

PP3

typesetting beautiful celestial maps
version 1.3.2



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This manual is for PP3 (version 1.3.2), which is a celestial charts drawing tool.

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1 Introduction

1.1 What it is

There are many programs that can create stellar maps. But none of them reaches PP3's typographic and graphical quality. In contrast to other programs PP3 produces vector images (e.g. PDFs) rather than mere bitmaps. Therefore it is perfectly suited for creating illustrations for books or other print media. But even converted to bitmaps for web pages, it exceeds usual quality.

PP3 is optimised for the semi-automatic generation of large sets of sky maps. It has decent default behaviour, however it can be customised very flexibly. It tries to take as much fine-tuning work away from you as possible.

1.2 What it is not

But I must also point out what PP3 is *not*. It cannot help you to professionally prepare your next observation night, nor is PP3 a visualisation tool for astronomical databases, with pop-up window information for every sky object on the screen.

In fact, PP3 not even has a graphical user interface. So don't expect any windows at all, and your mouse will be useless. Instead, PP3 reads from one file and writes to another file. (This is done not only because its author was lazy but because it increases efficiency, too.) So, the program itself is quite stunted, but its results are worth it!

1.3 Online resources

Further information about PP3 beyond this manual and downloads on the Internet:

<http://pp3.sourceforge.net>

PP3's homepage.

<http://sourceforge.net/projects/pp3>

PP3's project page with quick links to downloads.

[Download area](#)

List of all downloadable files, also for older versions.

[Bug data base](#)

Here you can see open bugs, make comments, and report new bugs that you've found.

[Discussion forums](#)

Ask questions about PP3 here.

[Feature requests](#)

Suggest new features and improvements here.

Please login when you use one of the services on Sourceforge. It makes responding easier.

1.4 Successful use of PP3

PP3 has been used in real life already and has proven its helpfulness.

Wikipedia

PP3 has created the celestial maps of all 88 constellations on [Wikipedia](#), the free encyclopedia. Feel free to browse through a [list of all constellations](#).

This is a web page, so you need bitmaps¹, and a short [Gimp](#) script² helped me to convert PP3's EPS vector output to PNG bitmaps. Additionally, this script creates smaller thumbnail version for all charts that exceed a certain width.

The result is that one can create all maps plus their thumbnails with one simple command call:

```
make
```

Surely it can't become simpler. You may retort "Well, but creating the maps must have been the actual work". Of course it was, but first it took only 10–15 minutes per map, because much work is done by the default behaviour of PP3 itself. And secondly:

French Wikipedia

Several months later the [French division of Wikipedia](#) wanted to translate the maps to French. They wanted another background colour and French labels and constellation names. They provided me with a translation table. It took me three hours to adjust the scripts, to run 'make' again, and to upload the ZIP file with all the demanded bitmaps. See for example the [Scorpius entry](#).

h2g2

Originally PP3 was written for a project on [h2g2](#), an *edited* Internet encyclopedia. Unfortunately the BBC editors wanted very small bitmaps that would not have been helpful, and they were too lazy to include all the 88 bitmaps. So the project died, but on a smaller scale (for ten constellations or so), it indeed motivated authors to contribute articles about constellations. The maps were externally linked.

¹ as long as we don't have SVG

² which is included into the distribution

2 Installation

You can get the latest PP3 file releases from [PP3's project page on Sourceforge](#). The main PP3 distribution comes as several files, namely

`'pp3-version-win.zip'`
is the complete Windows distribution.

`'pp3-version-1tb.i386.rpm'`
is the complete Linux RPM distribution. (There is also the corresponding source RPM called `'pp3-version-1tb.src.rpm'`.)

`'pp3-version.tar.bz2'`
is the complete source distribution.

`'pp3-version-cripple.tar.gz'`
is a partial source distribution. Milky Way, Nebulae, and the CWEB source code are omitted.

Obviously you need only *one* of these files.

2.1 Installation on Windows

Although PP3 runs independently of other programs, it is not useful when it's alone. It needs two external tools in order to work properly: \TeX and Ghostscript.

You need not know how to use \TeX and Ghostscript!

On most Unix/Linux systems \TeX and Ghostscript are already installed. But on Windows, you have to install them yourself. Fortunately this is not difficult, and both programs may be useful for other purposes, too.

2.1.1 Getting \TeX

\TeX is a mighty typesetter. PP3 calls \TeX in order to actually create the stellar map. The result is a Postscript file.

There are two major \TeX variants for Windows, namely [Mik \$\text{\TeX}\$](#) and [\$\text{\TeX}\$ Live](#). Both are rather similar in their functionality, and both come with a nice installation tool. Please assure that the PSTricks package as part of \TeX is installed, however this is highly probable anyway.

2.1.2 Getting Ghostscript

The best tool for dealing with Postscript files is [Ghostscript](#). In particular, if you've installed Ghostscript, PP3 is able to generate PDF files for you. It is wise (although not necessary) to install [GSView](#), too. It lets you view arbitrary Postscript files on screen.

2.1.3 Installation of PP3 itself

When \TeX and Ghostscript are in the right place, you finish the installation by unpacking the PP3 ZIP file and copying its content in the proper directories:

1. Copy `'pp3.exe'` to an arbitrary directory that is in your PATH.
2. Copy all the other files to *one single* arbitrary directory. Then set the environment variable PP3DATA to this directory.

For the sake of simplicity, I recommend to copy everything to ‘C:\Programs\pp3’ and to set your PATH environment variable to

```
old PATH;C:\Programs\pp3
```

and to set the PP3DATA environment variable to ‘C:\Programs\pp3’. That’s it.

2.2 Installation on Linux

Before you install PP3, ensure that \TeX and Ghostscript are installed.

2.2.1 RPM installation

You should consider to use the RPM file, because it is the simplest installation. It works for SuSE Linux and probably also for Red Hat. Just enter (as root)

```
rpm -i RPM-file-name
```

That’s it.

2.2.2 Building from sources

(Actually you can compile the sources on Windows, too (of course), but since most people who do compile are Linux users, I dare to put it in the Linux section.)

PP3 is written in CWEB. This is special form of C++ and can be transformed to real C++ trivially. You only need the **CWEB programs** installed. For your convenience the C++ code of PP3 is included into the source distribution, so you need CWEB only if you want to modify the program.

There is no ‘configure’ script. Just call **make** and (as root) **make install**. Before that, you may want to adjust some paths in the ‘Makefile’.

PP3 looks for its data files (all files with the ‘.dat’ extension) in a special directory that is pre-compiled in the executable. The Makefile assures that this is the correct one, but you can override that at runtime with the environment variable PP3DATA.

2.3 Increase \TeX ’s memory

There is exactly one object that can need a lot of memory: the Milky Way. Therefore it’s switched off by default. But if you want to see the Milky Way on your maps, you probably should set the main memory size of your \TeX distribution to its maximal value. This is very implementation specific. With te\TeX (Linux) you have to find the file ‘texmf.cnf’ and set ‘main_memory.latex’ to 7500000. Then call (as root)

```
fmtutil --byfmt latex
```

With fp\TeX / \TeX Live (Windows) it’s the same.

Mik\TeX however (Windows too) is different. Look for a directory called ‘localtexmf’. Then create the file¹ ‘localtexmf\miktex\config\miktex.ini’ and write

```
mem_max=7500000
```

in it.

Alternatively (albeit not cleanly), look for an existing file called ‘miktex.ini’ and change the line with **mem_max** to the above.

¹ It may be necessary to create the sub directories, too.

These are the most common T_EX variants. For others please have a look in the manual of your T_EX distribution for definitive information.

3 Basic astronomical terms

The following is a mere crash course. It is supposed to enable you to use PP3 even if you didn't know how astronomers describe the sky.

Readers competent in astronomy may skip it, although [Section 3.3 \[Constellations\]](#), [page 7](#) and [Section 3.4 \[Catalogues\]](#), [page 8](#) contain minor program peculiarities, too.

3.1 Celestial coordinate system

On a sheet of paper, every point has an x and a y coordinate. On planet Earth, every location has a *longitude* and a *latitude*.

With a very similar system astronomers give the coordinates of every point in the sky. The sky longitude is called *rectascension* and the sky latitude is called *declination*. There is a sky North Pole (near the Polar Star), a sky South Pole, and a sky equator. You can make globes of the sky like of the Earth, with the only difference that you must imagine being *inside* the globe.

