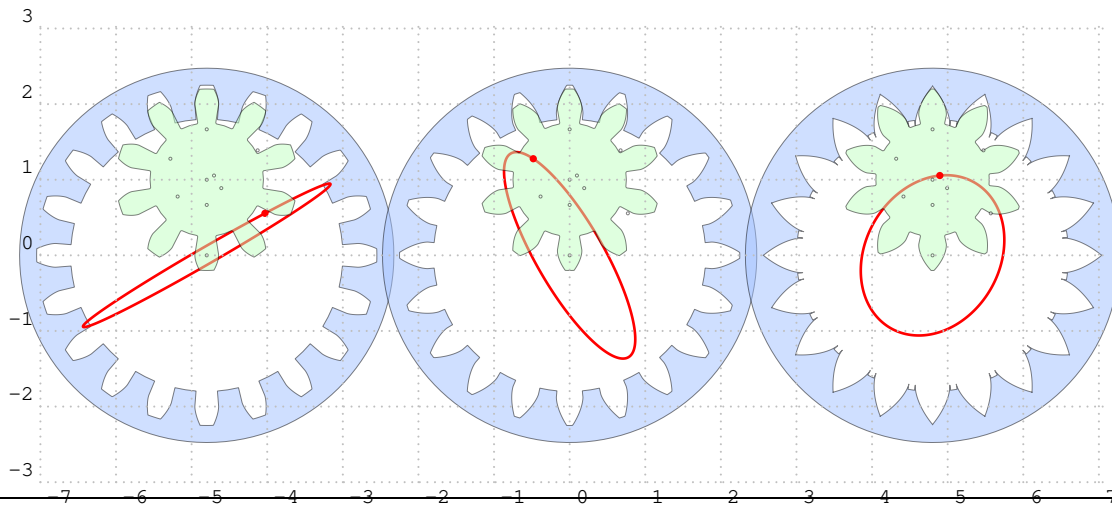
The holes (holenumber) for the pencil are ordered from outside into the center of the gear with different polar coordinates (radius and angle). They are numbered from 0 to 8 and the position cannot be changed. Every given number greater than 8 will be reset internally to 8.



```
\psset{unit=0.8cm}
\begin{pspicture}[showgrid=top,opacity=0.5](-7,-7)(7,7)
\psframe*[linecolor=yellow!30](-7,-7)(7,7)
\psset{thetamax=720,Z1=120,Z2=48,m=0.1,ap=10,linewidth=0.025,curvewidth=1.1pt}
\psSpirograph[holenumber=0]
\psSpirograph[holenumber=1,curvecolor=blue] \psSpirograph[holenumber=2,curvecolor=green]
\psSpirograph[holenumber=3,curvecolor=cyan] \psSpirograph[holenumber=4,curvecolor=magenta]
\psSpirograph[holenumber=6,curvecolor=black] \psSpirograph[holenumber=5,curvecolor=black!50]
\psSpirograph[holenumber=7,curvecolor=blue!50]\psSpirograph[holenumber=8,curvecolor=red!50]
\end{pspicture}
```

