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# Astronomic and other programmes (written in Pascal)

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Anything outside the map disturbs the view, so it is preferable hide everything else from your sight. If you are watching black-and-white maps, it is nice to separate the maps by a black (in case of a computer screen) or white (for printed maps) cardboard going till your face, so that each eye sees just one map. If the maps are to match each other, their width is to smaller then the mutual shift of the distant stars. (75 mm at most).

An alternative of glasses is a mirror, which replaces also the piece of cardboard in separating the maps. In this case one of the maps is to be mirror-reversed (my programme can do it for the left map). The advantage is that the 75 mm width limit is overcome this way, as the maps can stretch far away from the mirror. (To make the map wider, you can set the second item in the stereo geometry parameter somewhere near to two hundred, e.g., as `s30:190`). (This mirror option is an idea I saw in the examples published in November 1999 on the Hipparcos pages [9].)

If using red and green (or blue) colour (parameter `sc`), the maps can overlap each other. The necessary aid are colour glasses, filtering perfectly both colours (if the filtration is not perfect, there remain unpleasant ghosts). They can be bought, e.g., from [19]. The dioptric glasses can be made obsolete in this case, if you choose the base shift as zero or very small (e.g., by giving `s20:2`).



face) reside. The same directory contains usually the Borland unit `Graph.tpu`, and so it is to be included in the `/U` parameter of `tpc.cfg`, as well as the directory with the source files of units (`C:\s\Pas\Units` in my case).

The above examples say, that I have most of software I use in the `\S` directory. It is hidden there, as I do not need to see it very often, and I do not want to be bored by its long list in the root directory `C:\`. When I am looking at the programmes at all, it's just into their source texts (I have them in the `c:\s\PAS` directory, where I get any time by `Pas.bat`).

If your computers access more than one disk, you should avoid starting file names by a disk letter in the batch files. Instead, make a line in `Autoexec.bat` reading like `Set SWDir=C:\s` and just then `Set BGI=%SWDir%\tp\bgi`. Similarly, explicit `c:\s` should be replaced by `%swdir%` in all batch files. If the software will then shift to a disk `D` (you will shift it, or the disk will have such letter when accessed from another computer), it is sufficient to change the letter in the definition of environmental variable `SWDir`, and the rest will work as previously. If the space for environmental variables does not suffice, you can enlarge it by a line in the `Config.sys` reading like `Shell=c:\command.com /p /e:1024`. Then, 1024 bytes of environmental space will be available instead of default 256 B.

## 3 Development of programmes (remarks for Pascal users)

The programmes are used on PCs, and are written in the Borland Turbo Pascal language. We use version 6.0 of the language, but no its new features with respect to some previous versions. Thanks to the existence of Free Pascal Compiler, they can now be developed not only in MS-DOS, but also in Linux or even in some still popular commercial systems.

The programmes have been developed gradually, according to my needs and possibilities. Included are also similarly developed programmes of my colleagues, who agree with their spreading under the same GNU General Public License [2]. We have used mostly algorithms from a booklet by Zdeněk Pokorný [5] (who himself used the book by Jan Meeus [6]) and from text by Jana Vondrák in [7].

As the programmes became more complicated, or as the author could not remember algorithms of old programmes, a need for some documentation emerged, at least in the form of comments in the source codes. In spite of that, the comments remained mostly quite insufficient, and the programmes are very far from the ideal of *literate programming*, as formulated and made true by Donald Knuth (author of programmes like `WEB` and TeX[16]). Further, the programmes have been supplemented to behave well, like (e.g.) programmes of MS-DOS which explain their meaning and use when being started a suitable way. These instructions how to use the programme are contained at the beginning of its text.

