Lenses and Mirrors: PST-optic v0.96

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Abstract

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 bundle is available at ftp://ftp.dante.de/pub/tex/macros/latex/contrib/xkeyval/. It is also important that after `pst-optic` no package is loaded, which uses the old keyval interface.

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Introduction

pstricks writes pure PostScript[2] code, so it is not possible to run TEX files with pdfLATEX when there are pstricks macros in the document. If you still need a PDF output use the package pdftricks.sty[4] or the for Linux free available program vlatex (http://www.micropress-inc.com/linux/) or build the PDF with ps2pdf (dvi→ps→pdf).

If you need package graphicx.sty load it before any pstricks package. You do not need to load pstricks.sty, it will be done by pst-optic.sty by default.

Part I

General Options

All options are by default documentwide valid but not supported by all macros. Table 1 shows the general ones. Others are shown in table 2 and 4.

Option	Name	Default
Left value of the picture in cm	xLeft	-7.5
Right value of the picture in cm	xRight	7.5
Lowest value of the picture in cm	xBottom	-3
Highest value of the picture in cm	xTop	3
x-Offset	XO	0
y-Offset	YO	0
Node A as string	nameA	A
Angle A in degrees	spotA	270
Node B as string	nameB	B
Angle B in degrees	spotB	270
Node F as string	nameF	F
Angle F in degrees	spotF	270
Node O as string	nameO	O
Angle O in degrees	spotO	225
Node A' as string	nameAi	A'
Angle A' in degrees	spotAi	90
Node B' as string	nameBi	B'
Angle B' in degrees	spotBi	270
Node F' as string	nameFi	B'
Angle F' in degrees	spotFi	270
Ray color	rayColor	black

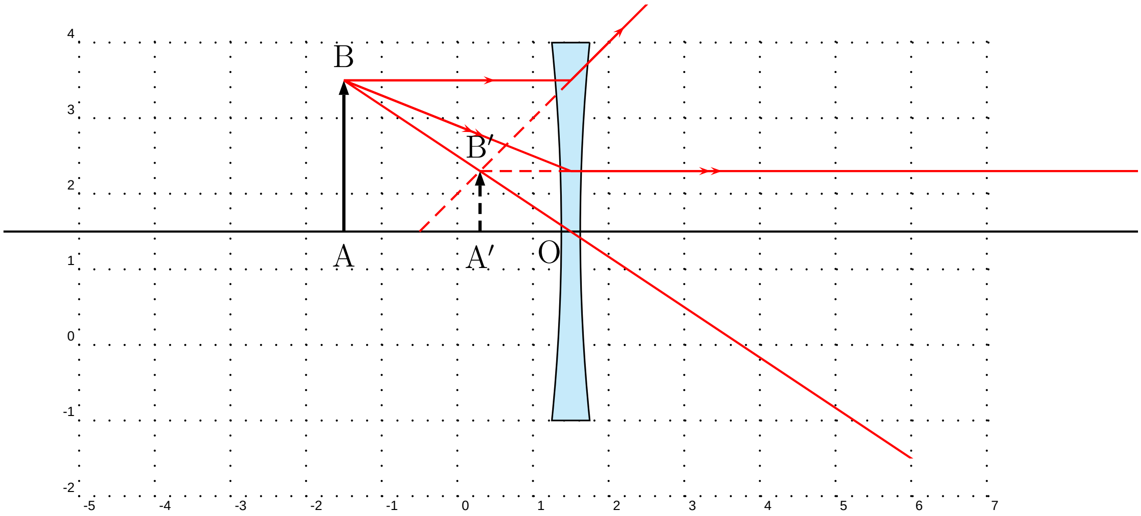
Table 1: General options and the defaults

`pst-optic` puts the lens and mirror macros in an own `pspicture` environment. The star version enables the clipping option of `pstricks`:

```
\begin{pspicture}*(xLeft,yBottom)(xRight,yTop)
  \lens[%
    focus=2,OA=-3,AB=1,XO=0,YO=0,%
    xLeft=-7.5,xRight=7.5,yBottom=-3,yTop=3]
\end{pspicture}
```

If you need other values for the `pspicture` environment, then use the `\rput` command to place the macro at any position.

```
\begin{pspicture}(-5,-1.5)(7,4)
  \rput(1.5,1.5){%
    \lens[lensType=DVG,lensGlass=true,lensWidth=0.5,rayColor=red,%
      focus=-2,AB=2,spotAi=270,spotBi=90]}
\end{pspicture}
```



1 \resetOpticOptions

This macro resets all `pst-optic` options to the default value.

Part II
Lenses

There are macros for the convergent and divergent lens

`\lensCVG` **C**onver**g**ent (Collecting lens) - default

`\lensDVG` **D**i**v**er**g**ent (Scatter lens)

2 The Coordinates of the predefined Nodes

Figure 1 shows the coordinates of the predefined nodes (see table 1).

```
\begin{pspicture}*(-8,-3.25)(8,3.25)
  \rput(0,0){%
    \lens[drawing=false]
    \psline[linewidth=1pt](xLeft)(xRight)
    \qdisk(A){1.5pt}
    \qdisk(B){1.5pt}
    \qdisk(A'){1.5pt}\qdisk(B'){1.5pt}
    \qdisk(F){1.5pt}\qdisk(F'){1.5pt}
    \qdisk(O){1.5pt}\qdisk(I){1.5pt}
    \qdisk(I'){1.5pt}\qdisk(I1){1.5pt}
    \qdisk(I2){1.5pt}
    \uput[270](A){A}\uput[90](B){B}
    \uput[270](F){F}\uput[0](I){I}
    \uput[0](I'){$\mathrm{I'}$}\uput[270](F'){$\mathrm{F'}$}
    \uput[270](B'){$\mathrm{B'}$}\uput[90](A'){$\mathrm{A'}$}
    \uput[180](I1){I1}\uput[0](I2){I2}%
  }
\end{pspicture}
```

3 The Lens Type

Using `\lens[<lensType>]` gives the in figure 2 and 4 shown lenses with the default values from table 2.

The origin of the coordinate system is by default vertically and horinzontally symmetric. If you want to place the lens at another coordinates then define your own `pspicture`-environment and use the `\rput`-command:

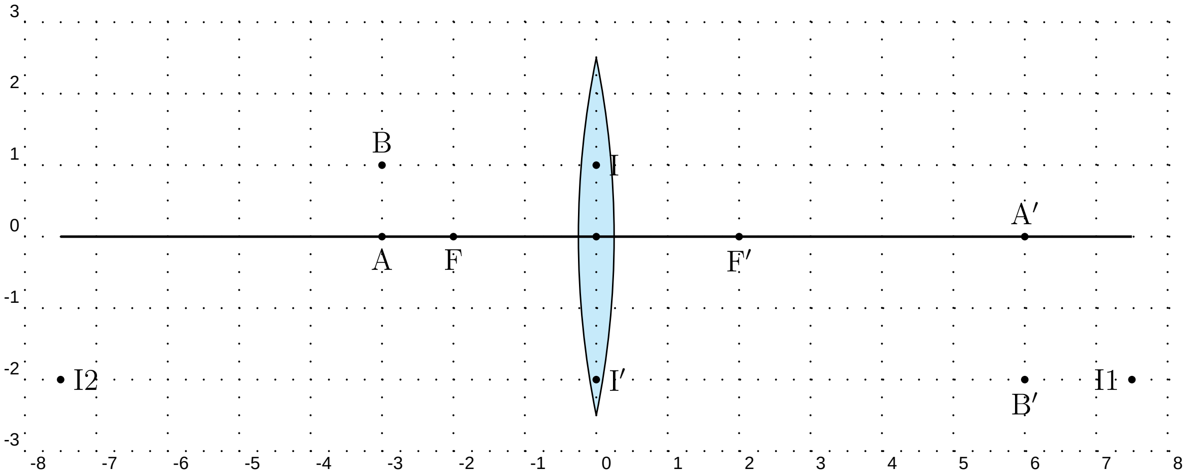


Figure 1: Coodinates of the predefined Nodes

Option	**Name**	**Default**
Lense type	lensType	CVG
Lense height in cm	lensHeight	5cm
Lense width in cm	lensWidth	0.5cm[1]
vertical scale (obsolet)	lensScale	1
View the lens	lensGlass	false
Second lens	lensTwo	false
Focus in cm	focus	2
Distance $\overline{\mathrm{OA}}$	OA	-4
Distance $\overline{\mathrm{AB}}$	AB	1.5
Lens color	lenscolor	black
Arrow length in cm	lensarrowsize	0.2
Arrow inset in cm	lensarrowinset	0.5

Table 2: Available options for lenses with the defaults

[1] only for `lensGlass=true`, otherwise set to `2\pslinewidth`

```
\begin{pspicture}*(-7.5,-3)(7.5,3)
  \rput(0,0){\lens[...]}
\begin{pspicture}
```

The star version enables the clipping option.

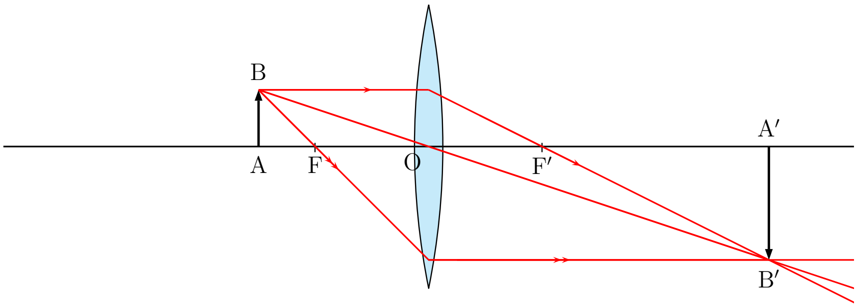


Figure 2: `\lens[lensType=CVG]` (Collecting lens)

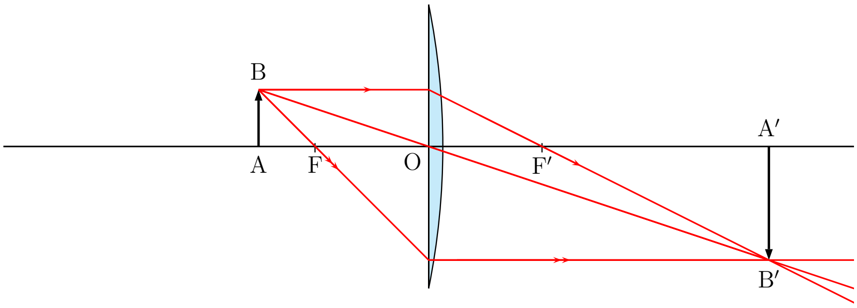


Figure 3: `\lens[lensType=PCVG]` (Plan Collecting lens)

4 `\Transform`

The `Transform`-macro renames all existing nodes in names with an additional "1". Table 3 shows a list of all nodes. `Transform` also defines a new node `factice` with the coordinates `(XO1,YO1)`. The renaming of all nodes makes it easier to handle objects with more than one lens. With the option `lensTwo=true` it is possible to chain the different rays of the lenses (figure 6).