So, in a way, the rectascension is the x coordinate. It is given in 'hours' (h) from 0 h to 24 h. Since the sky is circular, both 0 h and 24 h are the same rectascension, and 12 h is the opposite to it.

Usually the fraction of the rectascension that is smaller than 1 h is given in minutes and seconds, however in PP3 the rectascension is one decimal fraction number.

The declination corresponds to the y coordinate. It is measured from -90° (South Pole) over 0° (equator) to $+90^\circ$ (North Pole).

3.2 The system of magnitudes

Theoretically you could measure the brightness of stars in candela like the brightness of a light bulb. But this is rather awkward. Instead, astronomers use the system of *magnitudes* (m).

The brighter a star, the smaller is its magnitude. Sirius is the brightest star in the sky, and its brightness is -1.6 m. Vega has a brightness of 0.0 m, and Polaris, the Pole Star, of 2.0 m. The faintest stars that you can see with the naked eye in a very clear sky have 6 m.

The faintest stars in the standard catalogue of PP3 are of approx. 7 m, however extremely good terrestrial telescopes can see up to 22 m.

3.3 Constellations

Since the 1930s, the sky is officially divided into 88 constellations. At that time, the boundaries between the constellations were clearly defined, too: namely by the coordinates of sky points that, when connected with their respective neighbours, create the boundaries.

Every constellation has a Latin name and a three letter abbreviation. For example "Orion – Ori", or "Ursa Major – UMa" (Great Bear), or "Hydrus – Hyi" (Male Water Snake). This abbreviation plays a big role in PP3 because it's the only way to denote a constellation. You must use only uppercase letters in the abbreviation: 'ORI', 'UMA', 'HYI'.

One constellation, the snake or "Serpens", is divided into two parts, "Serpens Caput" (Head) and "Serpens Cauda" (Tail). They are abbreviated SER1 and SER2 in PP3. If you say SER only, you mean both parts.

3.4 Catalogues: Flamsteed, Henry Draper, NGC/IC and Messier

When you use PP3 you have to tell the program e.g. which star you want to delete from the map or which nebula shall get a different label. For this, every sky object must have a distinct name in PP3.

By and large there are two kinds of objects in the sky: stars and nebulae. Astronomers have created many catalogues of them. There are two star catalogues and three nebulae catalogues supported in PP3.

3.4.1 Denoting stars

The two star catalogues are the Flamsteed and the Henry Draper (HD) numbers. Flamsteed gave numbers beginning with ‘1’ to stars in each constellation. The Flamsteed catalogue is small and doesn’t contain the complete southern sky. In contrast to that, the HD catalogue doesn’t distinguish between constellations, it covers the whole sky, and also contains faint stars. However the HD names are harder to read.

For example Rigel, β Ori, can be identified in PP3 with either

ORI 19

where ‘ORI’ is Rigel’s constellation (Orion) and ‘19’ the Flamsteed number; or with

HD 34085

where ‘34085’ is Rigel’s Henry Draper catalogue number. Both are totally equivalent. The free program [Celestia](#) is very useful for finding Flamsteed or HD numbers.

3.4.2 Denoting nebulae

The two nebula catalogues NGC and IC are complementary, i.e. they don’t have¹ any nebulae in common. For example, the North America Nebula is called ‘NGC 7000’ and the Orion Nebula is ‘NGC 1976’. The IC catalogue usually contains fainter objects.

Parallel to that there is the much older and much smaller Messier catalogue, abbreviated ‘M’. For example, the Orion Nebula can also be called ‘M 42’, whereas the North America Nebula isn’t included in Messier’s catalogue.

Pay attention to

- the catalogue abbreviation in all uppercase and
- the space between the catalogue abbreviation and the number.

¹ well, shouldn’t have

4 Usage

4.1 Starting PP3

Invoking PP3 is very straightforward. Since it is a command line program you only have to call it somehow and give a so-called input script as the parameter, see [Chapter 5 \[Input scripts\]](#), page 11. For example, entering

```
pp3 orion.pp3
```

on the command line starts PP3 and lets it generate the file ‘`orion.pdf`’, which is a PDF file with a star map of Orion. You can view this PDF with Acrobat Viewer, convert it to a bitmap, or you can embed it into a text of yours.

Actually there are three possible output formats. By default, PP3 generates a \LaTeX file in the current directory. But most people cannot do much with it, therefore certain commands in the input script trigger EPS or PDF output, see [Section 6.2.1.2 \[Output control\]](#), page 21.

PP3 can’t generate bitmaps. If you need bitmaps you must use an appropriate program (e. g. GSView or the [Gimp](#)) for converting the vector data to bitmaps.

4.2 Using pipes

Especially on Unix it is very common to read from standard input and to write to standard output. I don’t think that this is sensible for PP3, but anyway, I included this facility. If you give ‘-’ as the only parameter, PP3 reads the input script from standard input, and if you don’t give an output filename in the input script (see [Chapter 5 \[Input scripts\]](#), page 11), PP3 writes to standard output.

Input scripts are the most important part of PP3, at least for the user. They contain some sort of wishlist about the map that you want PP3 to create.

The minimal PP3 input script is – well – the empty file. Then PP3’s default values create a dark blue star map of Orion:



```
filename output swan.tex
switch pdf_output on

set center_rectascension 19.95
set center_declination 40.8
```

pp3 swan.pp3

The lines of ‘`swan.pp3`’ are not difficult to explain: The very first line is a comment. Everything that starts with a `#` is a comment. You can write descriptive text in them to make the file more readable.

The line

```
filename output swan.tex
```

makes PP3 write the generated map to the file ‘swan.tex’. But such a file is rarely the desired output. Therefore the next line

```
switch pdf_output on
```

tells PP3 that we want to have a PDF file. So PP3 does everything necessary for that. And finally,

```
set center_rectascension 19.95
set center_declination 40.8
```

denotes the area of the sky that we want to be displayed. Both values indicate the celestial point that we want to have in the centre of the map. In this case, 19.95 h rectascension and +40.8° declination which is the centre of the constellation Swan. See [Appendix C \[List of all constellations\]](#), page 43, for a complete list of all constellations, along with their coordinates and more.

5.2 More bells and wistles

Let’s continue with our Swan example of the previous section.

Normally the Milky Way is switched off, because it consumes a lot of memory, see [Section 2.3 \[Increase TeX’s memory\]](#), page 4. However it looks rather nice, so let’s switch it on:

```
switch milky_way on
```

Maybe you want to use the map in a book that is supposed to be printed in black and white. Then the current colour scheme is disadvantageous. The following lines redefine it:

```
color nebulae          0 0 0
color background       1 1 1
color grid             0.5 0.5 0.5
color ecliptic         0.3 0.3 0.3
color constellation_lines 0.7 0.7 0.7
color labels           0 0 0
color boundaries       0.8 0.8 0.8
color highlighted_boundaries 0 0 0
color milky_way        0.5 0.5 0.5
```

Colours are given as red–green–blue values, for further information see [Section 6.2.4.1 \[Colours\]](#), page 23. With these redefinitions, all elements on the map are printed either in black or in shades of grey.

A special problem are stars. With

```
color stars 0 0 0
```

stars are printed in black colour, one could think. But this is not always true. By default, stars get their ‘real’ colour according to their B–V brightness. For example, Saiph in Orion is a little bit blue, while Antares in Scorpius is known to be red. Therefore PP3 ignores any ‘color’ directive for stars, unless you also say

```
switch colored_stars off
```

Last but not least you should change the *highlighted constellation*. By default, it’s Orion. But we want to highlight the Swan, so we say

```
set constellation CYG
```

because “Cyg” is the astronomical abbreviation of the Swan (“Cygnus” in Latin). Highlighting means that its borderline gets another colour.

This is the map that results from all this (I removed the Milky Way from this figure in order to keep the PDF manual small):



5.3 Dimensions and scale

When you include a map in a text of yours, usually you can scale the graphics to fit your needs. The exact procedure depends on the program you use of course. Such additional scaling is helpful, but actually it should be superfluous since PP3 can deliver the map with the desired size.

The parameters

```
set box_width 10
set box_height 5
```

set the width of the map to 15 cm and the height to 10 cm. (By the way, all dimensions are given in centimetres in PP3.) The only thing that’s still missing is the scale of the map. It is set with

```
set grad_per_cm 6
```

which sets it to 6 degrees per centimetre. With the current projection method¹, the given scale is only exactly true for the centre of the map. Towards the rim there is a slight magnification (and distortion).