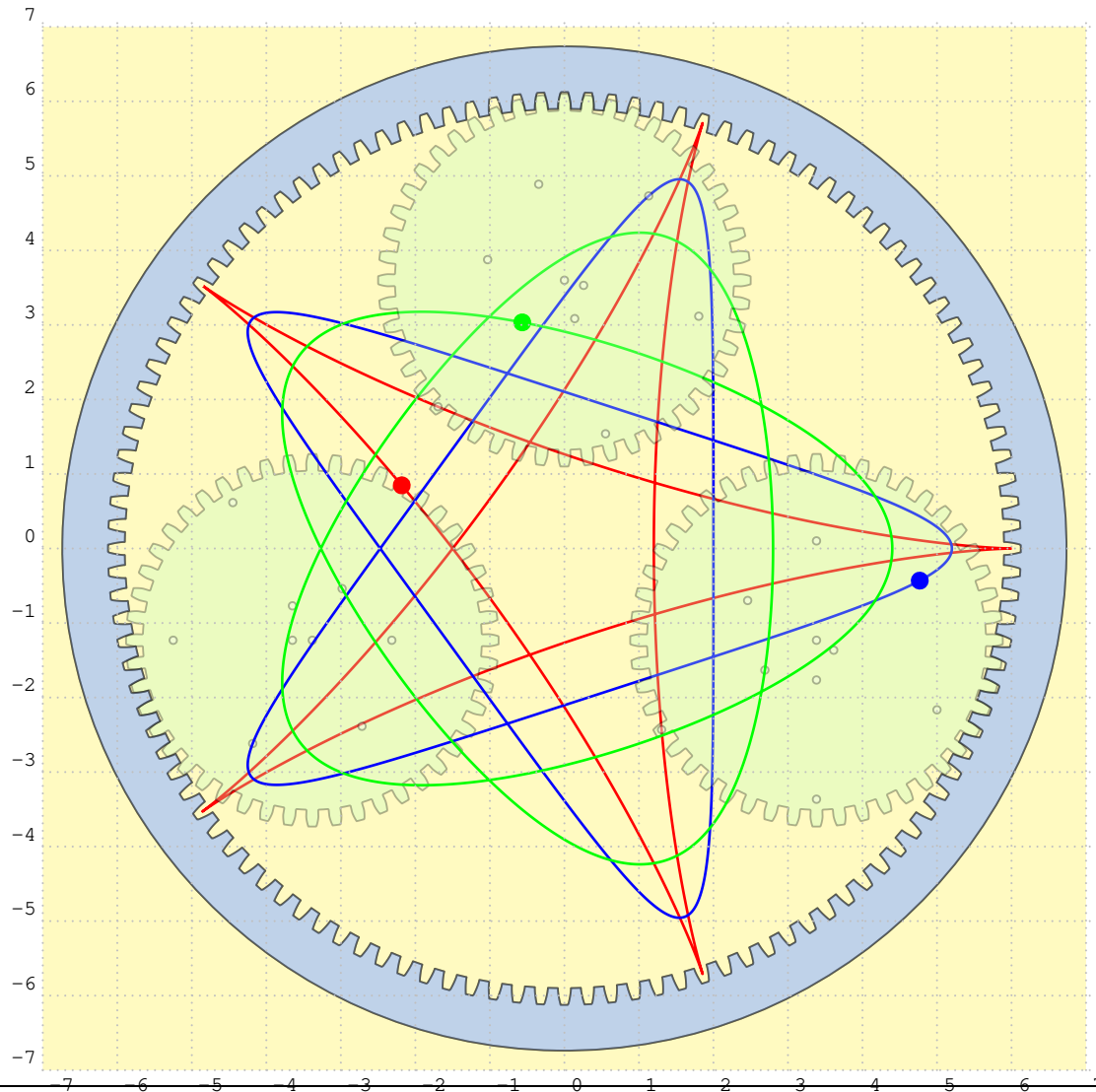
2.3 Pressure Angle

This value defines the look of a “teeth”. Values greater than 30 make no real sense.