Some time ago, I have noticed two problems of Borland Turbo Pascal when run with or without numeric co-processor. The first one concerns different ways of rounding. Pascal itself rounds real numbers ending .5 to a greater absolute value, whereas

List of programs in package Pas_JH (cont.)

| **directory** programme | |
|---|---|
| DbBridge | Reading, writing into and creating dBaseIII+ files (based on an old program by Milan Drášil). |
| FtBridge | Reading FITS tables/images |
| G_scree | Printing (not in PCL), saving and restoring a graphic screen |
| GCVS | Reads a record from the General Catalogue of Variable Stars (GVCSred.dbf) |
| Graph_m8 | Graphic interface: simultaneous PostScript/LaTeX file, stars, graphs |
| Graph_tx | text replacement of unit graph (very simple, only `outtext` does something) |
| HdConv | Conversion from decimal to hexadecimal and vice versa |
| Mbox | Rectangle of any size and orientation, movable by cursor keys |
| Params | Decoding usual parameters of programs by J.Hollan, common help-consts. |
| Params_G | Same as Params, for programmes using graphic mode |
| Planets | Ephemeris (helio/geo-centric) of 10 “planets” and Sun-orbiting bodies |
| Precesse | Changing the equatorial coordinates due to precession of the Earth axis |
| Regress | Polynomial regression (without weights) |
| Solar_ut | Calendar, time, some astronomical co-ordinate transformations |
| Str_num | String operations, Numeric conversion, Babylonian digital systems |
| Un_str_m | String justification and conversion, date and time de- and en-coding (a substitute for parts of Unit_Str from Power Tools by Blaise Computing) |

## 8 Hints on using the Map_BSC programme

The `Map_BSC` program plots maps using a modified *The Bright Star Catalogue* [8], which I offer as a package with files of `*.dbf` type. (Since 1999, it can use large Hipparcos or huge Tycho star catalogue instead [9].) Apart from `B5_cd.dbf` (or `hip_main.dat` or `tyc_main.dat`) file it can use another database files, which I offer as `Sol_Syst` and `Litt_Atl` packages. Maps produced using the Bright Star Catalogue are sufficient for observation without a telescope, and they can serve even for finding bright comets with binoculars. An example, not much edited from the automated output, is *Malý hvězdný atlas* (*A Little Star Atlas*) in the Czech book *Báječný svět hvězd* (*A Wonderful World of Stars*).

The program is able to produce very diverse outputs, depending on a number of parameters. It may take some time to tune the output to your needs. Especially complicated it may be in the case of cometary heads and tails.

Several configuration files `*.cnf` and batch files `mb*.bat`, shipped together with the source code, could be a good starting point for you. To understand them, you may use the overview of the parameters of `Map_BSC`, which you obtain running the programme with a `h` and then with a `$h` option (or simply by running `mb_hfile.bat`) — file `map_bsc.hlp` is produced this way.

Using Hipparcos data [9] instead of the Bright Star Catalogue enables to print ten times more stars and to get true stereoscopic charts (parallaxes in the ground-



Martin Škutek, what is always mentioned in the comments inside the programmes) and for their suggestions.