Alt	A	B	A'	B'	O	F	F'	I	I'	XO	YO	OA'	A'B'
Neu	A1	B1	A'1	B'1	O1	F1	F'1	I1	I'1	XO1	YO1	O1A1'	A'1B'1

Table 3: Renaming of the nodes after calling the macro `\Transform`

```
\begin{pspicture}*(-7.5,-3)(7.5,3)
\rput(0,0){%
  \lens[lensScale=0.6,XO=-4,%
    nameF=F_1,nameA=A_1,nameB=B_1,%
    nameFi=F'_1,nameAi={ },nameBi={},nameO=O_1,
    focus=1,OA=-2,lensGlass=true, lensWidth=0.5]%
```

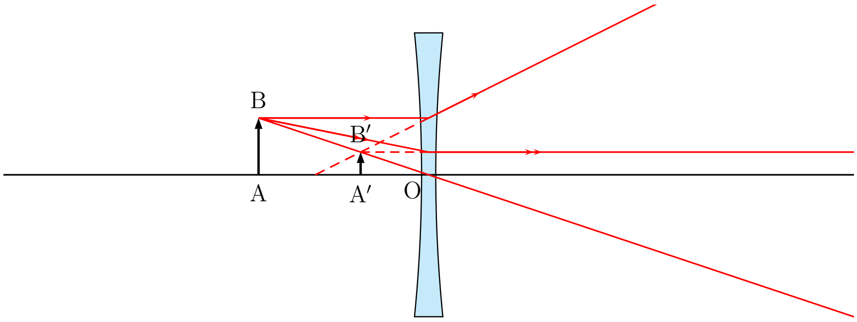


Figure 4: `\lens[lensType=DVG,focus=-2,spotAi=270,spotBi=90]` (Scatter lens)

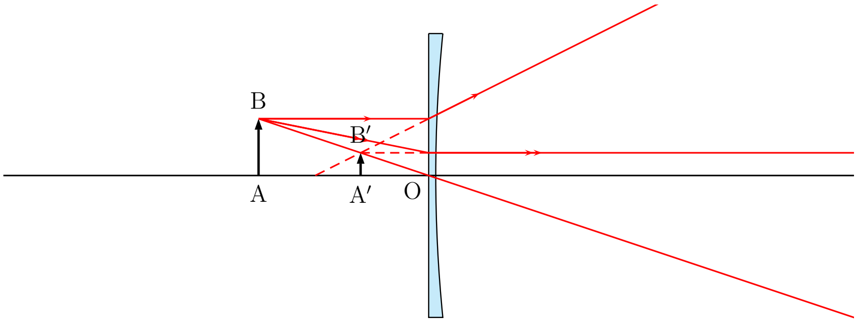
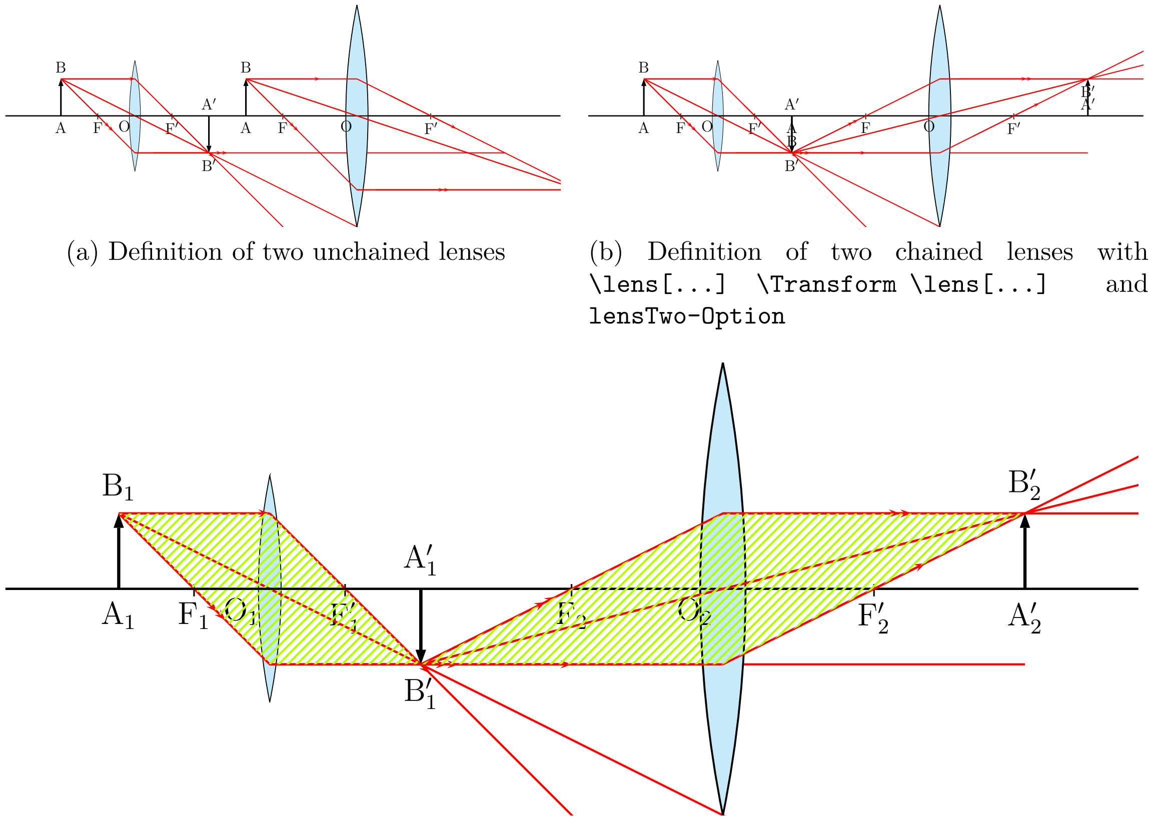


Figure 5: `\lens[lensType=PDVG,focus=-2,spotAi=270,spotBi=90]` (Plan Scatter lens)

```
}
\pspolygon[style=rayuresJaunes,linestyle=none](B)(I)(B')(I')(B)
\Transform
\rput(0,0){%
  \lens[lensScale=1.2,XO=2,focus=2,%
    nameA=A'_1,spotA=90,nameB=B'_1,spotB=270,%
    nameO=O_2,nameAi=A'_2,spotAi=270,%
    nameBi=B'_2,spotBi=90,nameF=F_2,nameFi=F'_2,%
    lensTwo=true,%
    lensGlass=true,lensWidth=0.5]%
}
\pspolygon[style=rayuresJaunes,linestyle=none](B)(I)(B')(I')(B)
\end{pspicture}
```

5 \rayInterLens

This macro is only useful for a two-lens-system. Figure 7 shows such a system. The nodes `B1, I11, F'1, B'1` are predefined by the `lens`-macro. To draw the two rays



(a) Definition of two unchained lenses

(b) Definition of two chained lenses with `\lens[...]` `\Transform` `\lens[...]` and `lensTwo-Option`

(c) Definition of two chained lenses and an additional modification of the node labels.

Figure 6: The meaning of the `\Transform`-Macro with the default labels

from the left lense via the node `B’1` to the second lens, we need the coordinates of these points. `\rayInterLense` defines such nodes. The Syntax:

```
\rayInterLense(StartNode)(IntermediatNode)(LensDistance){LensNode}
```

For the node of figure 7 we have

```
\rayInterLens(I11)(B'1){4}{Inter1L2}
\psline(B1)(I11)(B'1)(Inter1L2)
\rayInterLens(O1)(B'1){4}{Inter2L2}
\psline(B1)(O1)(B'1)(Inter2L2)
```

The two parallel lines are drawn with the `\Parallel`-Macro.

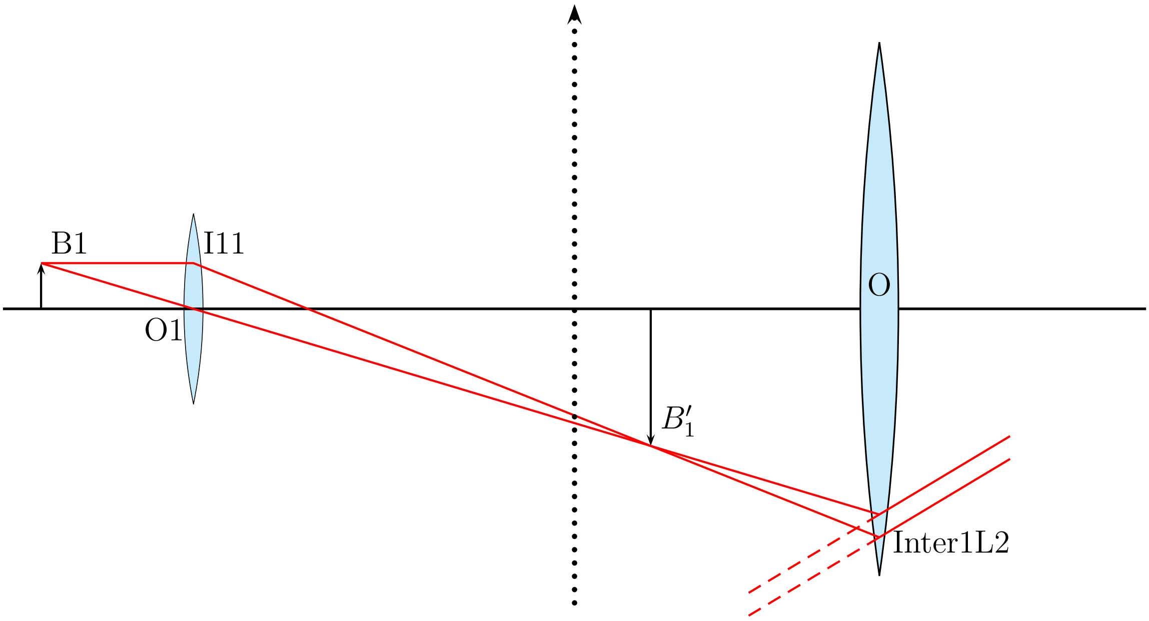


Figure 7: Demonstration of `\rayInterLens`

6 \telescope

Figure 8 shows the configuration of a telescope and table 4 the special options for the `\telescop`-Macro.