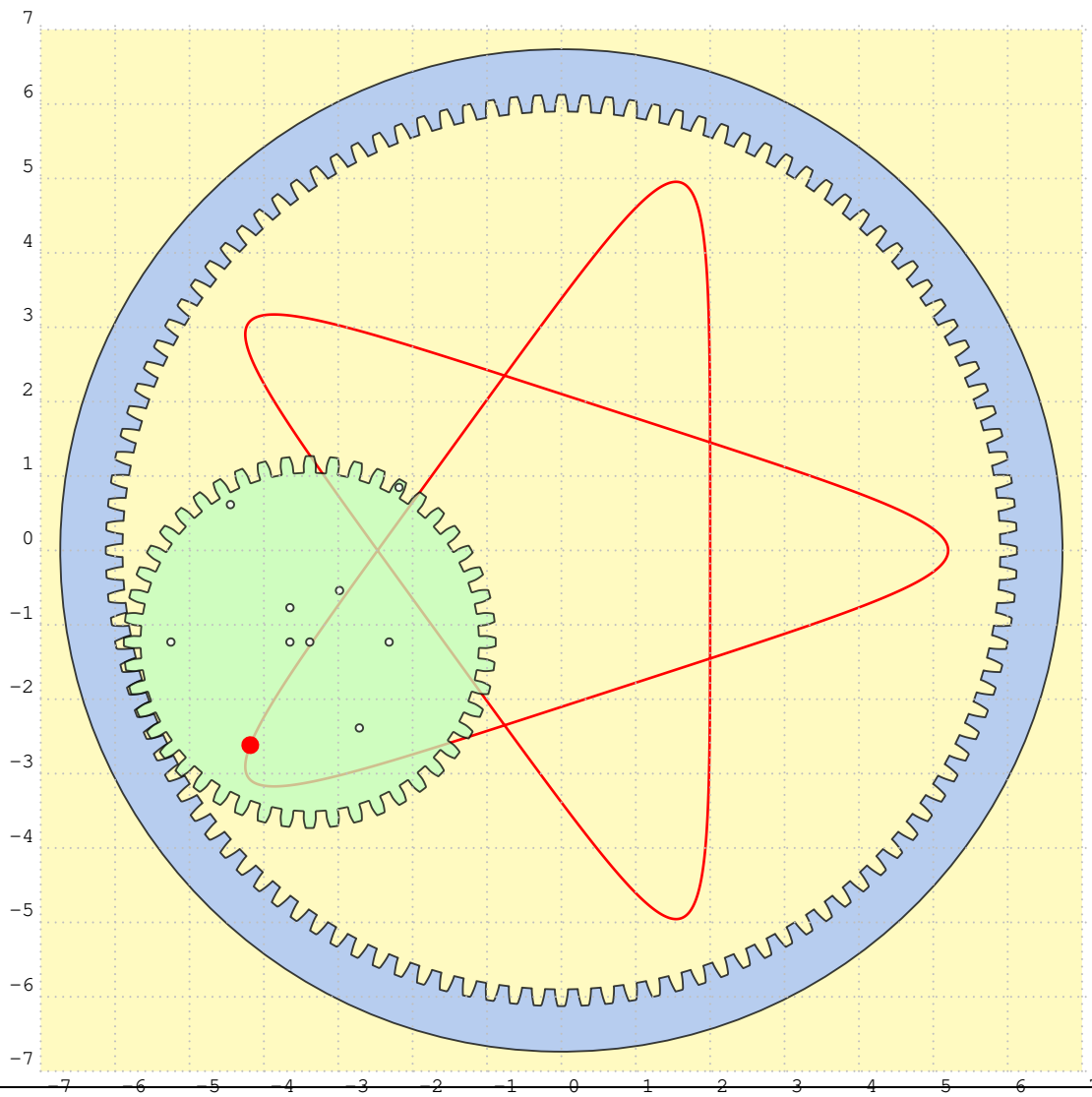


```
\begin{pspicture}[showgrid=top,opacity=0.5](-7,-3)(7,3)
\psset{unit=0.4,linewidth=0.025,fillstyle=solid,polarangle=90}
\psSpirograph[ap=0](-12,0)
\psSpirograph[ap=20, holenumber=4](0,0)
\psSpirograph[ap=30, holenumber=8](12,0)
\end{pspicture}
```