## 7 List of programmes

| **directory** programme | |
|---|---|
| **Util** | *Various useful programs, namely the Graph_d, CutBE and ASCII* |
| ASCII | Displays an ASCII table with decadic or hexadecimal numbers |
| B2D | Babylonian to decimal conversion, like dd:mm:ss to degrees |
| CutBE | Output is a part of input file starting and ending at some % of its length |
| Dec2hex | Decimal to hexadecimal number conversion |
| Fa2Ce | Fahrenheit to Celsius conversion |
| fit2dbf | `*.FITs` to `*.dbf` conversion, for ASCII tables FITS files |
| GFDate | Sets the date (or even time) of a file (files), e-mail or general ones |
| Grafik | Graph from a text file (for PostScript or LaTeX ouptut use Graph_d). |
| Graph_d | Graphs and histograms from dBase files and from really text files. (Offers finding symmetry axis, polynomial regression, PostScript and LaTeX outputs.) |
| Hex2dec | Hexadecimal to decimal number conversion |
| Interval | Julian date, or two dates and a time interval between them |
| ISBN | A check digit of an International Standard Book Number |
| Key | Displays a number code of the pressed key |
| NumFont | An overview of numbered Borland Turbo Pascal fonts |
| PrnToFil | Redirects prints to a file |
| Psychro | dry and wet temperature to humidity |
| Rel2Abs | relative humidity and Celsius temperature to Humidity Absolute |
| ShowFont | Shows a named Borland Turbo Pascal font |
| Slohni | Redirects <Ctrl><PrtScr> (copy of a text screen) to a file instead of `prn` |
| TestSpee | Number of different operations per 0.01 s |
| Transmis | Fraction of light transmitted through a layer of glass at various angles |
| **Text** | *Various programs for handling (changing) text files (or nearly-text). Programs off*.pas (not listed here) put away various ANSI (escape) sequences — this is for cleaning terminal log files. The most useful files are:* |
| CS_code.txt | Explanation of coding of special characters of the Czech and Slovak languages |
| CS_Conv | Converts (Czech) diacritics to another code table or (ev. partly) discards it; works also for dBaseIII+ files and for T602-editor ones. Decoding XXEncoded files, making character-occurrence tables. |
| CutTrBla | Cuts away trailing spaces (empty ends of lines) |
| Dis_Comm | discards comment lines from a *.ps file |
| HR2Par | inserting `\par` or `<p>` at hard returns or `<p>` after blank lines |
| LF2CRLF | UNIX-type text file to MS-DOS-type one |
| In32_127 | Checking the file on being directly e-mailable |
| Nons2bla | Repairing texts: character 255 to 32 (blank), or any to any |

use it, you have to buy a CD with that marvelous computer star atlas. As a facility not contained in the MegaStar itself (at least not in version 3), my programme offers a possibility to create maps according to command-line parameters or according to parameters in some of the configuration files. Both `Map_*` programmes can be run by means of batch files `m*.bat`, which, e.g., make a map centered on a given object (a comet or Moon). The new versions of MegaStar can do it as well, but it takes more time to make them do so. I used to write just `mb_hb` to have an actual map of the surroundings of the Hale-Bopp comet. [2]

As said above, these graphic programmes can produce also true PostScript [14] (or LaTeX[16]) file, easy to edit. However, even the screen is nicer than for most star-mapping programmes, as grayscale is employed to get smooth stars, with faintest ones visible only using the full luminance. If you like to save the screen to a file, use, e.g., the Screen Thief programme by Villa Software [15]. Some examples I offer have been saved this way [18].

Then there is a group of programmes giving tables of positions of celestial bodies and sky events, namely `Sun`, `Moon` and `Planet` programmes. Various small programmes deal with transformations of coordinates and of photometric quantities — these may be quite instructive. A large programme `SunDial` offers a proposal and accurate construction of sundials and computes insolation of absorbers in solar collectors.

In the `Screen` directory the most useful programme is `VMod`. I employ it mainly through `v.bat`, which reads `Vmod 3`. When a screen is due to some conflict of software and hardware entirely confused, entering this only letter is sufficient to see again what you write.

## 6 Final remarks

For further information on the programmes please see their overview on the following pages. Some programmes of `Screen` and `Tisk` directories, useful for few people, are not contained there; if you would be interested in them, you would to look directly their source codes (rather then just to translate and try them).

I will be grateful for information on errors in the programmes. I will even enrich the programmes according to your wishes, with respect to my time possibilities, mood and your insisting on me. But I prefer the programmes being supplemented by you; just blame me for insufficient comments in the source codes. By the way, the first changes in the programme should be your comments on your assumptions on the inquired algorithm, whenever you get an idea, what a given part serves for.