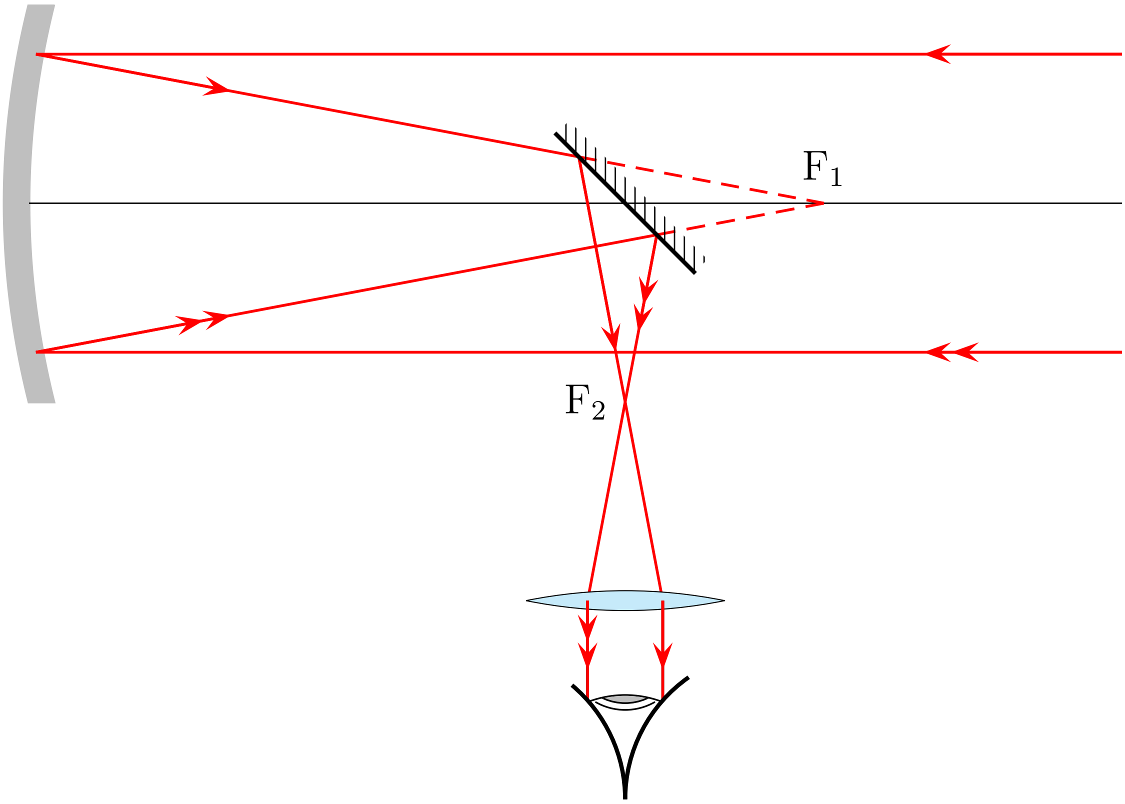


Figure 8: `\telescope`-Macro

Part III
Mirrors

7 options

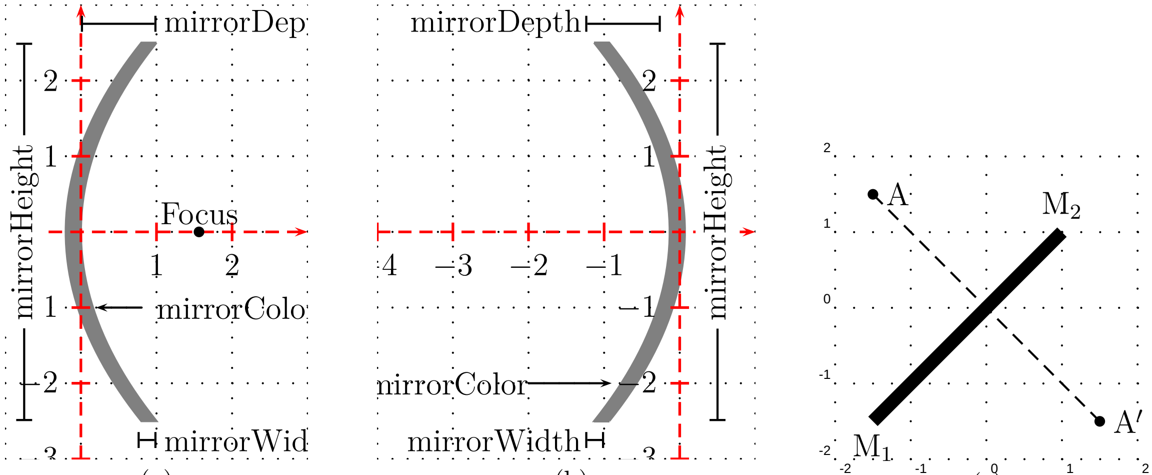
Figure 9 shows the available mirrors and table 4 the possible options.

Option	Name	Default
Left value of the picture in cm	xLeft	-0.5
Right value of the picture in cm	xRight	11
Lowest value of the picture in cm	xBottom	-6
Highest value of the picture in cm	xTop	2.5
Mirror height in cm	mirrorHeight	5
Mirror depth in cm	mirrorDepth	1
Mirror width in cm	mirrorWidth	0.25
Mirror color	mirrorColor	lightgray
Ray color	rayColor	black
Focus in cm (only together with the option `posMirrorTwo` senseful)	mirrorFocus	8
Position of the 2. mirror in cm	posMirrorTwo	8
Inclination of the 2. mirror in degrees	mirrorTwoAngle	45
Draw lines	drawing	true

Table 4: List of options for mirrors with the predefines values

8 `\mirrorCVG`

Figure 10 shows the default for the `mirrorCVG`-macro with the predefined nodes anf three default rays.



(a)

(b)

(c)

Figure 9: The different mirror macros: a) `\mirrorCVG` b) `\mirrorDVG` c) `\planMirrorRay`

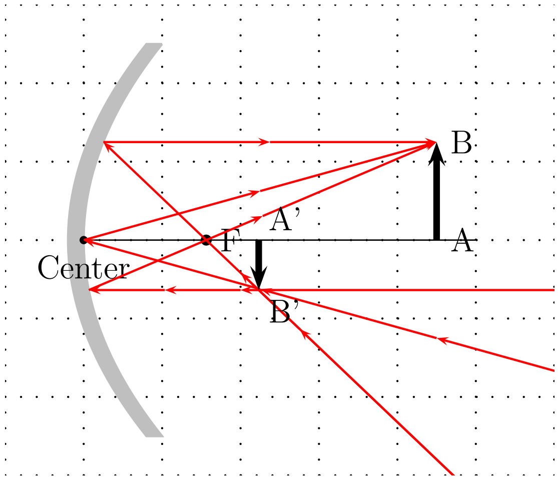


Figure 10: Parabolic Mirror `\mirrorCVG`

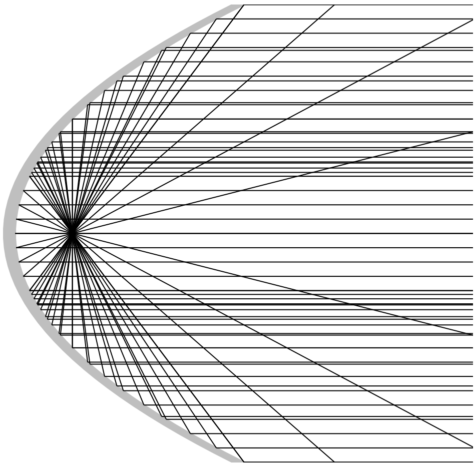


Figure 11: Example

9 `\mirrorDVG`

Figure 12 shows the defaults for the macro `mirrorDVG`-Makros.

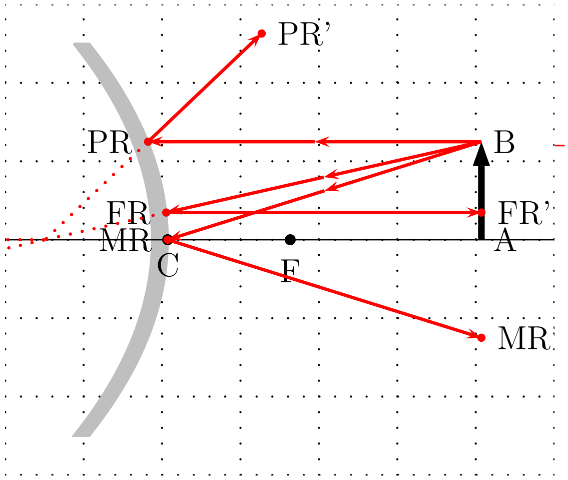


Figure 12: `\mirrorDVG`

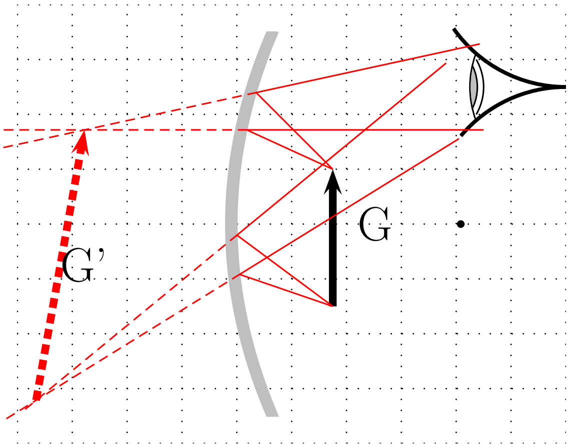


Figure 13: Example as a magnifier

9.1 Drawing Rays in the Mirror Macros

There are two different macros for drawing rays:

```
\mirrorCVGRay[options](Node1)(Node2){MirrorNode}
\mirrorDVGRay[options](Node1)(Node2){MirrorNode}
```

The `MirrorNode` maybe

MirrorNode	first point on the mirror
MirrorNode'	end node or second point on the mirror if one more reflection happens
MirrorNode"	end node for a second reflection

If there are only one reflection, then `MirrorNode'` and `MirrorNode''` are the same.

9.2 `\planMirrorRay`

The `planMirrorRay`-Macro caculates the coordinates of a mirrored point. In figure 9c is a given node `A`, whereas `A'` is calculated by the macro. The syntax is:

```
\planMirrorRay(Mirrorbegin)(Mirrorend)(Originalpoint){New point}
```

The macro doesn't draw any lines, only the coordinates of the new point are saved by the new node name.

9.3 \symPlan

`\symPlan` allows to mirroring complete plain graphical objects along a virtual center line. Figure 14 shows that this mirroring is a mathematical one and not a physical one. For more examples look at [3]. The syntax is:

`\symPlan(node1)(node2){Graphicobject}`

The two nodes define the mirror axis and the graphics object is in most cases a user defined macro, f.ex:

```
\newcommand{\dtk}{%
  \pstextpath(0,0){%
    \psplot[linestyle=none]{0}{8}{x sqrt sqrt 2 mul}}%
        {\Large Die \TeX{}nische Komödie von DANTE}%
}
\begin{pspicture}(-4.5,-2)(2.5,5)
  \pnode(-4,-2){M1}  \uput[-90](M1){M1}
  \pnode(4,4){M2}\uput[90](M2){M2}
  \psline[linewidth=5\pslinewidth,linecolor=lightgray](M1)(M2)
  \rput(-3.5,-1.75){\dtk}% Original schreiben
  \symPlan(M1)(M2){\rput(-3.5,-1.75){\dtk}}% Spiegelbild schreiben
\end{pspicture}
```

This example needs the package `pst-text.sty` for the `\pstextpath` macro (`CTAN:/graphics/pstricks/generic/pst-text.tex`).

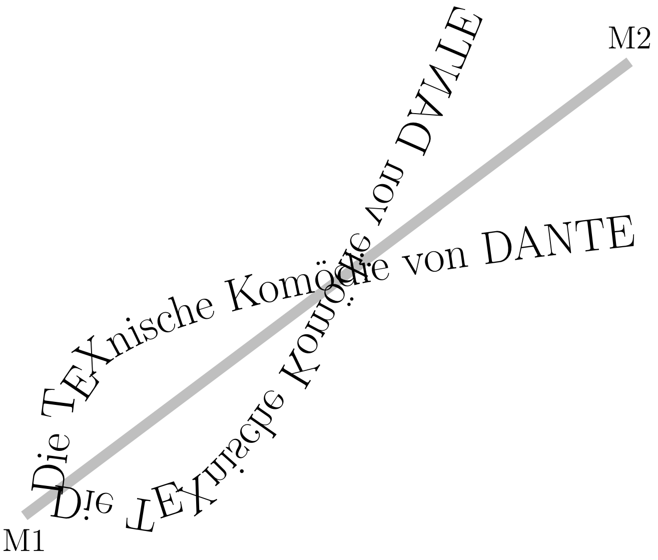


Figure 14: Demonstration of the `\symPlan`-Macro

10 Beam Light

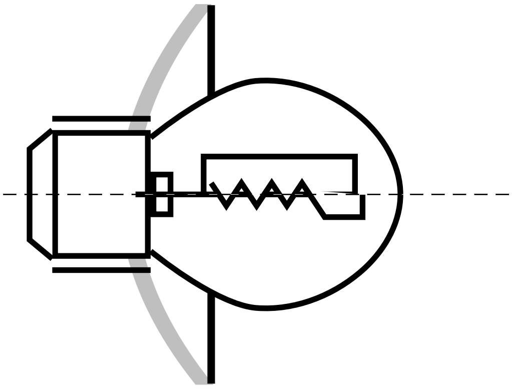
This macro is useful for the demonstration of high and low beam light. The syntax for this macro is:

```
\beamLight[<Options>]
```