¹ the equidistant azimuthal projection

5.4 Parameters and Commands

Every PP3 file can contain *parameters* and *commands*. So far, we've had parameters only. Both types of keywords must be neatly separated in the input script. First come the parameters, then the special keyword

```
objects_and_labels
```

and then the commands. The purpose of the commands is adding and deleting objects and their labels, to reposition the labels, and to add arbitrary text on the map. You can also change the contents of automatically generated labels.

5.5 Labels

My personal experience is that the most difficult part of writing input scripts is to fiddle about with labels. Although PP3 does most of the labelling work on its own, it is not perfect (yet). Thus you will value the features described in this section.

Please note how the texts themselves must be given: Either they don't contain any spaces or line breaks. Then you can just enter them. But if they do contain such white space, you must enclose them with quotes "...". For example, you say

```
set_label_text HD 128620 Toliman
```

but

```
set_label_text HD 128620 "Rigil Kent"
```

If you (must) use quotes, and only then, you have to enter two symbols in a special way, namely the backslash '\ ' and the quotes '"':

```
set_label_text HD 128620 "\\footnotesize Toliman"
```

prints 'Toliman' with small letters, see [Section 7.1 \[LaTeX in labels\]](#), page 29. Quotes must be entered as '\ " '.

5.5.1 Changing label texts

I change the label for Deneb, the alpha star in the Swan. At the moment, its label is a simple ' α '. But Deneb has a real name, and with

```
set_label_text CYG 50 Deneb
```

I change the label text to "Deneb". This 'CYG 50' is the astronomical name for Deneb, see [Section 3.4.1 \[Denoting stars\]](#), page 8.

You can use that also for changing the label for a nebula:

```
set_label_text NGC 7000 "N. America Neb."
```

As said, please note that you have to enclose the label text in quotation marks if it contains spaces.

Now we get (only the changed part printed):



PP3 takes star names from a file. PP3's standard file contains only the astronomical symbols for the stars (Bayer's Greek letters and Flamsteed numbers), so if you want to have real star names, you must use `'set_text_label'` as above. Or you use another star data file with PP3, see [Section B.1 \[Stars data file\]](#), page 37.

5.5.2 Deleting and adding labels

PP3 decides which labels are printed on the map by itself. But, of course, you can configure this behaviour, and you can delete or add any label.

For example, the command

```
delete_labels NGC 884 NGC 869 TAU 27 ;
```

deletes the labels for the nebulae NGC 884 and NGC 869, and for the star 27 Tau from the map. The nebulae and the star themselves remain on it of course. Correspondingly,

```
add_labels CNC 65 CNC 47 CNC 43 CNC 48 ;
```

adds the currently set labels texts for the stars 65, 47, 43, and 48 Cnc. All of them are too faint to get their labels implicitly.

But you can also influence labels globally in the parameters section of the input script. If you don't want to have any labels at all, simply say

```
switch labels off
```

in the parameters section. Another parameter keyword is

```
set faintest_star_with_label_magnitude 2.0
```

which means that only stars of brightness of at least 2.0 m get an implicit (automatic) label.

5.5.3 Reposition labels

If you think that PP3 mispositioned a label you can change that with `'reposition'`:

```
reposition M 39 S ;
```

This puts the label for the nebula M39 *below* the nebula. 'S' means 'south'. The following table shows all possible values, however you know it by and large from the windrose probably:

- 'E' prints the label to the right.
- 'NE' prints the label to the upper right.

'N' prints the label to the top.
 'NW' prints the label to the upper left.
 'W' prints the label to the left.
 'SW' prints the label to the lower left.
 'S' prints the label to the bottom.
 'SE' prints the label to the lower right.

(See [The keyword 'towards'], page 16, for a figure visualising these abbreviations. But be careful since this figure is actually intended for the 'towards' keyword.)

Using 'reposition' is also necessary if PP3 has suppressed a label because it hadn't found a good place for it. 'reposition' forces a label to be printed.

5.5.4 Text labels

Changing existing labels is a nice thing to do, however sometimes you want to add arbitrary text on the map, e.g. 'Pleiades' or 'Virgo galaxy cluster'. For all user defined text there is the keyword 'text'. For example,

```
text "Virgo galaxy cluster" at 12.7 10
color 0.0 0.0 0.9333 towards SE ;
```

This places the text 'Virgo galaxy cluster' at the celestial coordinates 12.7 h rectascension and +10° declination in blue colour. See Section 6.2.4.1 [Colours], page 23, for how to denote colours in PP3.

The keyword 'towards'

In a text label, after the keyword 'towards', you can say in which direction, seen from the celestial coordinates given after the 'at' keyword, the label should be printed. The following figure illustrates the ten possible values after 'towards':



The red point marks the spot that lies *exactly* on the celestial coordinates given after the 'at' keyword.

The default value for ‘`towards`’ is NE, so if you don’t use ‘`towards`’, PP3 places the text label to the upper right. In particular, PP3 does not perform any algorithm for finding the best position for the label as it does with automatically generated labels.

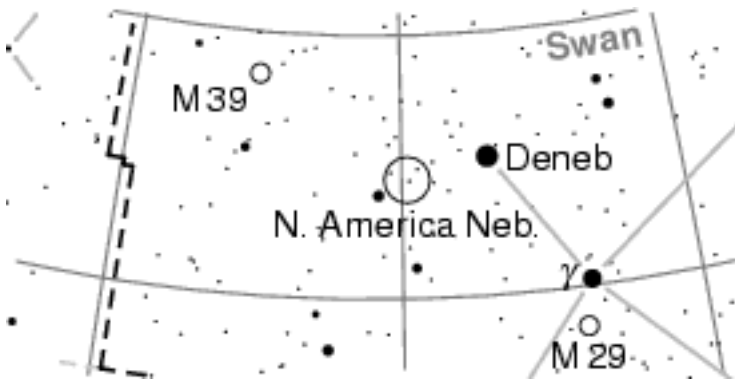
For some nice tricks with text labels and ‘`towards`’, see [Section 7.1 \[LaTeX in labels\]](#), [page 29](#).

5.5.5 Using flexes

But the ‘`text`’ keyword can do more. When you include the keywords ‘`along declination`’ the label becomes a *flex*. This is printed along a declination circle as a curved text. It’s especially nice for constellation names. So let’s try it out:

```
text "\\bfseries Swan" at 20.05 49.8 along declination towards SW ;
```

This ‘`\\bfseries`’ tells the typesetter to print it in **bold face**, see [Section 7.1 \[LaTeX in labels\]](#), [page 29](#). The result is the following:



5.5.6 Tic mark labels

But ‘`text`’ can do even more. With

```
text "$#3$" at 0 20 along declination
tics rectascension 1 towards N ;
text "$#5$" at 11 0 along declination
tics declination 10 towards S ;
```

you create automatic tic mark labels at the $+20^\circ$ declination circle and the 11 h rectascension circle. See [Section 6.3.3.2 \[Tic mark labels\]](#), [page 27](#), for more information about these placeholders like #3. Typically you will embed the placeholders in $\$ \dots \$$, because this tells the underlying T_EX typesetting engine to typeset the number as a formula. This makes it look nicer.

5.6 Deleting and adding stars and nebulae

Sometimes you have to remove stars or nebulae from the map, especially because they collide with other objects. If you’ve already read how to change labels, this is very straightforward. You remove sky objects with ‘`delete`’ and add them with ‘`add`’. Both commands take a list of objects that is ended with a semicolon ‘`;`’:

```
delete LEO 63 HD 97605 ;
add NGC 6992 ;
```

The ‘add’ command is useful mostly for nebulae, because by default, PP3 only includes all objects of the Messier catalogue, but only other objects with a minimal brightness, see [Section 6.2.3 \[Filtering by brightness\]](#), page 22.

5.7 Penalty scheme

It is a tricky task to place labels on a dotted star map without creating too many overlaps, and especially overlaps with other labels are very annoying. Therefore PP3 tries to avoid that.

It does so by using a penalty algorithm: It tests the eight windrose positions around the respective object, and calculates the resulting overlaps for each position. The overlaps are counted as *penalties*. The position with the smallest penalty value is chosen. In very bad cases when the penalties exceed a certain threshold, the label is not printed at all.

