Astronomic and other programmes (written in Pascal)

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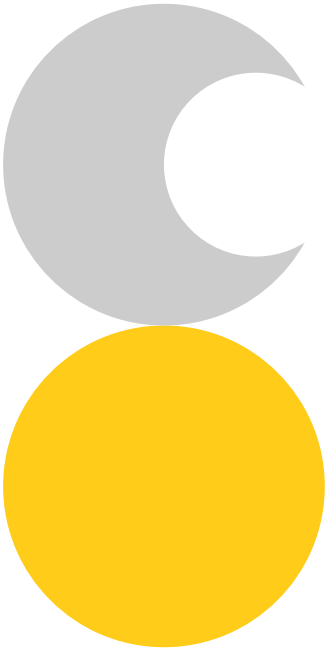

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1 Introduction

The set of programmes has been made at the *Nicholas Copernicus Observatory and Planetarium in Brno* (http://www.sci.muni.cz/obsbrno). It contains mostly work of members of the *Amatérská prohlídka oblohy* (*Amateur Sky Survey* [3]), whose professional member I am. The programmes solve a lot of various tasks I have encountered, astronomical and another ones.

All programmes and their parts are *free software*, and to ensure the freedom further on, their use is regulated by the GNU General Public License as published by the Free Software Foundation, either version 2 of the License, or (at your option) any later version. If you do not have the text of the license (it should accompany the programmes as `gpl.txt`), you will find it at http://www.gnu.org/copyleft/gpl.html. The same directory (http://www.gnu.org/copyleft/) gives also the reasons, why is such specification needed and what *free software* in general is. GNU license demands, e.g., that anyone, who gets some of the programmes in an executable form, would obtain its original text or an information, where it is available.

The programmes can be best used by those people, who have access to the Borland Turbo Pascal compiler, or who will download a very good Free Pascal Compiler [4]. The last one works on many platforms (under Linux as well). Source texts of all programmes are available as a packed file `pas_jh.zip` at

http://astro.sci.muni.cz/pub/hollan/programmes .

The same address hosts also translated executable files for a PC-XT with numeric coprocessor (as a package `exe87_jh`), for a PC without it (`exe_jh`) and for Linux PC's. The disadvantage of executable files is they cannot be adapted to your environment, which can differ in directory structure, time zone, etc.

Some programmes need astronomical data, and these are available as further packages (or archives, `*.zip` files). The packages are packed by programme `pkzip` (or by programme `zip`, on UNIX platforms). They can be "unzipped" by e.g. `pkunzip /d pas_jh.zip` or by `unzip pas_jh.zip`.

2 Using computers with MS-DOS

To make a computer serve you well, you need to configure it properly. Start with the file `AutoExec.bat` in the root directory of MS-DOS[1]. I recommend you very much to define the beginning of "environmental variable" `Path` (list of directories, where executable files are sought) as

```
Path=C:\bat;C:\DOS;C:\s\exetpu;
```

— the very beginning is the directory with batch files (programmes in the operating system language), which you use to start programmes contained in many different directories. There is no need to include these many directories into the `Path` variable.

[1] This simple operating system (or its analogues ∗-DOS) used to be the only one for "personal computers". It can be run on these computers (at least simulated) from more sophisticated systems as well, and so most of the programmes written for this old system can be used further on.

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.

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

numeric co-processor to an even number. I have changed in some programmes the rounding procedure to a third possibility, namely always to a greater value (by a function RoundUp). The second problem concerns formatting. With co-processor, all unformatted real numbers are output as extended, with e.g. four digits in exponent. Some formatting procedures at the beginning of `str_num` unit overcome different behaviour of different hardware.

The programmes are English-written, with few exceptions. Why is that so, when most of the users are speaking Czech? The main reason is, that the author hates disabled Czech without diacritics, and that Czech diacritics has not just one possibility how to be implemented in the computers. The problem of two main MS-DOS-based "code pages" can be solved by the programme `CS_Conv`. But the English programmes are easier to read, when names of variables, subroutines and comments are English as well as the programming language. And each potential user of these programmes surely reads English, with some effort at least.