The predefined options especially for the `pspicture`-coordinates are

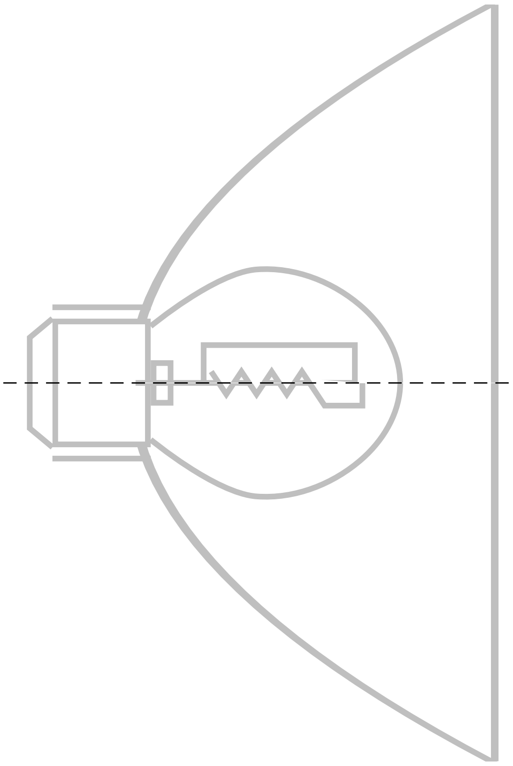
```
\psset[pst-optic]{xLeft=-5,xRight=5,yBottom=-5,yTop=5,drawing=false}% the defaul
```

You can place this macro with the `\rput`-command at any place in your own `pspicture`-environment.



```
\begin{pspicture}(-1,-3)(3,3)
        \rput(0,0){\beamLight}
\end{pspicture}
```

Figure 15: `\beamLight` without any Options



```
\begin{pspicture}(-1,-5.5)(5,5.5)
  \rput(0,0){%
    \beamLight[mirrorDepth=4.75,%
        mirrorWidth=0.1,mirrorHeight=10,%
        linecolor=lightgray]}
\end{pspicture}%
```

Figure 16: `\beamLight` with Options

Part IV
Refraction

11 `\refractionRay`

The syntax is

```
\refractionRay(A)(B)(C)(D){n1}{n2}{EndNode}
```

The macro uses the law of Snell

$$\frac{n_1}{n_2} = \frac{\sin\beta}{\sin\alpha} \tag{1}$$

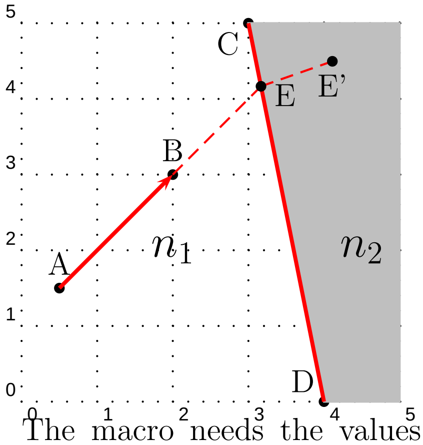
where the n_1 and n_2 are the refraction numbers with the predefined values

$$n_1 = 1 \tag{2}$$
$$n_2 = 1.41 \tag{3}$$

and α the incoming abd β the outgoing angle of the ray.

The refractionnumbers have the internal names `refractA` and `refractB`.

A total reflection instead of a refraction is possible, when the ray starts in a medium with a higher refrectionnumber. This happens when $\sin\beta > 1$ in equ.1. In this case we have $\alpha = \beta$, a total reflection.



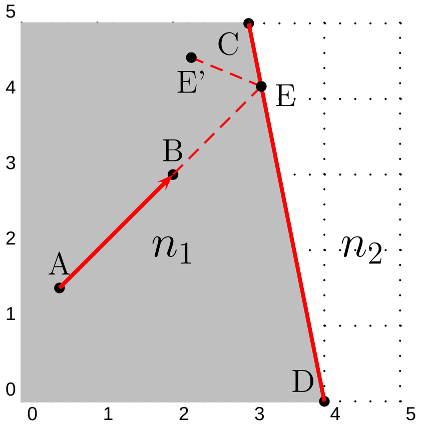
The macro needs the values for the four nodes, the two refractionnumbers and the name for the end node. As you can see in the figure the end node of the ray is the intermediate point between the linear ray and the linear medium. The end node of the refracted ray has the same name with an additional single quotation mark. In the figure the macro was called as

```
\refractionRay(A)(B)(C)(D){1}{4}{E}
```

$$n_1 < n_2 \tag{4}$$

It is no problem to draw a ray which is going straight through another medium. It can be done by using the macro twice as shown in the following examples.

12 Total Reflection



In the figure the macro was called as

```
\refractionRay(A)(B)(C)(D){4}{1}{E}
```

$$n_1 > n_2 \tag{5}$$

Part V
Prism

This command allows to simulate the deviation of a mono-chromatic light ray with a prism. There are only few parameters. The indicated values are the default ones.

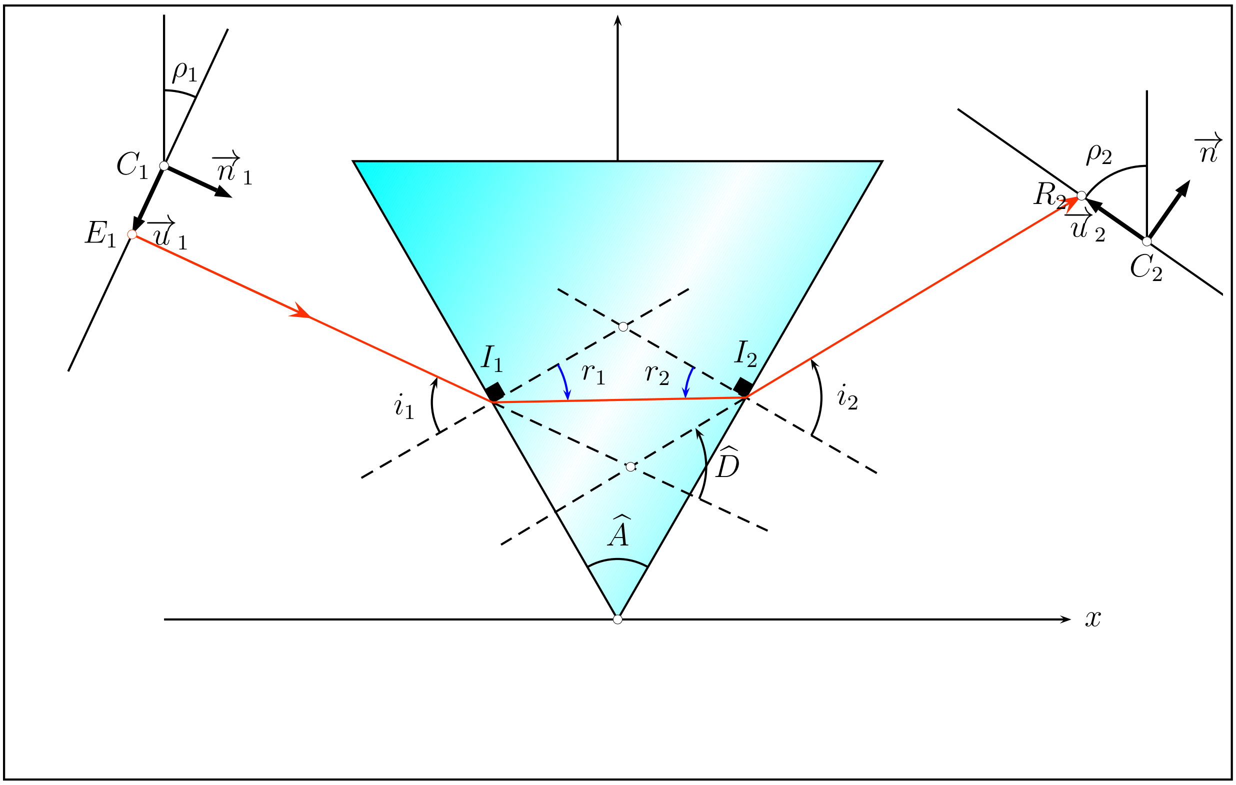
- The angle to the top of prism : `AnglePrism=60`.
- The angle between the plane (1), where the tranmitter takes place, and the vertical : `AnglePlan`. Negative values are allowed.
- The angle between the plane (2) (the screen), and the vertical : `+AnglePlan2=55`. Negative values are allowed.
- Position of transmitter relative to choosen origin C_1 on the plane : $\overrightarrow{C_1E_1} = k\overrightarrow{u_1}$, `k=1`.
- The wavelength `lambda=632.8`, in nm.
- The plane where transmitting source takes place, with all indications, origin, angle, etc., as well as the screen are displayed by default. This can be useful in order to finalize a figure, but it is possible to deactivate this feature with the option `[notations=false]`

Thanks to the `AnglePlan1`, the incident ray direction can be changed. The incidence spot changes according to `k`.

The outline of processing we have adopted is the Gernot Hoffmann one. He details it in its document : http://www.fho-emden.de/~hoffmann/prism16072005.pdf

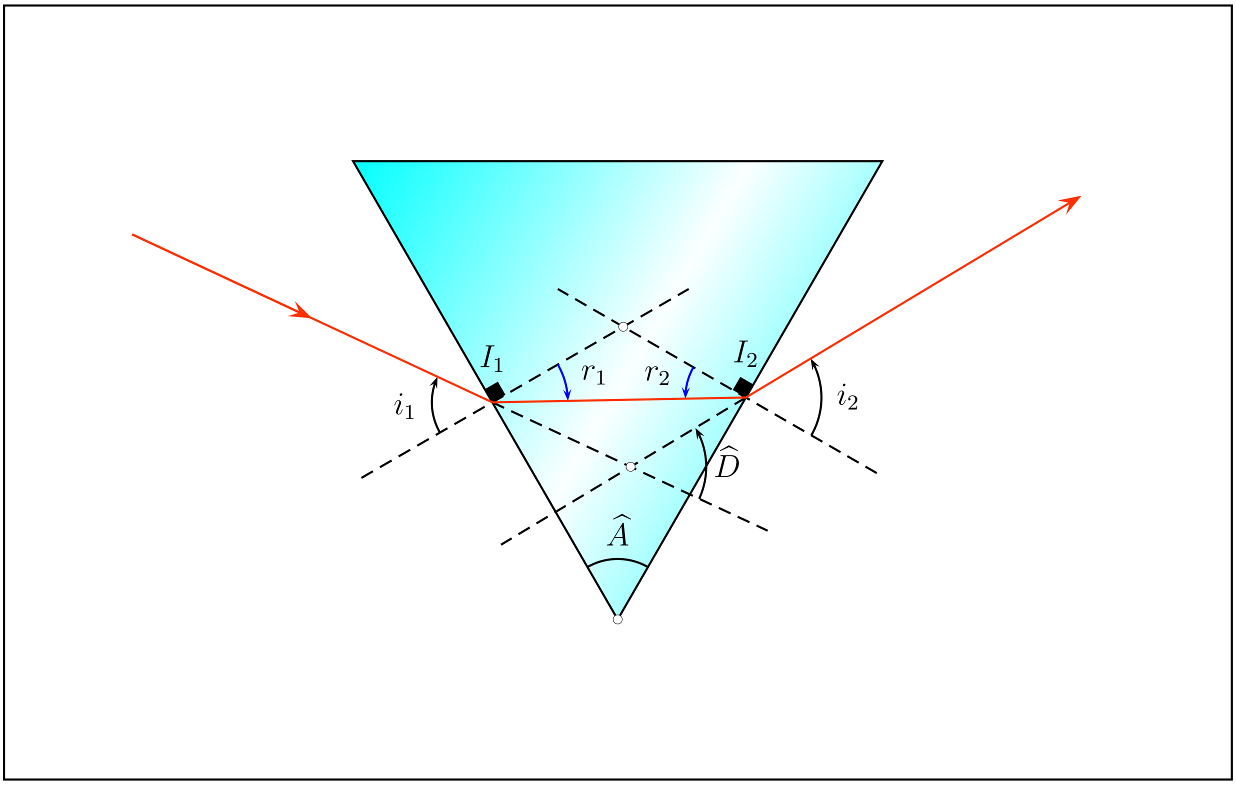
13 Figure with Default Values and Construction Indications

```
\psframebox{%
   \begin{pspicture*}(-8,-2)(8,8)
     \psprism
   \end{pspicture*}}
```