All of this can be overruled by the user, but normally the standard behaviour is good enough. So read this section only if you are really keen to know how it works.

5.7.1 Basics about penalties

PP3 calculates overlaps with all objects on the map: stars, nebulae, constellation lines, boundary lines, and – last but not least – other labels. All overlaps are weighted, and their sum is the penalty value. You can influence the weighting. By default, it’s ‘1000’ for all objects. But with

```
penalties stars 2000
```

you double the significance of stars. Thus you make overlaps of labels with stars less probable. In contrast,

```
penalties boundaries 0
```

tells PP3 that printing a label on a boundary line isn’t bad at all.²

5.7.2 The rim

Each label has a *core area*, which is the text area itself, and a *rim*, which is an area around the text area. Both are rectangles, separated by a *skip* that is the same as the one that separates labels and their respective celestial object, see [Section 6.2.4.3 \[Other layout parameters\]](#), page 25.



PP3 takes both rim and core into account. The relative significance of the rim can be set with e.g.

```
penalties rim 2000
```

which doubles the default value of ‘1000’. With

² Avoid negative values, although PP3 doesn’t reject them. They wouldn’t make sense anyway.


```
penalties rim 0
```

the rim loses its effect completely. Notice that PP3 adds rim penalties also for the whole core area, so that the core is always more significant than the rim, no matter how you set the penalty values.

What’s the point in the rim? The core avoids overlaps, but the rim is supposed to make *approximations* of labels with other things on the map less probable.

You may have noticed that the rim overlaps with the object (star or nebula) itself. Usually this only adds some sort of bias to the penalty values of the diagonal positions, but this direct contact is particularly useful for double stars: There both components get “their” label on “their” side due to the small rim overlaps with the respectively other component.

5.7.3 Overlaps with line objects

“Line objects” means constellation lines and boundary lines. PP3 treats both of them in a special way: When they collide with the *rim* of a label, it’s less bad than for non-line objects. The reason is that lines are so different from labels visually, that it’s not fatal if they are rather close together.

The two new penalties that are used for the rim are ‘`constellation_lines_rim`’ and ‘`boundaries_rim`’. Their default value is ‘1000’ as usual. For example, with

```
penalties boundaries_rim 0
```

you tell PP3 that a label directly next to a boundary line is totally okay for you.

5.7.4 Penalty threshold

Sometimes a certain region of the map is so much crowded with stars, nebulae, labels, and more, that there simply is no space left for yet another label. In this case the penalty value reaches a very high number. If it exceeds a given threshold, PP3 suppresses that label. You can still override this, see [Section 5.5.3 \[Reposition labels\], page 15](#).

You can set this threshold with

```
penalties threshold 3000
```

Again, ‘1000’ is the default value.

6 Keywords reference

On [PP3's project page](#) you can download a neat reference card. If you fold it twice it is a handy zigzag.

6.1 General structure

The outline of a PP3 input script is:

```
# Some introductory comments,
# i.e. what the file is about to do.

Section I: Parameters: Output format and global style.

objects_and_labels

Section II: Commands: Delete/add/modify objects and/or labels
```

6.2 Setting Parameters

All keyword here are *parameters*. This means that they are allowed only in the *first* part of an input script, i.e. before the `objects_and_labels` command (if there is one).

6.2.1 Essential parameters

6.2.1.1 Map view, scale, and size

```
set center_rectascension rectascension [Parameter]
set center_declination declination [Parameter]
    Set the rectascension and declination of the centre of the map to rectascension (in
    hours) and declination (in degrees) respectively.
    Defaults: 5.8 (rectascension), 0.0 (declination)

set box_width width [Parameter]
set box_height height [Parameter]
    Set the width and height of the resulting map to width and height (in centimetres)
    respectively.
    Defaults: 15 (width), 15 (height)

set grad_per_cm scale [Parameter]
    Set the scale of the resulting map to scale (in degrees per centimetre).
    Default: 4.0
```

6.2.1.2 Setting what file should be created

```
filename output filename [Parameter]
    The resulting map will be written to the file filename in LATEX format. It must have
    the file extension ‘.tex’. If filename is empty the map will be written to standard
    out.
    Default: "" (empty)
```

switch eps_output *on/off* [Parameter]
 If on, PP3 creates a PDF file. (Additionally to the L^AT_EX and EPS files that you then can ignore.)
 Default: off

switch pdf_output *on/off* [Parameter]
 If on, PP3 creates an EPS file. (Additionally to the L^AT_EX file that you then can ignore.)
 Default: off

6.2.1.3 The highlighted constellation

set constellation *abbreviation* [Parameter]
 Highlight the constellation that is given by *abbreviation* (given with all-uppercase letters). If you don't want to highlight anything, set it to "" or to an invalid abbreviation.
 At the moment, highlighting means that the boundaries of the respective constellation get another colour, see [Section 6.2.4.1 \[Colours\], page 23](#).
 Default: ORI

6.2.2 Switching things on or off

switch milky_way *on/off* [Parameter]
switch nebulae *on/off* [Parameter]
switch grid *on/off* [Parameter]
switch ecliptic *on/off* [Parameter]
switch boundaries *on/off* [Parameter]
switch constellation_lines *on/off* [Parameter]
switch labels *on/off* [Parameter]
 Print or don't print the respective (class of) object(s) on the map. 'Grid' means the coordinate grid, 'boundaries' are the borderlines of the constellations, and 'constellation lines' denote the lines between the brightest stars that are supposed to help to see the shape of a constellation.
 Defaults: off (Milky Way), on (all others)

switch colored_stars *on/off* [Parameter]
 If switched on, all stars get a colour that represents their real colour according to their spectral class. This may be unsuitable on a bright background since most stars are pretty white.
 If switched off, all stars get the colour given by 'color stars', see [Section 6.2.4.1 \[Colours\], page 23](#).
 Default: on

6.2.3 Filtering stars and nebulae by their brightness

set faintest_cluster_magnitude *magnitude* [Parameter]
 Don't print open star clusters that are fainter than *magnitude*.
 Default: 4.0

- set faintest_diffuse_nebula_magnitude** *magnitude* [Parameter]
 Don't print nebulae that are fainter than *magnitude*. In this case, 'nebulae' is meant in the narrower sense, i. e. no stellar clusters.
 Default: 8.0
- set faintest_star_magnitude** *magnitude* [Parameter]
 Don't print stars that are fainter than *magnitude*.
 Default: 7.0
- set faintest_star_with_label_magnitude** *magnitude* [Parameter]
 Only stars that have a brightness of at least *magnitude* get an automatically generated label.
 Default: 3.7
- set faintest_star_disk_magnitude** *magnitude* [Parameter]
 Only stars that have a brightness of at least *magnitude* will be printed as more than just dots.
 Default: 4.5
- set minimal_star_radius** *radius* [Parameter]
 Set the *radius* (in centimetres) of the dots that are used for the faintest stars.
 Default: 0.015

6.2.4 Colour, line style, and other layout

6.2.4.1 Colours

In PP3, colours are given by their red–green–blue values (also called the RGB colour scheme). Every value is between 0 and 1. For example, '1 0 0' is red, '0 0 1' is blue, '0 0 0' is black and '1 1 1' is white.

For shades of grey all three values must be the same. So a medium grey is '0.5 0.5 0.5'. For further examples have a look at the following default values.

- color background** *red green blue* [Parameter]
 Set the background colour of the map to the given colour.
 Default: 0 0 0.4 (dark blue)
- color grid** *red green blue* [Parameter]
 Set the coordinate grid colour to the given colour.
 Default: 0 0.298 0.447 (dark blue-grey)
- color ecliptic** *red green blue* [Parameter]
 Set the ecliptic line colour to the given colour.
 Default: 1 0 0 (red)
- color boundaries** *red green blue* [Parameter]
 Set the ordinary constellation boundaries colour to the given colour.
 Default: 0.5 0.5 0 (dark yellow)

`color highlighted_boundaries red green blue` [Parameter]

Set the highlighted constellation boundaries colour to the given colour. See [Section 6.2.1.3 \[Highlighted constellation\]](#), page 22.

Default: 1 1 0 (yellow)

`color constellation_lines red green blue` [Parameter]

Set the constellation lines colour to the given colour.

Default: 0 1 0 (green)

`color milky_way red green blue` [Parameter]

The Milky Way is printed in shades of different colour, representing its brightness. The darkest areas of the Milky Way get the background colour, and the brightest the colour that you give here.