3 Examples



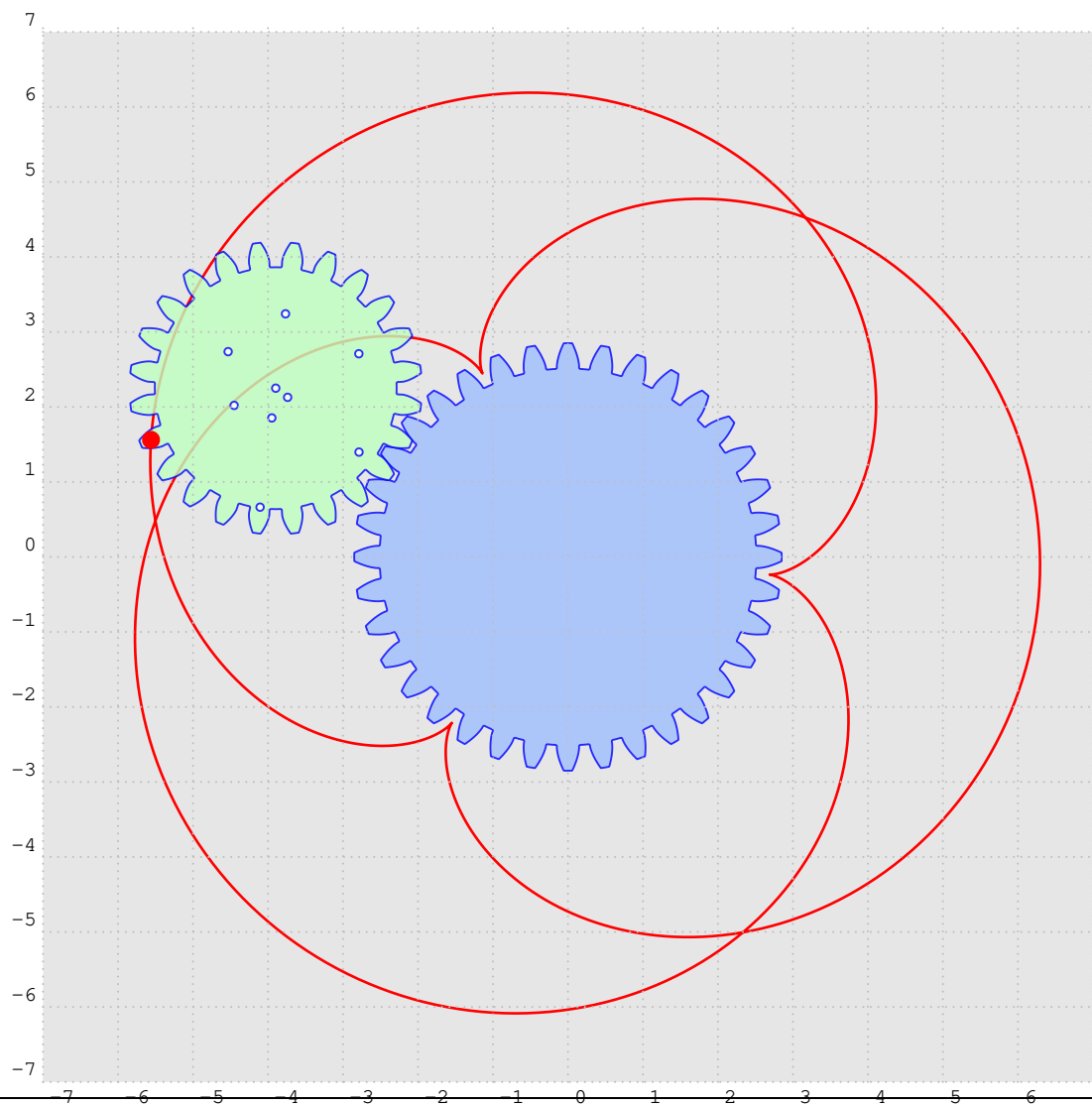
```
\begin{pspicture}[showgrid=top](-7,-7)(7,7)
\psframe*[linecolor=yellow!30](-7,-7)(7,7)
\psSpirograph[thetamax=720,Z1=120,Z2=48,m=0.1,ap=10,linewidth=0.025,
  fillstyle=solid,polarangle=200,holenumber=0,opacity=0.3]
\psSpirograph[thetamax=720,Z1=120,Z2=48,m=0.1,ap=10,linewidth=0.025,
  fillstyle=solid,polarangle=340,holenumber=3,opacity=0.3,curvecolor=blue]
\psSpirograph[thetamax=720,Z1=120,Z2=48,m=0.1,ap=10,linewidth=0.025,
  fillstyle=solid,polarangle=90,holenumber=6,opacity=0.3,curvecolor=green]
\end{pspicture}
```