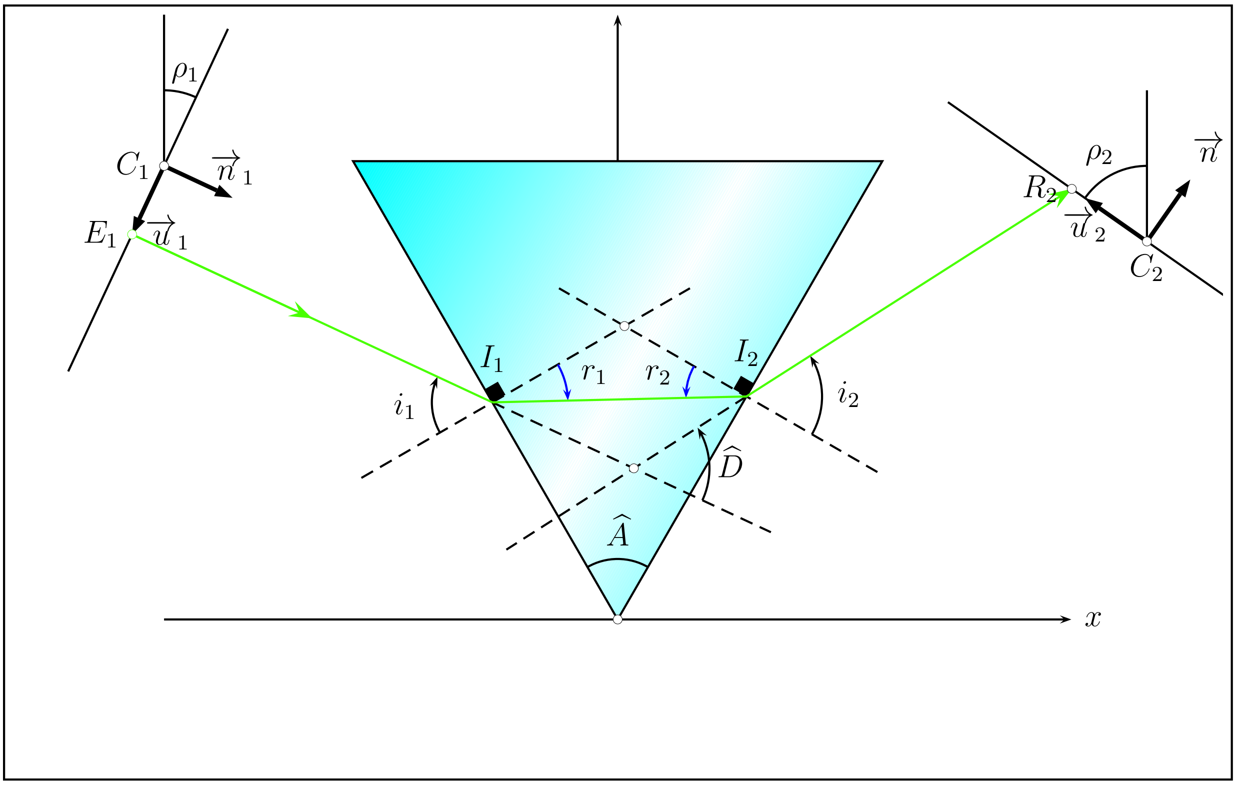
14 Figure with Default Values, without Construction Indications

```
\psframebox{%
  \begin{pspicture*}(-8,-2)(8,8)
    \psprism[notations=false]
  \end{pspicture*}}
```



15 Color matches Wavelength

```
\begin{pspicture*}(-7,-2)(7,8)
  \psprismColor[lambda=530]%
\end{pspicture*}
```



16 What is not Planned!

We have not planned physical impossibilities. When r_2 is greater than the limit angle, there is no transmission in air, and it's impossible to calculate i_2. Then, we have a PostScript message:

```
Displaying page 1
Displaying page 2
Displaying page 3
Displaying page 4
Error: /rangecheck in --sqrt--
Operand stack:
   alpha2   -1.02701   -0.0547467
```

We remind you that `alpha2` is i_2.

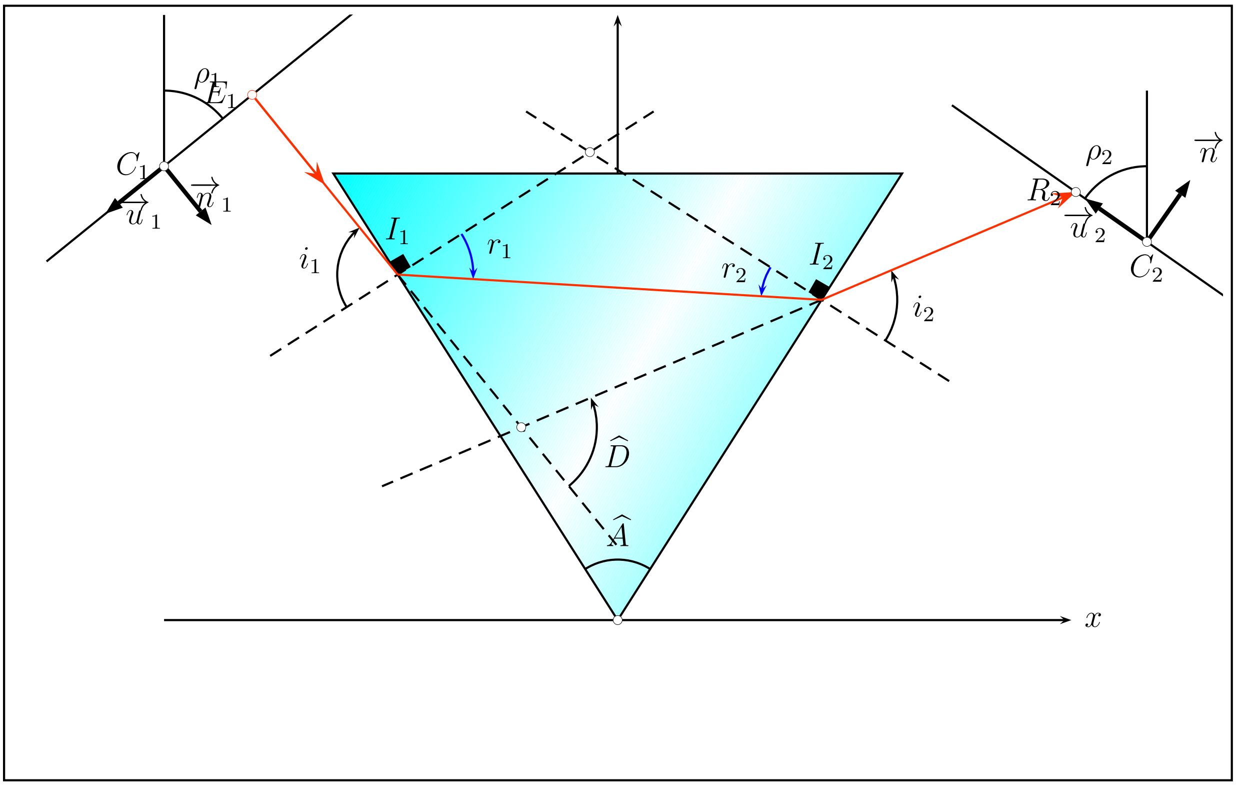
For instance, `AnglePrism=65`, other default parameters remains unchanged.

```
\psframebox{%
```

```
  \begin{pspicture*}(-7,-2)(7,8)
    \psprism[AnglePrism=65]
  \end{pspicture*}}
```

It will become right when we change the incident ray slope:

```
\psframebox{%
  \begin{pspicture*}(-7,-2)(7,8)
    \psprism[AnglePrism=65,AnglePlan1=51,k=-1.5]
  \end{pspicture*}}
```



We choose `k=-1.5` in order to have a incident ray which strikes (?) the input side roudly in its center. But, in these particular cases, the physicist know-how is important (*bis repetita*). Isn't it?

Part VI
Spherical Optic

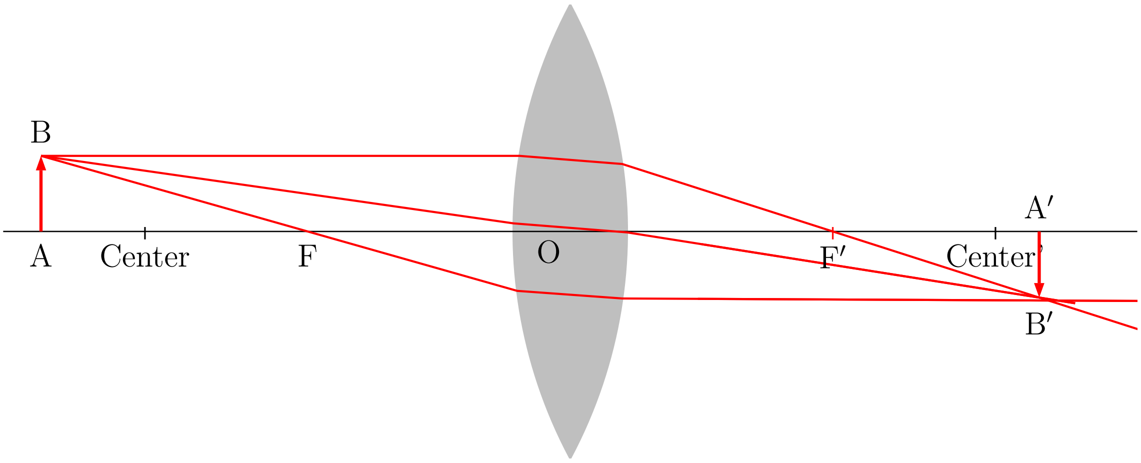
17 \lensSPH

17.1 Convergent Lens

The syntax is

```
   \lensSPH[<Options>]
\lensSPH[lensType=CVG,<Options>]
```

Without any option it draws a spherical convergent lens:



It changes some default values for the options to:

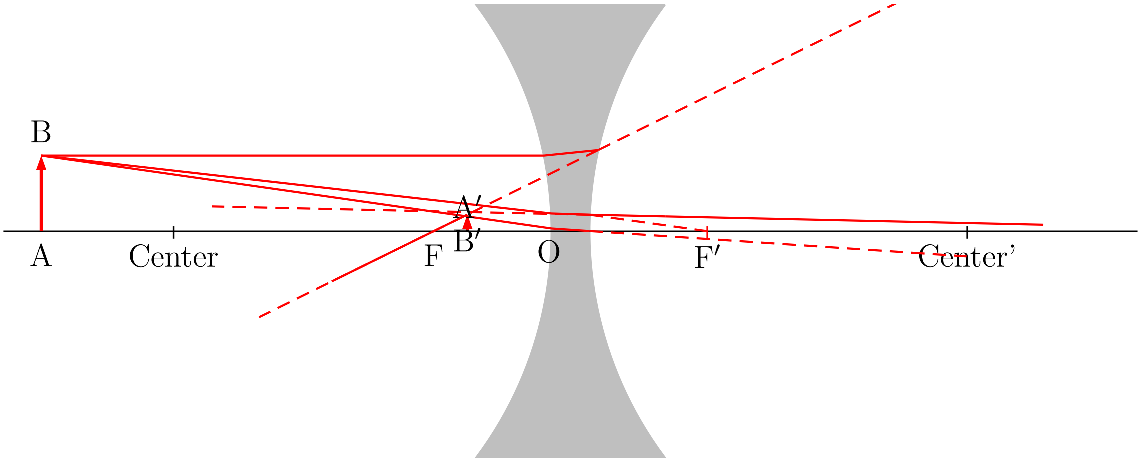
Meaning	Name	Default
Object Distance in cm	OA	-7
Lens Height in cm	lensHeight	6
Lens Width in cm	lensWidth	1.5
Refraction Number n_2	refractB	2

17.2 Divergent Lens

The syntax is

```
\lensSPH[lensType=DVG,<Options>]
```

It draws a spherical divergent lens:



It changes some default values for the options in the same way as for the convergent lens.