The Milky way must be switched on of course in order to savour it, which is not the case by default, see [Section 6.2.2 \[Switching things on or off\]](#), page 22.

Default: 0 0 1 (blue)

`color nebulae red green blue` [Parameter]

Set the colour of the nebulae circles to the given colour.

Default: 1 1 1 (white)

`color stars red green blue` [Parameter]

Set the colour of all stars to the given colour. Please note that this only has effect if the switch ‘colored_stars’ is off, see [Section 6.2.2 \[Switching things on or off\]](#), page 22.

Default: 1 1 1 (white)

`color labels red green blue` [Parameter]

Set the colour of automatically generated labels to the given colour.

Default: 0 1 1 (cyan)

`color text_labels red green blue` [Parameter]

Set the colour of user defined labels to the given colour.

Default: 1 1 0 (yellow)

6.2.4.2 Line styles and widths

`line_style grid style` [Parameter]

`line_style ecliptic style` [Parameter]

`line_style boundaries style` [Parameter]

`line_style highlighted_boundaries style` [Parameter]

`line_style nebulae style` [Parameter]

`line_style constellation_lines style` [Parameter]

Set the line style of the respective object to *style*. Possible values are **none**, **solid**, **dashed**, and **dotted**.

Defaults: solid (grid, nebulae, constellation lines), dashed (ecliptic, boundaries)

<code>line_width grid width</code>	[Parameter]
<code>line_width ecliptic width</code>	[Parameter]
<code>line_width nebulae width</code>	[Parameter]
<code>line_width boundaries width</code>	[Parameter]
<code>line_width highlighted_boundaries width</code>	[Parameter]
<code>line_width constellation_lines width</code>	[Parameter]

Set the line width of the respective object to *width* (in centimetres).

Defaults: 0.025 (grid), 0.018 (ecliptic, nebulae), 0.035 (boundaries, constellation lines)

6.2.4.3 Other layout parameters

<code>set shortest_constellation_line length</code>	[Parameter]
---	-------------

Set the length of the shortest constellation line that is printed to *length* (in centimetres). All constellation lines shorter than *length* are suppressed.

Default: 0.1

<code>set label_skip length</code>	[Parameter]
------------------------------------	-------------

Set the distance between the outer rim of the celestial object and its label to *length* (in centimetres).

Default: 0.06

<code>set minimal_nebula_radius radius</code>	[Parameter]
---	-------------

All nebulae that would be smaller than *radius* centimetres are printed with a radius of exactly *radius* cm.

Default: 0.1

<code>set star_scaling factor</code>	[Parameter]
--------------------------------------	-------------

Make all star circles *factor* times bigger than normal.

Default: 1

<code>set fontsize size</code>	[Parameter]
--------------------------------	-------------

Set the default font size to *size* pt. *size* may be 10, 11, or 12.

Default: 10

6.2.5 Implementing a global style

<code>filename include filename</code>	[Parameter]
--	-------------

If non-empty, the file *filename* is interpreted as a PP3 input script and read before the keywords in the current script are interpreted. This enables you to enforce global style parameters and other commands for all maps in a set of maps. The included script must not include yet another file.

Please note that PP3 looks for the included file in the current directory, and not in the directory where the main input script is.

Default: "" (empty)

`filename latex_preamble filename` [Parameter]
 If non-empty, the contents of the file *filename* is included at an appropriate position in the resulting L^AT_EX file. This enables you to use arbitrary L^AT_EX macros to customise the map, see [Section 7.2 \[LaTeX preamble\]](#), page 30.
 Default: "" (empty)

6.2.6 Penalties

`penalties stars penalties` [Parameter]
`penalties labels penalties` [Parameter]
`penalties nebulae penalties` [Parameter]
`penalties boundaries penalties` [Parameter]
`penalties constellation_lines penalties` [Parameter]
 Set the penalties for an overlap of a label with the respective object to *penalties*.
 Defaults: 1000 (all)

`penalties rim penalties` [Parameter]
 Set the significance of an overlap with the label's rim relatively to the label's core to *penalties*.
 Note that the rim can never become more significant than the core, because the rim penalties add to the core penalties while calculating the core.
 Default: 1000

`penalties boundaries_rim penalties` [Parameter]
`penalties constellation_lines_rim penalties` [Parameter]
 Set the penalties for an overlap of the label's rim with the respective object to *penalties*.
 These two objects get their own rim penalties because approximation of a label with a line object is not so bad usually.
 Defaults: 1000 (all)

`penalties threshold penalties` [Parameter]
 If the penalties for a label exceed *penalties*, the label is suppressed.
 Default: 1000

6.2.7 Filenames

`filename stars filename` [Parameter]
`filename nebulae filename` [Parameter]
`filename label_dimensions filename` [Parameter]
`filename constellation_lines filename` [Parameter]
`filename boundaries filename` [Parameter]
`filename milky_way filename` [Parameter]
 This lets PP3 look for the respective data in the given file. The filenames must be full paths from the current directory.
 Defaults: 'stars.dat' (stars), 'nebulae.dat' (nebulae), 'labeldims.dat' (label dimensions), 'lines.dat' (constellation lines), 'boundaries.dat' (boundaries), 'milkway.dat' (Milky Way)

6.3 Setting or deleting celestial objects and their labels

All keyword here are *commands*.

objects_and_labels [Command]

This keyword splits the input script in two parts. The first part must contain *parameters* only, whereas the second contains *commands* only.

This keyword must occur either once or never in a PP3 input script. If never, the whole script consists of parameters.

6.3.1 Adding and deleting stars and nebulae

add objects ... ; [Command]

Add the *objects* to the map, even if PP3's implicit behaviour would have excluded them. This is sensible for nebulae mostly.

delete objects ... ; [Command]

6.3.2 How to add, delete, and reposition labels

add_labels objects ... ; [Command]

delete_labels objects ... ; [Command]

reposition object towards direction ; [Command]

set_label_text object "label-text" [Command]

6.3.3 How to place text on the map

text label-text at rectascension declination [color red green blue] [towards direction] ; [Command]

All user defines texts on the map are generated with the keyword ‘**text**’. However there are two sub-variants, namely *flexes* and *tic mark labels*. Note that they can have the **color** and **towards** keywords as well.

6.3.3.1 Flexes

text label-text at rectascension declination along declination ; [Command]

Create a flex label at the given coordinates. A flex label follows the respective declination circle.

For further options see [Section 6.3.3 \[Arbitrary text\]](#), page 27.

6.3.3.2 Tic mark labels

text label-text at rectascension declination tics (rectascension | declination) step ; [Command]

With the keyword **rectascension**, one rectascension circle gets tic marks, analogously with **declination**. The celestial position after ‘**at**’ denotes the starting point of the labelling, and *step* is the step skip (in hours or degrees respectively) for the subsequent tic mark labels.

The label should contain one of the following special expressions:

- #1 Rectascension in hours.
- #2 Declination in degrees.
- #3 Rectascension in integer hours (truncated, not rounded).
- #4 Rectascension fraction of hour in minutes (truncated, not rounded).
- #5 Declination in rounded integer degrees.

For further options see [Section 6.3.3 \[Arbitrary text\]](#), page 27. Tic mark labels can also be flexes, see [Section 6.3.3.1 \[Flexes\]](#), page 27.

7 PP3 and L^AT_EX

We're entering now the phase of sophistication. Here you learn how to customise the graphical appearance of all text on your sky map almost arbitrarily. You also learn how to achieve special text effects using the L^AT_EX language.

I can't explain L^AT_EX itself though. So I must assume that you've been taught the basics elsewhere. On the other hand, the L^AT_EX snippets that I will give in this chapter may be enough for many purposes.

It is *not* necessary to use the features described here, so it's still true that you needn't know about L^AT_EX in order to use PP3. However if you want to have full control, L^AT_EX competence is unavoidable.

7.1 Using L^AT_EX in labels

You can use all L^AT_EX macros in PP3 labels that are allowed in horizontal boxes (like `\mbox{...}`). Additionally, you can use many commands from the [PSTricks package](#).

The most important pitfall is the backslash '`\`', because when using quotes as string delimiters, you have to write it as '`\\`'.