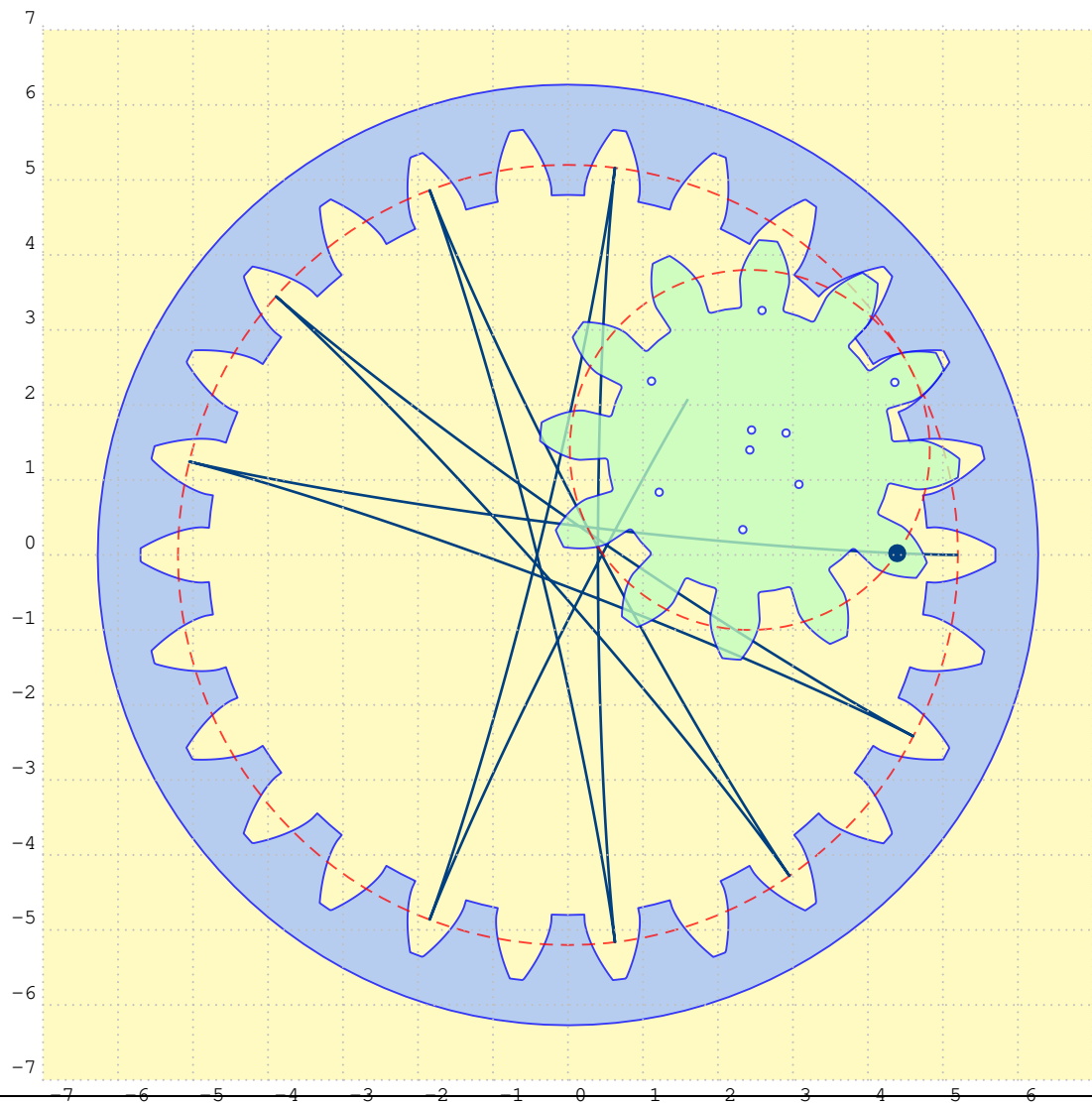
```

\begin{pspicture}[showgrid=top](-7,-7)(7,7)
\psframe*[linecolor=yellow!30](-7,-7)(7,7)
\psSpirograph[thetamax=720,Z1=120,Z2=48,m=0.1,ap=10,linewidth=0.025,
fillstyle=solid,polarangle=200,holenumber=3,opacity=0.75]
\end{pspicture}