I hope that at least some programmes will prove useful to you, as they have already for my colleagues. I thank them for their development (in an alphabetic order the involved people are David Motl, Rudolf Novák, Leoš Ondra, Tomáš Rezek and

[2]In April 2000 I have added a possibility to use the standard files with description of trajectories [13] in the MPC and xpehem formats.



based Bright Star Catalogue are often much in error) [18]. With huge Tycho catalogue, maps containing all stars visible with small binoculars can be made, including precise photometric information. The program can be considered a graphic batch viewer of these two large catalogues, which displaying any infomation from them. In case of Tycho, a subset of data (e.g., one third in size, as those made by `tyc_sel` programme) can be used for input as well.

### 8.1 Examples: charts to be put and moved under masks

"Rotating charts" or planispheres are common as planar circular structures; however, the programme enables to make conical maps (which become really conical, when their ends are glued together) and straight belts as well. Their purpose is always the same: to show, which stars are over horizon, and to demonstrate, how they rise, move and set. The following explanation is meant for those people, who really print the maps and masks using the prepared batch files.

It may seem obsolete to make paper toys like that, when computer can show you the sky at any moment and any place on the Earth. However, the computer is not so easy to hold in front of you under the open sky. And the resolution of the screen is far inferior to the resolution of advanced printers.

To make a pair of plain turnable charts for a latitude of, say, 55 degrees, run `mb_ns_ch f55`. It will prepare and print (if you are using GhostScript) four sheets: north-pole-centered map (equidistant in declination), south-pole-centered map (stereographic) and zenithal grids for these maps. Cutting, folding and gluing will provide you then with a turnable star chart with one face for an all-sky view, but much distorted near to south, and another face for looking at the southern horizon without much distortion. See further section for detailed instructions regarding the assembly.

To make a conical map with a turnable mask, use `mb_c_ch.bat`. It will produce two sheets to be cut in an obvious way and glued to make real cones (just bottom part, in case of a mask). A pair of a conical mask and achart has an advantage, than no special folding is necessary to center the mask properly: the conical shape does it itself.

To get a map with no bias toward one or the other celestial pole, run `mb_e_ch.bat`. It will produce four sheets. Three of them are maps; they should be cut along the lines corresponding to celestial poles and then glued together to form a single long map with stars repeated two times. The remaining sheet should not be cut but folded along these lines of declination plus and minus 90 degrees, to fit around the prepared long map. Then its face part should be cut (preferably by a razor on a cardboard) along the horizon line and then along the marginal lines above the horizon, till the upper fold. It becomes the mask then. Insert then the long map belt there and shift it to match the sky at the wanted moment.

For example, you can start the Windows system by `win.bat` or just `w.bat`, which read probably `C:\Windows\win.com` — no other programmes in the `\Windows` directory are run by MS-DOS, and so it is dull to include that huge directory in the `Path`. (Why it is so common? MS-DOS makes no `\bat` directory during its installation, and so no programmes are relying on it during their own installation.)

Batch files enable to define starting values for various programmes. For example, I have a batch `t.bat`, which reads `C:\s\t602\t602.exe /EGAm %1 %2`, and by which I can easily open up to two files in that popular Czech editing program, and use a bit higher letters. Another batch you will surely need is `tpc.bat`, running a command-line compiler of Turbo Pascal (you can place a `/m` parameter there, which makes sure that changed units will be compiled as well, or parameter `/l`, to overcome insufficient free memory). The Borland system for developing programmes is started by a batch `tp` on my computers, Free Pascal Compiler by `fp`.

You would do well to copy the batch files contained in directories `Astro` and `Util` of the archive `pas_jh` into the `\bat` directory. From the root directory of the archive, copy two batch files there, `tpc.bat` and `tpc_all.bat`. The first one compiles one file, the other one compiles all files in a current directory by the fist one. Failing compilations are logged in `fail_tra.lst`.

The `ExeTPU` directory, as I call it, has to appear in the `tpc.cfg` file in the `/E` parameter — there the compiled units and programmes should be placed, and there the compiler tries to find the units compiled before. The `tpc.cfg` file should reside in the same directory as the compiler `tpc.exe` itself (which I call by `tpc.bat`).