Let's have a look at a more complex example:

```
text "\\small Wolf 359\\hskip0.3em
      \\psdots[dotstyle=+,dotangle=45](0,0)"
at 10.902 7.32 color 0.3 0.3 0.9333 towards W_ ;
```

This prints an 'x' at the position of the star Wolf 359 and prints the label 'Wolf 359' at the top left next to it:



The row of L^AT_EX macros consists of the following elements:

`\small` This prints the whole label in a small typeface. Please note that such commands only apply to the current label, since the label will be typeset within a box. In effect, the next label will be big again, unless you say ‘`\small`’ there, too.

`\hskip0.3em` This adds a horizontal skip at its position. Its width is 0.3em, where ‘em’ is the width of the letter ‘M’. In this case, it creates a little bit of space between the ‘Wolf 359’ and the ‘×’.

`\psdots[dotstyle=+,dotangle=45](0,0)` This is a PSTricks command. Normally it prints a dot at the current position on the text baseline. However the ‘`dotstyle=+`’ option makes it a ‘+’, and the ‘`dotangle=45`’ option turns it by 45 degree, which makes it an ‘×’ effectively. The clever bit is the fact that this macro is the very last one in the row. Since it says ‘`towards W_`’ (towards left, on baseline) in the PP3 command, this means that the ‘×’ lies *exactly* on the celestial coordinates given after the ‘`at`’ option.

7.2 L^AT_EX preamble

Providing a L^AT_EX preamble is the most elegant, mighty, but also – if you know L^AT_EX – the easiest way to adjust the map layout according to your taste and needs. There is a default preamble that defines the standard map layout. This you can override in a user preamble as much as you want.

7.2.1 Default preamble

By default, the L^AT_EX document that PP3 creates begins with

```
01 \documentclass[10pt]{article}
02
03 \nofiles\usepackage[dvips]{color}
04 \usepackage{pstricks,pst-text}
05 \newcommand*{\DP}{.}
06 \newcommand*{\TicMark}[1]{#1}
07 \newcommand*{\Label}[1]{#1}
08 \newcommand*{\TextLabel}[1]{#1}
09 \newcommand*{\FlexLabel}[1]{#1}
10 \newcommand*{\Starname}[1]{#1}
11 \newcommand*{\Messier}[1]{M\, #1}
12 \newcommand*{\NGC}[1]{NGC\, #1}
13 \newcommand*{\IC}[1]{IC\, #1}
14
15 \usepackage{mathptmx}
16 \usepackage{helvet}
17 \AtBeginDocument{\sffamily}
18
19 [optional input of user provided file]
```

The above is not provided by you, it is the L^AT_EX code that PP3 generates every time. If you don’t look at its L^AT_EX output file, you never see it. But it may be helpful to know what happens here, so let’s skim through it line by line:

Line 1 The ‘10pt’ in the first line defines the standard font size in points. You can change that with the input script parameter

```
set fontsize 12
```

which changes it to 12 pt. Possible values are ‘10’, ‘11’, and ‘12’.

Lines 5–13

All the so-called hooks of PP3, see [Section 7.3 \[LaTeX hooks\]](#), page 32.

Lines 15–17

They set the standard font for PP3’s maps: The Helvetica for all the Latin letters, and the Symbol for all the Greek ones.

Line 19 Here your own preamble is included, if you have provided one.

7.2.2 User preamble

You tell PP3 where your own preamble is with the filename parameter ‘`latex_preamble`’ in the input script, for example:

```
filename latex_preamble mypreamble.tex
```

The file ‘`mypreamble.tex`’ contains your L^AT_EX preamble macros and must reside in the current directory, or in another directory where T_EX looks for its files.

The following is the contents of the file ‘`wiki.tex`’ of the PP3 distribution. It is the original user L^AT_EX preamble that was used for the Wikipedia Project, see [Section 1.4 \[Successful use of PP3\]](#), page 2.

```
01 \usepackage{amsmath}
02 \usepackage[T1]{fontenc}
03 \IfFileExists{eulervm.sty}{\usepackage{eulervm}}{}
04 \usepackage{relsize}
05 \IfFileExists{tipmy.fd}{
06   \renewcommand*{\sfdefault}{pmy}
07 }{
08   \renewcommand*{\sfdefault}{phv}
09 }
10 \renewcommand{\Messier}[1]{\footnotesize{\scriptsize M}\,,#1}
11 \renewcommand{\NGC}[1]{\footnotesize{\scriptsize NGC}\,,#1}
12 \renewcommand{\IC}[1]{\footnotesize{\scriptsize IC}\,,#1}
13 \renewcommand{\FlexLabel}[1]{\bfseries #1}
14 \renewcommand{\TicMark}[1]{\mdseries\scriptsize\mathversion{normal} #1}
15 \AtBeginDocument{\sffamily\boldmath}
```

And this is what it does:

Line 1 includes the AMSMath package which provides additional macros that can be useful in text labels. You can include almost arbitrary L^AT_EX packages.

Line 2 activates the so-called T1 font encoding. It’s not important to know what this means, but it is recommended and doesn’t do any harm.

Line 3 activates nicer Greek letters. Well, your taste may be different. This ‘`\IfFileExists`’ thing tests whether the package is available on the current computer. The package is included only if it exists.

Line 4 enables the macro ‘`\smaller`’ which can be very useful in text labels. It reduces the current font size. For example I can say

```
set_label_text LEO 32 "\smaller Regulus"
```

Lines 5–9 test whether the font Myriad is available on the current computer, and if it does, it makes it the new standard sans-serif font. Else it uses Helvetica for that.

Lines 10–14

re-defines various L^AT_EX hooks in order to have nicer looking automatic labels, see [Section 7.3 \[LaTeX hooks\]](#), page 32.

Line 15 switches to sans-serif font (Myriad/Helvetica) with ‘`\sffamily`’ and to bold Greek letters with ‘`\boldmath`’.

Please note that you have to delete the file ‘`labeldimens.dat`’ in the current directory if you have changes the font setup with a new own L^AT_EX preamble. This forces PP3 to recalculate the dimensions of all labels – and since the fonts have changed, this is necessary.

7.3 L^AT_EX hooks

First of all – what is a hook? A hook in general is a macro or command that can be re-defined by the user, and that is called implicitly. Thus, by re-defining a hook, the user can modify the behaviour of the program at certain points.

In PP3, hooks are called for printing text of various kinds. For example, every implicit (i.e. automatically generated) star name is printed by ‘`\Starname`’ as in ‘`\Starname{γ}`’. By default, this macro does nothing more than printing its argument:

```
\newcommand*\Starname}[1]{#1}
```

But if you re-define it, you can make every (implicit!) star label a little bit larger:

```
\renewcommand*\Starname}[1]{\larger #1}
```

Notice that the macro ‘`\larger`’ is provided by the ‘`relsize`’ package that must be loaded before, see [Section 7.2.2 \[User preamble\]](#), page 31. So, just write the lines

```
\usepackage{relsize}
\renewcommand*\Starname}[1]{\larger #1}
```

in the file ‘`mypreamble.tex`’, say

```
set latex_preamble mypreamble.tex
```

in the PP3 input script, and voilà – all star labels are larger.

PP3 knows nine hard-wired L^AT_EX hooks:

‘`\Label`’ Argument: the label text. It applies to all labels, *before* any specific hook of the following is applied.

‘`\TextLabel`’ Argument: the label text. It applies to all labels that the user creates with ‘`text`’.

‘`\FlexLabel`’ Argument: the label text. It applies to all flexes.

‘`\Starname`’ Argument: the star name. It applies to all automatically generated star names, in particular *not* to user-defined names given by ‘`set_label_text`’.

`'\Messier'`

`'\NGC'`

`'\IC'` Argument: the respective catalogue number. This generates the labels for nebulae. Notice that you must provide the catalogue name, or you can leave it as well. For example, many people prefer NGC numbers as plain numbers without an 'NGC' before it. You achieve this effect with

`\renewcommand*{\NGC}[1]{#1}`

`'\TicMark'`

Argument: the tic mark label text. It applies to all tic mark labels, see [Section 5.5.6 \[Tic labels\], page 17](#).

`'\DP'` No argument. This generates the decimal point. By default, it's a '.', however in many countries a ',' is used instead. You get this with

`\renewcommand{\DP}{,}`

Appendix A Known problems

The following issues are known to the maintainer of PP3. If you find another one, please report it on [PP3's project page](#).