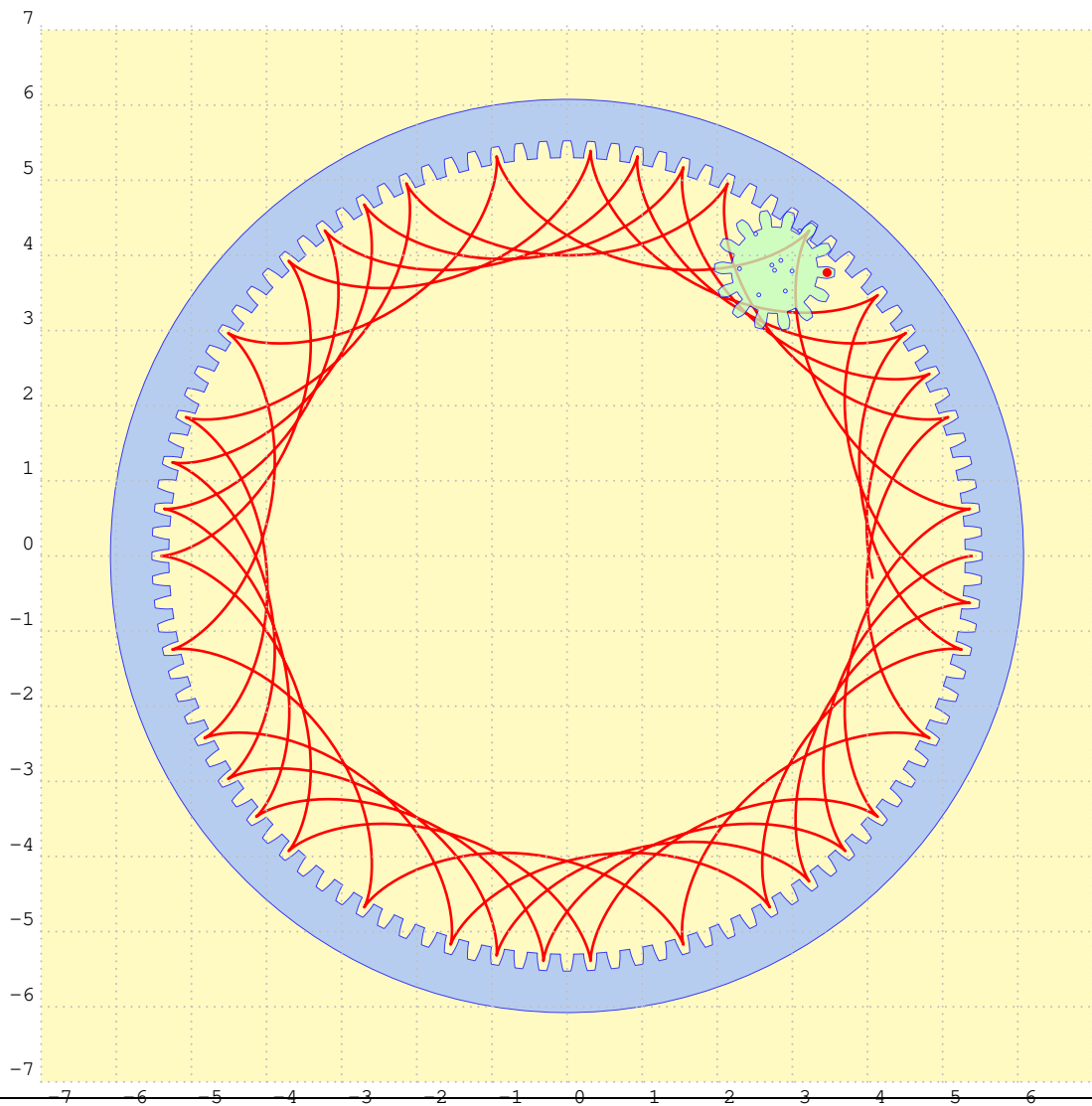
```



```
\begin{pspicture}[showgrid=top](-7,-7)(7,7)
\psframe*[linecolor=gray!20](-7,-7)(7,7)
\psSpirograph[thetamax=720,Z1=36,Z2=24,m=0.15,linewidth=0.025,ap=20,inner=false,
  fillstyle=solid,polarangle=150,linecolor=blue,hole=0,opacity=0.8]
\end{pspicture}
```