The `Path` variable should continue (or end) with a directory containing various viewing and packing programmes, in my case `C:\s\nc`. There I have the programmes for creating and expanding archives. To expand an archive, make a directory for it (it may have the same name), copy the archive there, and issue a command `pkunzip -d` *name of archive* (suffix `.zip` can be omitted)[1]. The `-d` switch ensures restoring the needed subdirectory structure. The archive file itself can be then deleted.

In case of archive `BSC5_cd` with a part of *The Bright Stars Catalogue* ([8]) there is a batch of the same name (i.e., `BSC5_cd.bat`), which makes that task, and then it runs a database programme which changes the files into a working form. To be able to run a database program, it needs a `d.bat` file with one parameter (in my case it reads `C:\s\db3\dbaza.exe %1`), which starts that program. If the programme is `dBaseIII+`, `Append.exe` (MS-DOS resident program) should run with a directory containing that program. In my case it is accomplished by `ApdB.bat` reading:

```
LH Append /e
Append c:\s\db3;c:\s\tp\bgi;
```

If your `Autoexec.bat` does not execute the above command, then (for programmes using a graphic mode) it should contain a line like

```
Set BGI=C:\s\tp\bgi
```

which informs the programmes where the graphic drivers (Borland Graphic Inter-

[1] When using unzip, the -d switch is default — it may be a good idea, having a batch file doing that for pkunzip as well, i.e., creating always the needed subdirectories.



## References


[1] The source texts and executable files are at http://astro.sci.muni.cz/pub/hollan/programmes, which is the same as ftp://astro.sci.muni.cz/hollan/programmes

[2] GNU General Public License, see http://www.gnu.org/copyleft/gnu.html. The same directory (http://www.gnu.org/copyleft/) gives reasons for this license.

[3] See http://www.ian.cz/apo (mostly in Czech only)

[4] Free Pascal Compiler, see http://www.freepascal.org

[5] Pokorný, Z.: Astronomické algoritmy pro kalkulátory. Hvězdárna a planetárium hl. m. Prahy, 1984.

[6] Meeus, J.: Astronomical Formulae for Calculators. Willmann-Bell, Richmond, Va, 1982.

[7] Wolf, M. et al: Astronomická příručka. Academia, Praha 1992. ISBN 80-200-0467-X

[8] The Bright Star Catalogue, 5th Revised Ed. (Preliminary Version); Hoffleit D., Warren Jr W.H.; <Astronomical Data Center, NSSDC/ADC (1991)>. Original form available as ftp://cdsweb.u-strasbg.fr/pub/cats/V/50, a dBaseIII+ format version as ftp://astro.sci.muni.cz/hollan/data/bsc5dbf.zip

[9] ESA, 1997, The Hipparcos and Tycho Catalogues, ESA SP-1200. See http://astro.estec.esa.nl/Hipparcos or http://cdsweb.u-strasbg.fr/hipparcos.html. The catalogues can be downloaded from ftp://cdsweb.u-strasbg.fr/pub/cats/I/239 even in the FITS format, which can be readily converted (by `fit2dbf`) to the dbf format.

[10] Little Star Atlas, see http://astro.sci.muni.cz/pub/hollan/data/litt_atl

[11] Dušek, J., Hollan, J., Gabzdyl, P.: Báječný svět hvězd. Hvězdárna a planetárium Mikuláše Koperníka v Brně, 1996. ISBN 80-85882-03-5

[12] MegaStar, version 1.5 CD, a computer star atlas by E.L.B. Software (by Emil Bonanno). Information on the current version (having a different format) is available on http://www.willbell.com/software/megastar/index.htm

[13] Files with elements of tractories of icy and stone minor planets are available at http://cfa-www.harvard.edu/iau/Ephemerides/index.html

[14] PostScript, a language by and trademark of the Adobe Corporation, see http://www.adobe.com/print/postscript/main.html