- Unknown stars in constellation line data files (the default is the file `'lines.dat'`) result in an error message, which is good, but the error message may include another – probably valid – star name, which is bad. Fortunately the actually wrong star and the printed star are within the same constellation line, the printed star coming first.
- The usage of semicolons in PP3 input scripts is not consistent. For example, a `'reposition'` needs one, but a `'set_label_text'` not.
- If you print a large portion of the sky, e.g. a hemisphere, and a pole-near region of the Milky Way (e.g. Southern Cross) is at the very rim of the map, the Milky Way dots are printed a little bit too coarsely, leaving tiny gaps between the dots.
- The declination circles have slight kinks at 0h rectascension. Except for the $\pm 80^\circ$ circles they are mostly invisible though.
- Ecliptic and grid don't take part in PP3's penalty scheme yet.
- Large nebulae are drawn as ellipses representing their approximative shape in the sky. However, the algorithm doing that is mathematically flawed and doesn't work for polar-near regions. Fortunately this only affects the Small Magellanic Cloud, the actual shape of which is, by a curious coincidence, rendered very well by that algorithm.

A.1 Wishlist

It would be nice to have the following things in PP3. Please contact [Torsten Bronger](#) if you want to contribute.

- Very faint stars, i.e. stars fainter than `'faintest_star_disk_magnitude'`, should be removed from the map automatically, if they overlap with a label. It shouldn't matter whether the label was implicitly created or user-defined.
- An ephemerides module that allows to insert the Sun, the Moon, and the planets on the map, for a given date, time, and observation location on Earth. By the way, the C++ module itself is already existing, but its integration into PP3 is not done yet.
- More map projections, in particular a real isogonal one.
- The resolution of the Milky Way should be determined in a way that $\text{T}_{\text{E}}\text{X}$'s memory doesn't overflow. Maybe one should switch to contour plots instead of dot patterns for the Milky Way.
- Create little bitmaps of all labels in order to determine kerning parameters for them.
- PP3 should become able to deal with large data bases.
- The [star names list of Celestia](#) or something like that should be used for identifying stars in input scripts.

Besides that, I'd like to re-structure the internals of PP3 because in some respect the code is not well maintainable and expandable. For the long-term future it may be worth thinking about using Guile as the scripting language.

Appendix B Data file formats

Maybe you want to use your own data bases with PP3. If they are not too large¹ you may well do so. Of course, then you need to know the internal structure of the files. Although they are so simple that reverse engineering should be almost trivial, you find here a complete description of all of them.

Additionally I will give information where the original data of PP3’s standard distribution came from.

The last point, the “label dimensions file”, isn’t a real data base file, but an internal temporary file. It is mentioned here just for completeness.

B.1 Stars data file

This is a text file usually called ‘**stars.dat**’. Four consecutive lines belong together and refer to one particular star. There is no header.

- Line 1 A row with seven fields separated by whitespace:
1. Henry Draper Catalogue number (‘0’ if unknown),
 2. BSC catalogue number (‘0’ if unknown),
 3. rectascension in hours,
 4. declination in degrees,
 5. visual brightness in magnitudes,
 6. B–V brightness in magnitudes (‘99.0’ if unknown), and
 7. Flamsteed number (‘0’ if unknown).
- Line 2 The label (astronomical name) for the star, as a L^AT_EX-ready string, e.g. “ α ”, “ ϕ^2 ”, or simply “23”. May be the empty string.
- Line 3 The astronomical abbreviation of the constellation. It must be all uppercase.
- Line 4 The spectral class. It must start with the spectral class letter, followed by the fraction digit, followed by the luminosity class as a Roman number, e.g. “F5III”. Anything may follow as in “K2-IIICa-1”, however the mandatory parts must not contain any whitespace.

Example

```
358 15 0.139805 29.0906 2.06 -0.11 21
 $\alpha$ 
AND
B8IVpMnHg
11636 553 1.91067 20.8081 2.64 0.13 6
 $\beta$ 
ARI
A5V
886 39 0.220611 15.1836 2.83 -0.23 88
 $\gamma$ 
PEG
B2IV
```

¹ Unfortunately PP3 still has the disadvantageous behaviour of reading the *whole* data base file.

PP3's star data origin

It's the Bright Stars Catalogue (BSC) as distributed with the program *Cartes du Ciel*. It contains almost 10,000 stars. I corrected minor mistakes and let all double stars collapse, i. e. their visual brightnesses were summed up and the respective minor partner was removed from the file.

B.2 Nebulae data file

This is a text file usually called `'nebulae.dat'`. There is no header. The file is just a whitespace separated stream of numbers and constellation abbreviations. In order to make it more readable though, the standard PP3 nebulae file has every nebula on one single line of its own.

Each dataset has the following eleven fields:

1. NGC catalogue number ('0' if not listed there),
2. IC catalogue number ('0' if not listed there),
3. Messier Catalogue number ('0' if not listed there),
4. The astronomical abbreviation of the constellation. It must be all uppercase.
5. rectascension in hours,
6. declination in degrees,
7. visual brightness in magnitudes,
8. large diameter in degree minutes,
9. small diameter in degree minutes (must be equal to the large diameter if unknown),
10. the horizontal angle if the large diameter in degrees ('720.0' if unknown), and
11. the type of the nebula: 0: unknown, 1: galaxy, 2: emission nebula, 3: reflection nebula, 4: open star cluster, and 5: globular star cluster.

Example

```
1 0 0 PEG 0.121083 27.7089 13.6 0.0283333 0.02 -30 1
2 0 0 PEG 0.121417 27.6786 15 0.0166667 0.01 -22 1
3 0 0 PSC 0.121333 8.30139 14.4 0.0183333 0.01 -21 1
4 0 0 PSC 0.123472 8.37389 16.9 0.01 0.005 55 1
5 0 0 AND 0.130222 35.3628 14.8 0.02 0.0116667 -25 1
6 0 0 AND 0.159056 33.3089 14.1 0.0283333 0.0266667 -50 1

1976 0 42 ORI 5.58808 -5.39028 4 1.08333 1 720 2
3034 0 82 UMA 9.93167 69.6831 9.2 0.186667 0.0716667 25 1
7000 0 0 CYG 20.9806 44.5167 4 2 1.66667 720 2
```

PP3's nebulae data origin

It's the NGC/IC catalogues as compiled by *Wolfgang Steinicke*.

B.3 Constellation lines data file

This is a text file usually called `'lines.dat'`. It has no header. You can define paths of constellation lines by lists of stars that are ended with a semicolon ';'. You can insert superfluous whitespace as you wish, and comments after every '#'.

Stars are given in the usual way: Either by a pair of constellation abbreviation and Flamsteed number, as in

ORI 19

(Rigel), or by ‘HD’ and the Henry Draper catalogue number, as in

HD 108248

(Acrux).

Example

```
# Orion

ORI 19 ORI 34 ORI 24 ;
ORI 53 ORI 50 ORI 46 ORI 34 ;
ORI 50 ORI 58 ;

# Southern Cross

HD 111123 # beta Cru
HD 106490 ; # delta Cru

HD 108248 # alpha Cru
HD 108903 ; # gamma Cru
```

PP3’s constellation lines origin

I created the lines after my fancy. The *Atlas für Himmelsbeobachter*² was an important source of inspiration though.

B.4 Boundaries data file

It doesn’t make much sense to use an own boundaries file, unless you want to use a different equinox, but anyway. This is a text file usually called ‘boundaries.dat’. It has no header.

The file is a sequence of elementary line segments. Every segment is a whitespace separated sequence of entries. The entries for each segment are:

1. Number of points n_1 in the segment.
2. Repeated n_1 times:
 1. rectascension of point in hours,
 2. declination of point in degrees.
3. Number of constellations n_2 touching this border line (is always 2, however it hasn’t always been due to flawed raw data).
4. Repeated n_2 times: All uppercase astronomical abbreviation of the adjacent constellation. It may distinguish between SER1 and SER2 for Serpens Caput and Serpens Cauda.