17.3 Options

The macro uses the law of Snell

$$\frac{n_1}{n_2} = \frac{\sin\beta}{\sin\alpha} \tag{6}$$

where the n_1 and n_2 are the refraction numbers with the predefined values

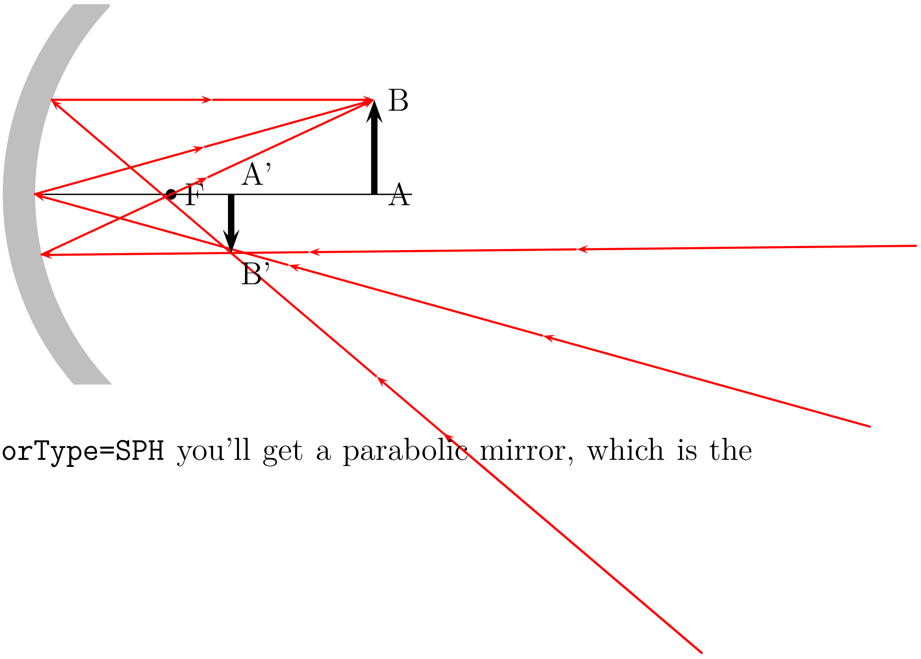
$$n_1 = 1 \tag{7}$$
$$n_2 = 1.41 \tag{8}$$

and α the incoming abd β the outgoing angle of the ray.
The refractionnumbers have the internal names `refractA` and `refractB`.

18 `\mirrorCVG`

The syntax is

```
\mirrorCVG[mirrorType=SPH]
```

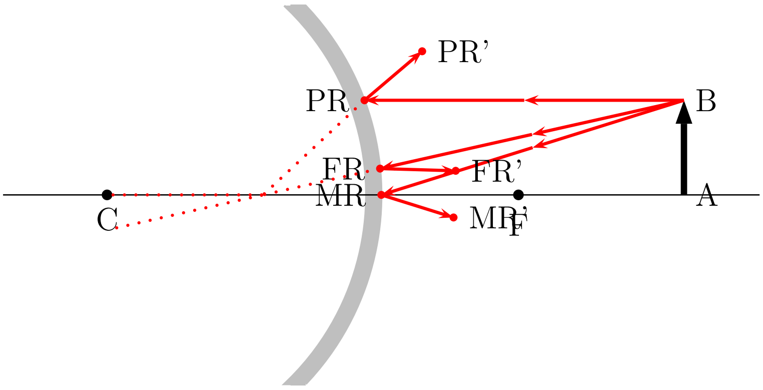


Without the option `mirrorType=SPH` you'll get a parabolic mirror, which is the default.

19 `\mirrorDVG`

The syntax is

```
\mirrorDVG[mirrorType=SPH]
```

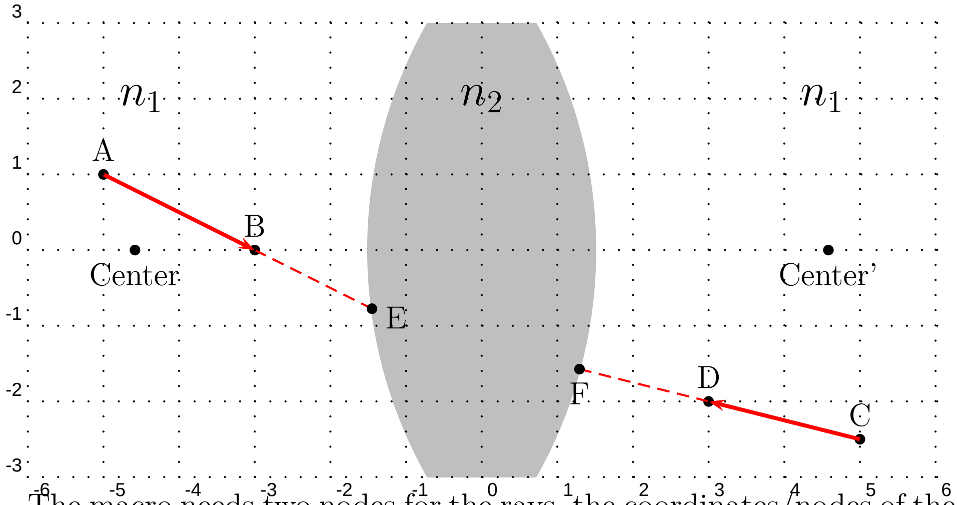


Without the option `mirrorType=SPH` you'll get a parabolic mirror (option PARA).

20 `\ABinterSPHLens`

The syntax is

```
\ABinterSPHLens(A)(B)(Center){NodeName}
```



The macro needs two nodes for the rays, the coordinates/nodes of the center/middle of the sperical lens and a name of the intermediate node.In the figure the macro was called as

```
\ABinterSPHLens(A)(B)(Center'){E} \ABinterSPHLens(C)(D)(Center){F}
```

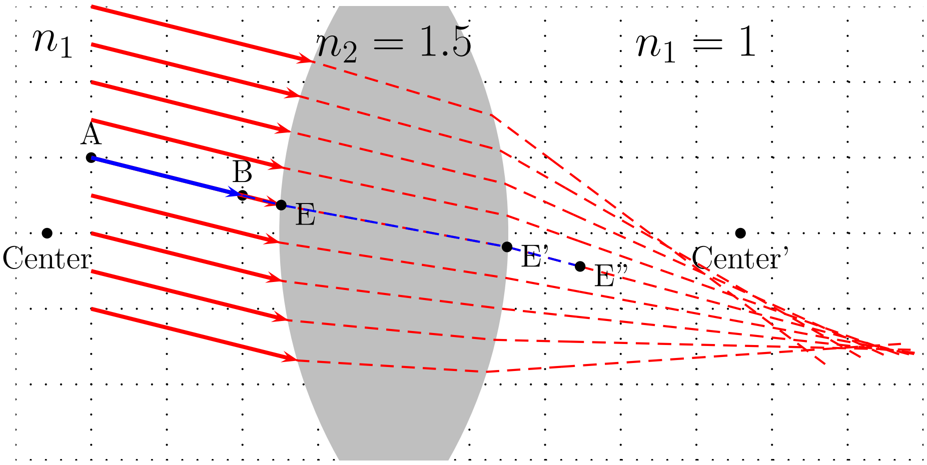
21 `\lensSPHRay`

The syntax is

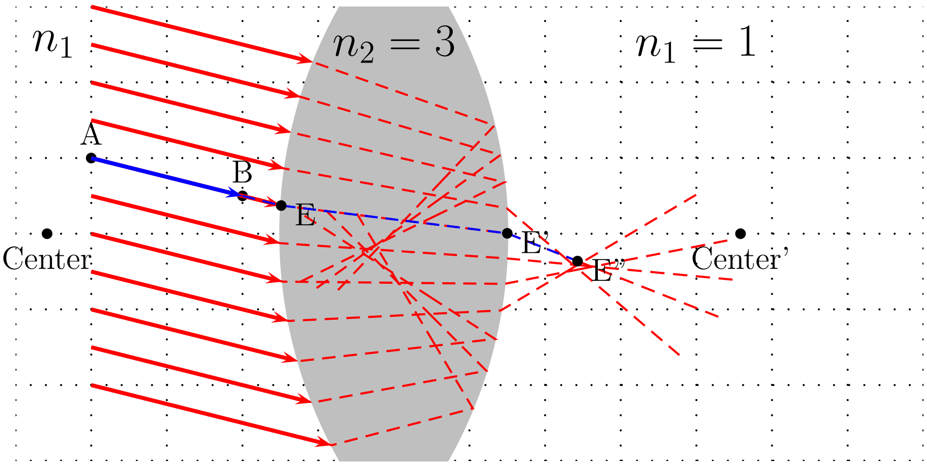
```
\lensSPHRay[Option](A)(B){refractA}{refractB}{NodeName}
```

This macro calculates the coordinates of the given ray $\overline{\mathrm{AB}}$ on its way into the lens. The only possible option `ightRay=false|tue`*[2] enables rays from the right to the left. There are still some problems with this option but try it out.

[2] Default is `false`



And the same with $n_2 = 3$:

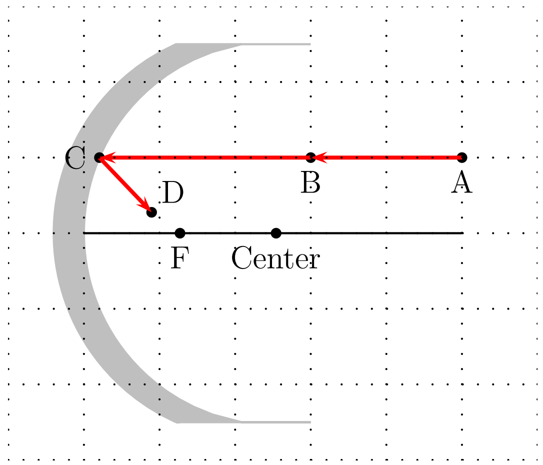


22 `\reflectionRay`

The syntax is

```
\reflectionRay[Option](A)(B){NodeName}
```

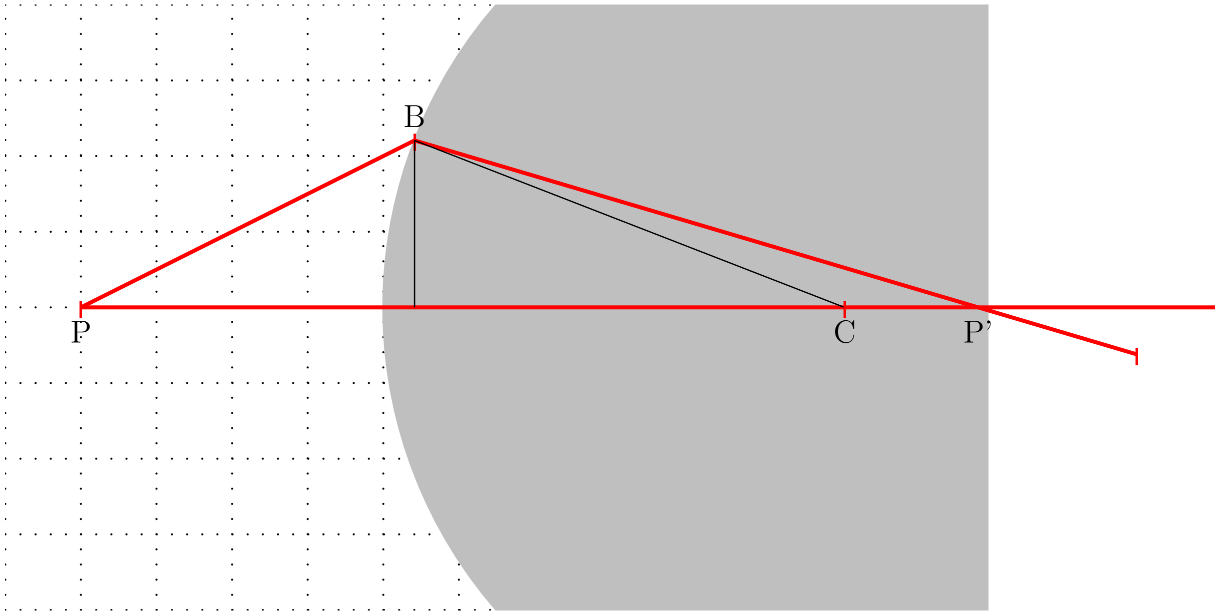
This macro calculates the coordinates of the given ray $\overline{\mathrm{AB}}$ on its way out of the mirror. The only senseful option is `mirrorType=CVG|DVG`. The most important fact is that the point `B` must be the one on the mirror. If you do not know it's coordinates you can use the macro `ABinterSPHLens[lensType=CVG](A1)(A2)(Center){NodeName}`, which calculates the coordinates of the intermediate point.



```
\begin{pspicture*}(-1,-3)(6,3)
  \rput(0,0){%
    \mirrorCVG[%
        mirrorType=SPH,%
        mirrorHeight=5, mirrorWidth=0.2,%
        yBottom=-3,yTop=3,drawing=false,%
        mirrorDepth=3]%
    \qdisk(Center){2pt}\qdisk(Focus){2pt}
    \uput[-90](Center){Center}\uput[-90](Focus){F}
    \psline(O)(xRight)
  }
  \ABinterSPHLens(5,1)(3,1)(Center){C}
  \reflectionRay[mirrorType=CVG-SPH](5,1)(C){D}
  \qdisk(5,1){2pt}\uput[-90](5,1){A}
  \qdisk(3,1){2pt}\uput[-90](3,1){B}
  \qdisk(C){2pt}\uput[180](C){C}
  \qdisk(D){2pt}\uput[45](D){D}
  \psset{linewidth=1.5pt,linecolor=red,arrows=->}
  \psline(5,1)(3,1)
  \psline(3,1)(C)
  \psline(C)(D)
  \psgrid
\end{pspicture*}
```

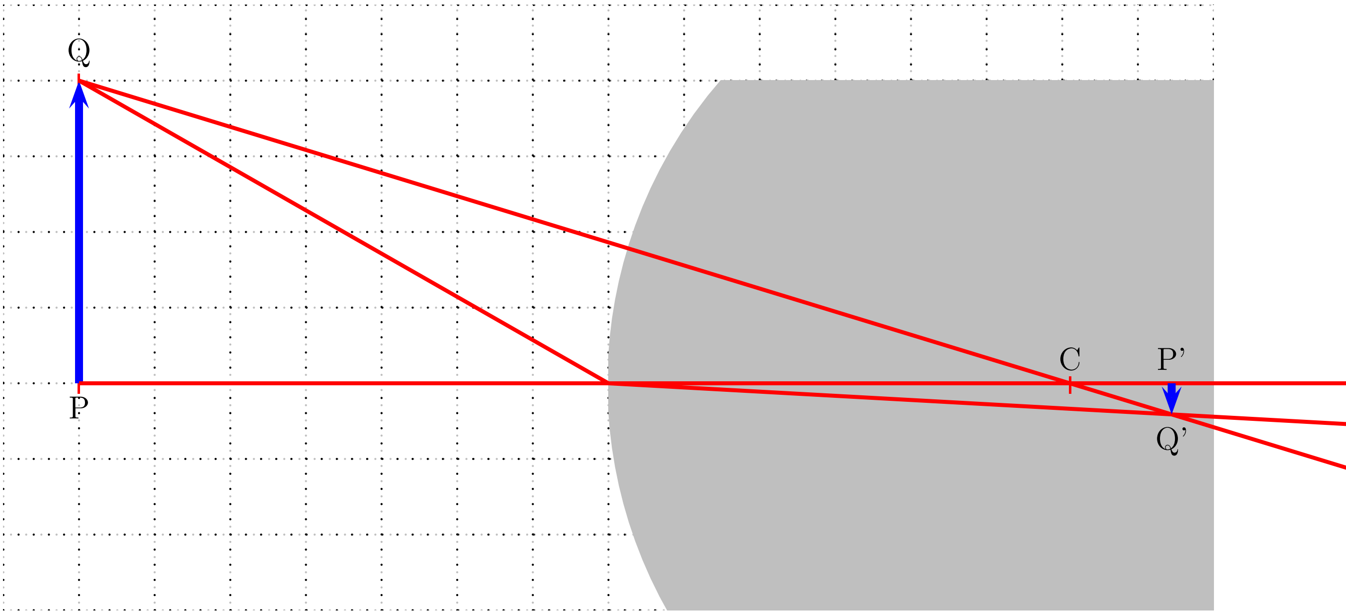
23 Refraction at a Spherical Surface

23.1 Construction for finding the position of the image point P' of a point object P formed by refraction at a sperical surface



```
\begin{pspicture}*(-10,-4)(3,4)
\psgrid[subgriddiv=0,griddots=5,gridlabels=7pt]
\rput(0,0){\lensSPH[%
  lensType=CVG,%
  lensHeight=12,lensWidth=10,%
  yBottom=-4,yTop=4,xLeft=-5,xRight=5,drawing=false]}
\psset{linecolor=red,linewidth=1.5pt,dotstyle=|}
\pnode(-9,0){P}\psdots(P)\uput[-90](P){P}
\psline(P)(xRight)
\lensSPHRay(P)(-5,2){1}{9}{Q}%
\psline(P)(Q)(Q')
\psdots(Q)\uput[90](Q){B}
\ABinterCD(Q)(Q')(0,0)(5,0){P'}
\psdots(Q')\uput[-90](P'){P'}
\psline[linewidth=0.5pt,linecolor=black](Center')(Q)
\psline[linewidth=0.5pt,linecolor=black](Q)(Q|0,0)
\psdots(Center')\uput[-90](Center'){C}
\end{pspicture}
```

23.2 Construction for determining the height of an image formed by refraction at a sperical surface



```
\begin{pspicture*}[showgrid=true](-13,-3)(3,5)
\rput(0,0){\lensSPH[%
  lensType=CVG,%
  lensHeight=12,lensWidth=10,%
  yBottom=-4,yTop=4,xLeft=-5,xRight=5,drawing=false]}
\psset{linecolor=red,linewidth=1.5pt,dotstyle=|}
\pnode(-12,0){P}\psdots(P)\uput[-90](P){P}
\pnode(-12,4){Q}\psdots(Q)\uput[90](Q){Q}
\psline[linecolor=blue,linewidth=3pt,arrows=->](P)(Q)
\psline(P)(xRight)
\lensSPHRay(Q)(Center'){1}{9}{S1}%
\lensSPHRay(Q)(-5,0){1}{9}{S2}%
\psline(Q)(S1')
\psline(Q)(S2)(S2')
\ABinterCD(Q)(S1')(S2)(S2'){Q'}
\pnode(Q'|0,0){P'}
\psline[linecolor=blue,linewidth=3pt,arrows=->](P')(Q')
\uput[90](P'){P'}
\uput[-90](Q'){Q'}
\psdots(Center')\uput[90](Center'){C}
\end{pspicture*}
```

Part VII
Utility Macros

24 \eye

Syntax:

`\eye`

There are no Options for this symbol of an human eye (figure 17).

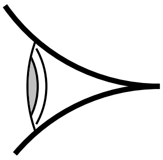


Figure 17: The `\eye`-Macro

Use the `\rput`-macro to put the eye elsewhere:

```
\begin{pspicture}(-1,-0.75)(1,0.75)
  \rput(1,0){\eye}
\end{pspicture}
```

25 \Arrows

Syntax:

`\Arrows[Options](NodeA)(NodeB)`

Option	Name	Standard
Offset for arrow start in cm	posStart	0
Length of the arrow in cm	length	2

Table 5: Options for the `Arrows`-Macro

The code for figure 18:

```
\Arrows[posStart=2,length=4](-3,-3)(3,3)
\Arrows[linewidth=3pt,length=2](0,-3)(0,0.5)
\Arrows[linewidth=5pt,linestyle=dashed](3,0)(2,3)
\Arrows[posStart=1,linewidth=5pt,linestyle=dotted,length=4](-3,2)(1,2)
```

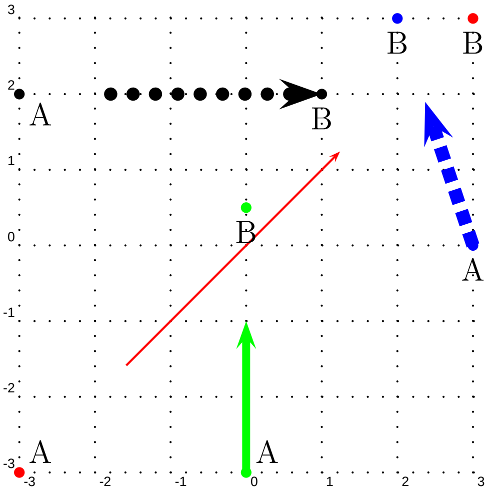


Figure 18: Arrows Demo

26 \psOutLine

Syntax:

`\psOutLine[Options](NodeA)(NodeB){EndNode}`

The only special option is `length=<avlue>`. All other which are possible for `\psline` can be used, too.

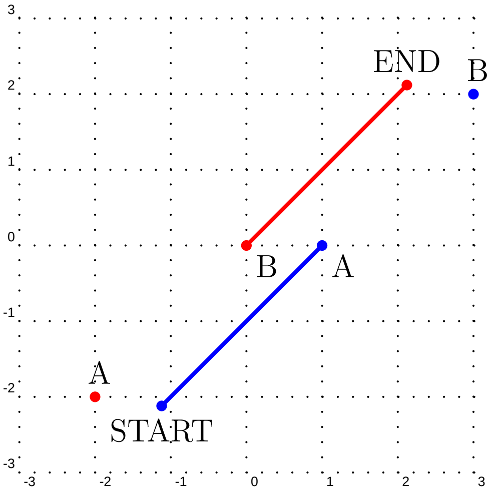


Figure 19: psOutLine and psBeforeLine Demo

The code for figure 19:

```
\psOutLine[length=3](-2,-2)(0,0){End}
```

27 \psBeforeLine

Syntax:

`\psBeforeLine[Options](NodeA)(NodeB){StartNode}`

The only special option is `length=<value>`. All other which are possible for `\psline` can be used, too.