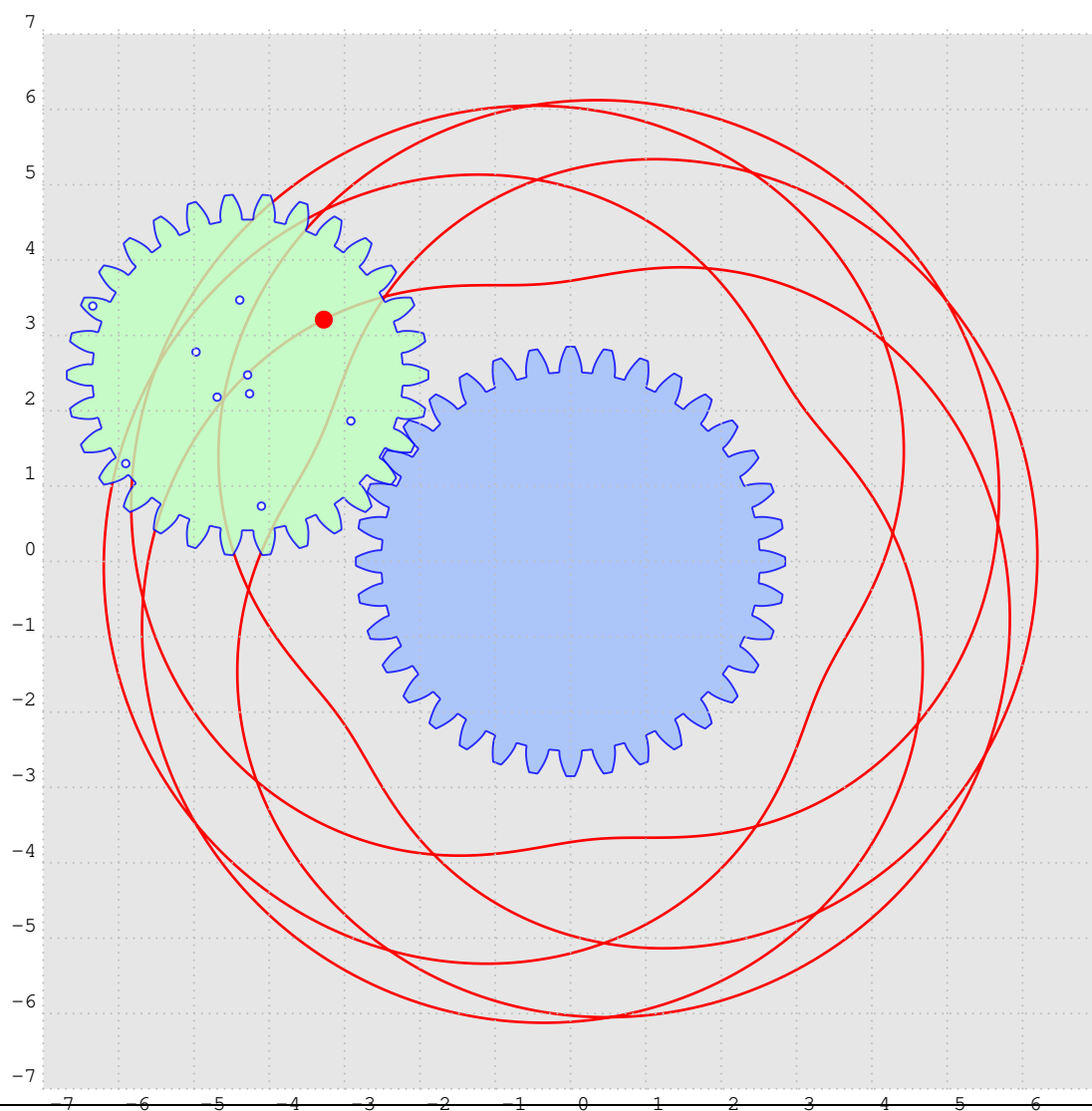
```
\begin{pspicture}[showgrid=top](-7,-7)(7,7)
\psframe*[linecolor=yellow!30](-7,-7)(7,7)
\psSpirograph[thetamax=1440,Z1=27,Z2=12,m=0.4,linewidth=0.025,
curvecolor={rgb}{0 0.25 0.5}},circles,fillstyle=solid,polarangle=30,
linecolor=blue,holenumber=0,opacity=0.75]
\end{pspicture}
```



```

\begin{pspicture}[showgrid=top](-7,-7)(7,7)
\psframe*[linecolor=yellow!30](-7,-7)(7,7)
\psset{unit=0.5}
\psSpirograph[thetamax=-1800,Z1=108,Z2=15,m=0.2,linewidth=0.025,ap=10,
  fillstyle=solid,polarangle=54,linecolor=blue,holenumber=0,opacity=0.75]
\end{pspicture}