Example

```
3 20.63865 2.43608 20.63929 1.43613 20.63992 0.43617 2 AQL AQR
10 20.63992 0.43617 20.64055 -0.56377 20.64118 -1.56373
    20.64181 -2.56368 20.64245 -3.56364 20.64308 -4.56359 20.64372 -5.56355
```

² by Erich Karkoschka, in German; ISBN 3440074889

```

20.64435 -6.56350 20.64500 -7.56346 20.64564 -8.56341 2 AQL AQR
9 17.71838 -67.57110 17.65152 -67.58319 17.58465 -67.59526
17.51772 -67.60731 17.45076 -67.61933 17.38378 -67.63130 17.31676 -67.64324
17.24970 -67.65515 17.21616 -67.66108 2 ARA APS

```

PP3's boundary data origin

It's the [Catalogue of Constellation Boundary Data](#) by Davenhall and Leggett. I had to fix some bugs though, because the Ophiuchus/Serpens region was flawed. Additionally, the original data has peculiarities because it tries to be useful for bounded maps, e.g. in Mercator projection. I removed the resulting spurious lines.

B.5 Milky Way data file

This is a text file usually called 'milkyway.dat'.

Its header is extremely simple: It consists of only one number which is the maximal (= equatorial) diagonal half distance of two pixels in degrees. This value is used as the radius for the milky way pixels. Of course it must be the minimal radius for which there are no gaps between the pixels.

What follows are the Milky Way pixels themselves. Each consists of three entries, separated by white space:

1. The rectascension in hours,
2. the declination in degrees, and
3. the grey value of the pixel from 1 to 255. Zero is not used because zero-value pixels are not included into the data file anyway.

Example

```

0.212
11.885 0.259 1
11.962 0.295 5
11.974 0.298 5

17.982 -26.999 136
17.982 -27.299 158
17.982 -27.599 169
17.982 -27.899 199
17.981 -28.199 235

```

PP3's boundary data origin

I used the [All-Sky Milky Way Panorama](#) by Axel Mellinger. His bitmap with the two hemispheres in equidistant azimuthal projection was greyscaled and smoothed with the Gimp, and then transformed to PP3's format with a small hand-written C program.

B.6 Label dimensions file

The default name of this file is 'labeldims.dat'. This file is never user provided but generated by PP3 itself in order to store typographic dimensions of all labels. Highly probably you needn't know its structure.

Every labels has two lines in the file:

- Line 1 The label itself in L^AT_EX form.
- Line 2 The typographic width, height, and depth of the label in centimetres, separated by whitespace.

Example

```
$10$\footnotesize UMa
0.97106 0.23043 0.00253
$\omega$
0.34197 0.17081 0.00000
10 UMa
1.11657 0.23389 0.00316
47 Tuc
0.94506 0.23389 0.00316
Pleiades
1.20865 0.24777 0.00316
\FlexLabel{Andromeda}
1.86061 0.25076 0.00316
\FlexLabel{Antlia}
0.93945 0.25076 0.00316
```


Appendix C List of all constellations

first column

Latin name

second column

astronomical abbreviation, ready for being used – in its all-uppercase form – with ‘`set constellation`’

third column

English name

fifth column

rectascension of constellation centre, in hours, ready for being used with ‘`center_rectascension`’

sixth column

declination of constellation centre, in degrees, ready for being used with ‘`center_declination`’

last column

recommended scale for a 9 cm × 9 cm map, in degrees per centimetre, ready for being used with ‘`grad_per_cm`’

The values are taken from the input scripts used for the Wikipedia Project, see [Section 1.4 \[Successful use of PP3\], page 2](#).

<i>Latin</i>	<i>ab.</i>	<i>English</i>	<i>rec.</i>	<i>dec.</i>	<i>sc.</i>
Andromeda	And	Andromeda	1	+38	4
Antlia	Ant	Air Pump	10.2	−35	3
Apus	Aps	Bird of Paradise	16	−75	3
Aquarius	Aqr	Water Carrier	22.3	−8	6
Aquila	Aql	Eagle	19.7	+3	4
Ara	Ara	Altar	17.5	−53	4
Aries	Ari	Ram	2.8	+18.8	4
Auriga	Aur	Charioteer	5.6	+38	4
Boötes	Boo	Herdsmen	14.7	+34	4
Caelum	Cae	Chisel	4.8	−38	3
Camelopardalis	Cam	Giraffe	5.5	+75	5
Cancer	Cnc	Crab	8.7	+20	4
Canes Venatici	CVn	Hunting Dogs	13	+40	4
Canis Major	CMa	Big Dog	6.5	−20	4
Canis Minor	CMi	Little Dog	7.5	+12	4
Capricornus	Cap	Goat	21	−16	4
Carina	Car	Keel	8.5	−64	5
Cassiopeia	Cas	Cassiopeia	0.5	+60.5	4
Centaurus	Cen	Centaur	13.6	−45	5
Cepheus	Cep	Cepheus	23	+75	4
Cetus	Cet	Whale	1.7	−7	6

Chamaeleon	Cha	Chameleon	11	−79	4
Circinus	Cir	Compasses	14.8	−62	4
Columba	Col	Dove	5.8	−35	4
Coma Berenices	Com	Berenice's Hair	12.4	+22.5	4
Corona Australis	CrA	Southern Crown	18.6	−42	3
Corona Borealis	CrB	Northern Crown	15.8	+33	4
Corvus	Crv	Crow	12.4	−18	4
Crater	Crt	Cup	11.4	−16	4
Crux	Cru	Southern Cross	13.2	−60.8	4
Cygnus	Cyg	Swan	19.95	+40.8	5
Delphinus	Del	Dolphin	20.5	+12	3
Dorado	Dor	Goldfish	5.1	−60	4
Draco	Dra	Dragon	16.5	+72	5
Equuleus	Equ	Little Horse	21.2	+8	3
Eridanus	Eri	River	3.8	−30	6
Fornax	For	Furnace	2.7	−32	4
Gemini	Gem	Twins	7	+20	4
Grus	Gru	Crane	22.5	−44	4
Hercules	Her	Hercules	17.55	+30	5
Horologium	Hor	Clock	3.3	−53	4
Hydra	Hya	Hydra (Sea Serpent)	11.15	−15	10
Hydrus	Hyi	Water Serpent (male)	2.5	−70	4
Indus	Ind	Indian	21.5	−60	4
Lacerta	Lac	Lizard	22.5	+46	4
Leo	Leo	Lion	10.8	+20	4
Leo Minor	LMi	Smaller Lion	10.3	+32	4
Lepus	Lep	Hare	5.6	−18	4
Libra	Lib	Balance	15.2	−17	4
Lupus	Lup	Wolf	15.3	−41	4
Lynx	Lyn	Lynx	8.2	+47	4
Lyra	Lyr	Lyre	18.8	+37	3
Mensa	Men	Table	5.7	−77	4
Microscopium	Mic	Microscope	21.15	−37	3
Monoceros	Mon	Unicorn	6.7	−3.5	4
Musca	Mus	Fly	12.6	−70	4
Norma	Nor	Square	16	−50	4
Octans	Oct	Octant	22	−85	4
Ophiucus	Oph	Serpent Holder	17.3	−9	6
Orion	Ori	Orion	5.8	+0	4
Pavo	Pav	Peacock	19.5	−67	4
Pegasus	Peg	Winged Horse	22.7	+20	6
Perseus	Per	Perseus	3.6	+47	4
Phoenix	Phe	Phoenix	0.7	−49	5
Pictor	Pic	Easel	5.6	−54	4
Pisces	Psc	Fishes	0.5	+14	6
Pisces Austrinus	PsA	Southern Fish	22.3	−31	4
Puppis	Pup	Stern	7.6	−31	4

Pyxis	Pyx	Compass	8.95	−30	4
Reticulum	Ret	Reticle	3.9	−60	3
Sagitta	Sge	Arrow	19.6	+15	4
Sagittarius	Sgr	Archer	18.5	−27	4
Scorpius	Sco	Scorpion	16.8	−30	4
Sculptor	Scl	Sculptor	0.5	−32	5
Scutum	Sct	Shield	18.7	−10	3
Serpens	Ser	Serpent	17.1	+2	6.5
Sextans	Sex	Sextant	10.2	−1	4
Taurus	Tau	Bull	4.6	+18	4
Telescopium	Tel	Telescope	19.3	−52	4
Triangulum	Tri	Triangle	2.2	+33	4
Triangulum Australe	TrA	Southern Triangle	16	−65	3
Tucana	Tuc	Toucan	23.7	−67	4
Ursa Major	UMa	Great Bear	11.5	+55	6
Ursa Minor	UMi	Little Bear	15	+78	4
Vela	Vel	Sails	9.6	−48	4
Virgo	Vir	Virgin	13	+3	5
Volans	Vol	Flying Fish	7.8	−70	4
Vulpecula	Vul	Fox	20.2	+25	4

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