The code for figure 19:

```
\psBeforeLine[length=3](0,0)(2,2){START}
```

28 \Parallel

Syntax:

`\Parallel[Options](NodeA)(NodeB)(Start node){End node}`

The only special option for `Parallel` is `length=<value>`. The nodes `nodeA` and `nodeB` are known nodes of a given line and `Start node` is the given node of a parallel line. `End node` is the name of the calculated line end. The use of `Parallel` is shown for an example (figure 20).

```
\begin{pspicture*}[showgrid=true](-5,-3.5)(5,3.5)
\pnode(2,-2){FF}\qdisk(FF){1.5pt}
\pnode(-5,5){A}
\pnode(0,0){O}
\multido{\nCountA=-2.4+0.4}{9}{%
  \Parallel[linecolor=red,length=9](O)(A)(0,\nCountA){P1}
  \psline[linecolor=red](0,\nCountA)(FF)
  \psOutLine[linecolor=red,length=9](0,\nCountA)(FF){P2}
}
\psline[linecolor=blue](A)(FF)
\psOutLine[linecolor=blue,length=5](A)(FF){END1}
\rput(0,0){%
  \lens[yBottom=-3.5,yTop=3.5,lensGlass=true,%
    lensHeight=6.5,drawing=false,spotFi=315,lensWidth=0.5]%
  \psline[linewidth=1pt](xLeft)(xRight)
  \psline[length=2,linewidth=2pt,arrows=->](F')(FF)
}
\end{pspicture*}
```

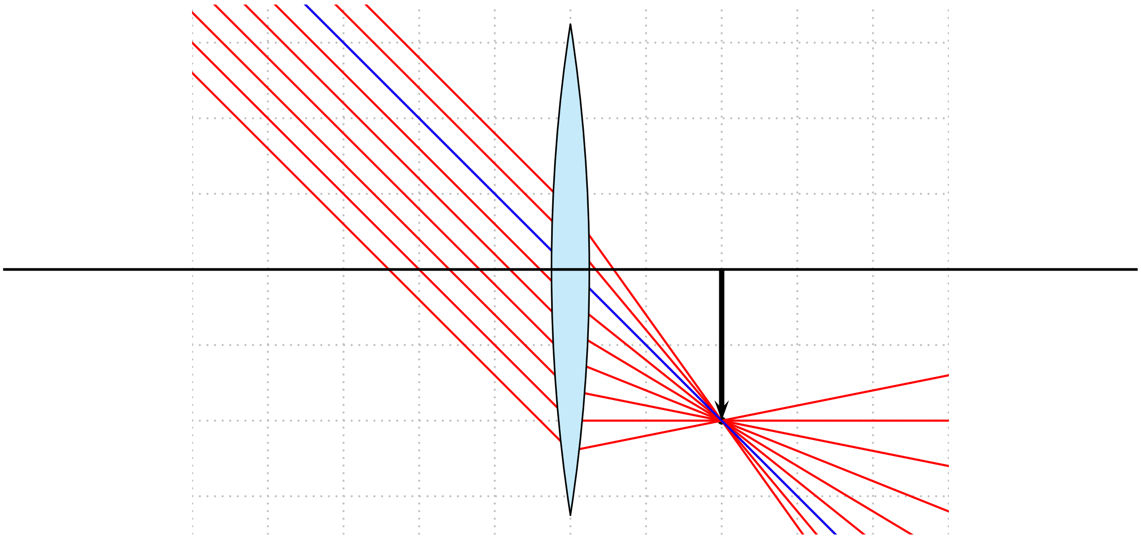


Figure 20: The `\Parallel`-Macro

29 `\ABinterCD`

This macro is used by the `\telescop` macro. It determines the intersection point of two lines, in this case a ray and the mirror axis. Figure 21 shows a part of figure 8. Given are the points A, B (focus), C/D (mirror axis). We need the point E to draw the other rays for the ocular, which can be done with the `\ABinterCD` macro. The syntax is:

```
\ABinterCD(A)(B)(C)(D){E}
```

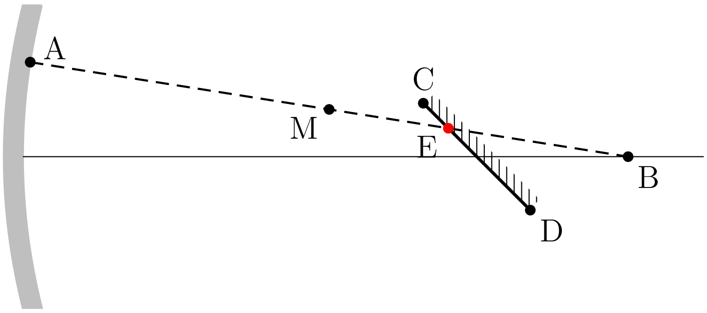


Figure 21: `\ABinterCD`-Makro

30 \nodeBetween

This macro determines the coordinates of the center of a line. The syntax is:
`\nodeBetween(A)(B){C}`

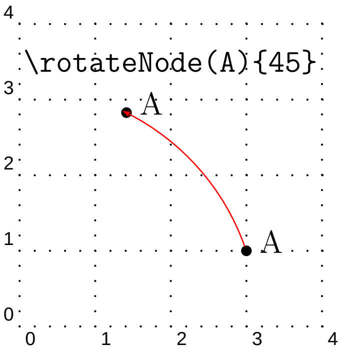
Figure 21 shows an example, where the node `M` was determined by the `\nodeBetween` macro.

31 \rotateNode

The syntax is

`\rotateNode{NodeName}{Degrees}`

The coordinates of the node `A` are changed to the new ones. Negative values are possible for rotating clockwise.



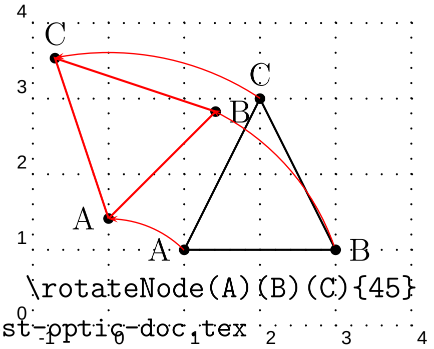
```
\begin{pspicture}(4,4)
\pnode(3,1){A}
\qdisk(A){2pt}\uput[20](A){A}
\rotateNode(A){45}
\qdisk(A){2pt}\uput[20](A){A}
\end{pspicture}
```

32 \rotateTriangle

The syntax is

`\rotateNode{NodeNameA}{NodeNameB}{NodeNameC}{Degrees}`

The coordinates of the nodes `A,B,C` are changed to the new ones. Negative values are possible for rotating clockwise.



```
\begin{pspicture}(-1,0)(4,4)
\pnode(1,1){A}
\pnode(3,1){B}
\pnode(2,3){C}
\qdisk(A){2pt}\uput[180](A){A}
\qdisk(B){2pt}\uput[0](B){B}
\qdisk(C){2pt}\uput[90](C){C}
```

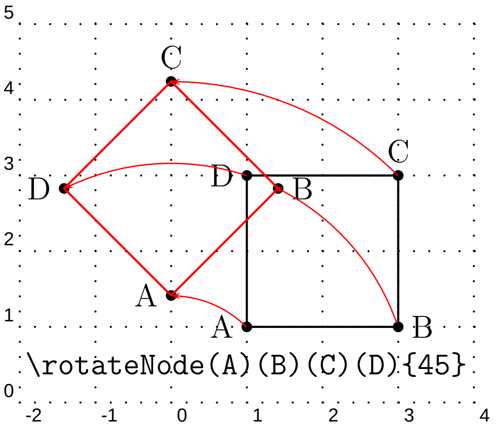
```
\psline(A)(B)(C)(A)
\rotateTriangle(A)(B)(C){45}
\qdisk(A){2pt}\uput[180](A){A}
\qdisk(B){2pt}\uput[0](B){B}
\qdisk(C){2pt}\uput[90](C){C}
\psline[linecolor=red](A)(B)(C)(A)
\end{pspicture}
```

33 \rotateFrame

The syntax is

`\rotateNode{NodeNameA}{NodeNameB}{NodeNameC}{NodeNameD}{Degrees}`

The coordinates of the nodes `A,B,C,D` are changed to the new ones. Negative values are possible for rotating clockwise.



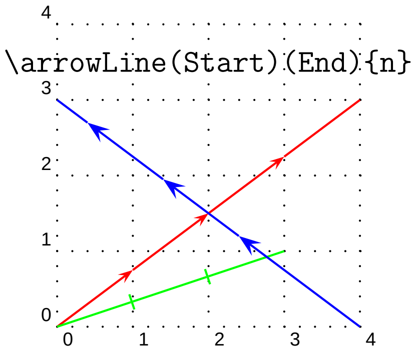
```
\begin{pspicture}(-2,0)(4,5)
\pnode(1,1){A}
\pnode(3,1){B}
\pnode(3,3){C}
\pnode(1,3){D}
\qdisk(A){2pt}\uput[180](A){A}
\qdisk(B){2pt}\uput[0](B){B}
\qdisk(C){2pt}\uput[90](C){C}
\qdisk(D){2pt}\uput[180](D){D}
\psline(A)(B)(C)(D)(A)
\rotateFrame(A)(B)(C)(D){45}
\qdisk(A){2pt}\uput[180](A){A}
\qdisk(B){2pt}\uput[0](B){B}
\qdisk(C){2pt}\uput[90](C){C}
\qdisk(D){2pt}\uput[180](D){D}
\psline[linecolor=red](A)(B)(C)(D)(A)
\end{pspicture}
```

34 \arrowLine

The syntax is

`\arrowLine[Options](Start)(End){ArrowNumber}`

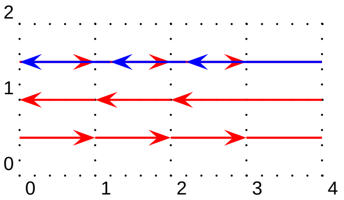
Draws a line from `Start` to `End` with `ArrowNumber` arrows inside.



```
\begin{pspicture}(4,4)
  \arrowLine[linecolor=red](0,0)(4,3){3}
  \arrowLine[linecolor=green,%
    arrowsize=6pt,arrows=-|](0,0)(3,1){2}
  \arrowLine[linecolor=blue,%
    arrowOffset=0.75,arrowsize=6pt](4,0)(0,3)
\end{pspicture}
```

34.1 Options

A special option is `arrowOffset`, which makes it possible to draw lines with different arrows. By default the arrows are placed symetrically. This can be moved by `arrowOffset`. Additionally all other valid options for pslines are possible her, too.



```
\begin{pspicture}(4,2)
\arrowLine[arrowsize=6pt,linecolor=red](0,0.5
\arrowLine[arrowsize=6pt,linecolor=red, arrow
\arrowLine[arrowsize=6pt,linecolor=red](0,1.5
\arrowLine[arrowsize=6pt,linecolor=blue,%
  arrows=<-,arrowOffset=0.2](0,1.5)(4,1.5){3}
\end{pspicture}
```

35 Credits

Jean-Come Charpentier | Aranud Schmittbuhl |

References

[1] Denis Girou and Manuel Luque. *PST-lens - PostScript macros for Generic TeX*. ftp://ftp.dante.de/tex-archive/graphics/pstricks/contrib/pst-lens/, 2001.

[2] Nikolai G. Kollock. *PostScript richtig eingesetzt: vom Konzept zum praktischen Einsatz*. IWT, Vaterstetten, 1989.

[3] Manuel Luque. *Lentilles convergentes: PST-optic v. 0.2*. http://members.aol.com/ManuelLuque2/optique.htm, 2001.

[4] Herbert Voss. *PSTricks Support for pdf*. http://PSTricks.tug.org, 2002.

[5] Michael Wiedmann and Peter Karp. *References for TeX and Friends*. http://www.miwie.org/tex-refs/, 2003.

[6] Timothy Van Zandt. *PSTricks - PostScript macros for Generic TeX*. http://www.tug.org/application/PSTricks, 1993.