```

```
\begin{pspicture}[showgrid=top](-7,-7)(7,7)
\psframe*[linecolor=gray!20](-7,-7)(7,7)
\psSpirograph[thetamax=1800,Z1=36,Z2=30,m=0.15,linewidth=0.025,ap=20,inner=false,
  fillstyle=solid,polarangle=150,linecolor=blue,hole=number=4,opacity=0.8]
\end{pspicture}
```

4 Animations

With package `animate` one can easily create animations. You get a better result with `\multiframe{360}{iA=0+4}{...}` but that increases the file size of the PDF. To save disk space the following examples use a bigger angle step than useful for a single animation.

```
\begin{animateinline}[
  width=0.9\linewidth,
  begin={\begin{pspicture}(-4,-4)(4,4)},
  end={\end{pspicture}},
  palindrome,controls,
  % autoplay
]{5}
\multiframe{80}{iA=0+10}{%
  \psSpirograph[thetamax=iA,Z1=59,Z2=24,m=0.1,ap=10,curvewidth=1.1pt,
    linewidth=0.025,fillstyle=solid,polarangle=iA,holenummer=5,opacity=0.5](0,0)}
\end{animateinline}
```

```
\psset{unit=0.6cm}
\begin{animateinline}[
  width=0.9\linewidth,begin={\begin{pspicture}(-14,-14)(14,14)},end={\end{pspicture}},palindrome,
  controls]{5}
\multiframe{181}{i=0+10}{%
  \psgrid[style=gridstyleA,unit=1.4](-10,-10)(10,10)%
  \ifnum\i=181 \psset{gearwheels=false}\fi
  \psSpirograph[Z1=50,Z2=20,m=0.2,linewidth=0.025,fillstyle=solid,opacity=0.75,polarangle=\i,circles,
    TypeA=false,
    thetamax=\i,curvecolor=red,curvewidth=2pt,HolePos=1.5]}
\end{animateinline}
```

5 Connect the two gears with a rubberband

This is an adaptation with PSTricks of an idea of Alejandro Teutli which he realized with Mathematica: <https://demonstrations.wolfram.com/ParametricMovementOfARubberBand/> which is a variation of a spirograph. A rubber band is fixed by its ends on two gears. A pencil tied in the middle of the elastic rubberband draws the curve obtained when the gears are rotating. The optional argument RubberBand must be used, if you want such a spirograph. It is only available in 3D.

```
\begin{animateinline}[
  width=0.9\linewidth,
  begin={\begin{pspicture}(-6,-3)(8,6)\psframe*[linecolor=yellow,opacity=0.4](-6,-3)(8,6)},
  end={\end{pspicture}}},
  palindrome,controls,
% autoplay
]{5}
\multiframe{181}{iA=0+4}{%
\psSpirograph[RubberBand,Z1=20,Z2=40,m=0.2,viewpoint=2 -5 3,arrowinset=0,arrowsize=0.2,wheelrotation=\
  iA,
  linewidth=0.025,color1=yellow,color2=blue!50]}
\end{animateinline}
```

6 List of all optional arguments for pst-spirograph

Key	Type	Default
Z1	ordinary	20
Z2	ordinary	10
m	ordinary	0.5
ap	ordinary	20
polarangle	ordinary	0
holenumber	ordinary	1
thetamax	ordinary	360
Rarct	ordinary	[none]
wheelrotation	ordinary	[none]
int	boolean	true
notdrawWheel	boolean	true
color1	ordinary	[rgb]{0.625 0.75 1}
color2	ordinary	[rgb]{0.75 1 0.75}
circlescolor	ordinary	red
curvecolor	ordinary	red
curvewidth	ordinary	1pt
inner	boolean	true
circles	boolean	true
HolePos	ordinary	[none]
gearwheels	boolean	true
TypeA	boolean	true
RubberBand	boolean	true
theta1	ordinary	[none]
theta2	ordinary	[none]

References

- [1] Victor Eijkhout. *T_EX by Topic – A T_EXnician Reference*. 1st ed. Heidelberg/Berlin: DANTE – lehmanns media, 2014.
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