If you make some programme better, and you suppose, that your adaptation may suit another people as well, please give them whole this package including your addition. I welcome you sending the modified programme me as well. I will gladly discard the original work and replace it by the same-named version by you in our set.

As follows from the License [2], everybody can modify the programmes and use their parts in her/his own programmes. If such programmes are spread further, they are obliged to remain free software subject to the same Public License.

If the change of a programme concerns only

- the list of directories where the data files are sought for, or
- the five default constants concerning the observing site (these are at the beginning of the `solar_ut` unit),

the programme can keep its name and no notice on the change is needed. The same holds in case, when just explanations are supplemented (it may be needed in some cases, to make the use of the programme understandable to another people than to author himself).

4 Handling the programmes

Some programmes explain how to use them, whenever they are run without parameters (this applies for those ones, which always need some parameters). Another ones offer instructions to users, if at least one of parameters is `?` (or `/?` or `-?`). Programs with long explanation should give a possibility to write it into a file instead to a screen. Mostly the standard redirecting of the output can be used, as `fGCVS >> fGCVS.hlp`. Some programmes, which have to react on each key during their work, make redirecting impossible, however (the `crt` tool of Borland Turbo Pascal language is guilty). These programmes create a file `*.hlp`, when asked to do that by `/h` (or `-h`) parameter. For example, `graph_d -h`.

All of the programmes are controlled by the parameters on the command line. Saying *parameter*, we understand a "word", single parameters are (as usual with

real words) separated by spaces. Controlling programmes by parameters is comfortable thanks to the fact, that the command can be repeated many times with just small changes of parameters (directly from MS-DOS you can do it easily, when the `DOSKey /insert` runs). Even greater advantage is a possibility to make batch files (i.e. `*.bat`), where some parameters are defined already (e.g., your geographical coordinates).

The above-mentioned programme `graph_d` is one of few exceptions. If you use it for polynomial (usually linear) regression of data, or if you try to find their axis of symmetry, then the programme asks you some questions also in the course of the work. This conversation is implemented in a rather simple way (it is an old programme already, what appears also through an unusual shape of its command-line parameters), but it suffices its task.

Most programmes in our set, which produce a graphic output on the screen, can simultaneously create a corresponding file with a picture in LaTeXor PostScript language (file `*.eps`). Using them, you can produce prints with unlimited resolution, and modify them before the print by any text editor. This is a notable advantage over those commercial programmes which offer a mere possibility to copy a screen on the paper. As far as PostScript [14] is concerned, it is language of all advanced printers and photo-setting machines. If you have none, install GhostScript (http://www.cs.wisc.edu/~ghost) into your computer. Its supplement PSView can be then used for comfortable viewing of PostScript outputs on the screen.

As the graphic screen may pose problems in some cases (e.g., on Linux text console), the graphic programmes may be converted to text versions, which produce just the PostScript output (there are conversion batch files available).

5 Remarks on selected programmes

I have mentioned the programme `Graph_d` already. It produces graphs and histograms, preferably from files of `*.dbf` type. It can handle also text files, which have some columns of numbers inside of them. Its another special feature is, that it can stack the data according to the given period, or even find their symmetry axis (this is a common task in astronomy).

The same directory `Util` contains a couple of another programmes I often use. One of them is a programme `CutBE`, which can copy a part of any (large) file, and by running several times, divide the file to several parts (see batch file `cut10`). The copied parts of reasonable size can be then edited by common editing programmes and by a MS-DOS command `copy` glued together to a single file again (see `copy10.bat`). The `CutTrBla` programme cuts away obsolete spaces at ends of lines of a text file (most editing programmes make it as well, but just for small files).

From the `Astro` directory I use many programmes quite often. The most complicated one is contained in a separate directory `Map_BSC` and described in the last section of this booklet. Another mapping programme is `Map_mGSC`. It uses the famous *Guide Stars Catalogue*, in the version of the MegaStar atlas [12]. To be able to

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.

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	`*.FIT`s 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

directory\ programme	
vlnka2	replaces spaces by `\ ` after specified one-letter prepositions or by ~ (default) (a slight modification of Vlnka.pas, offered by $\mathcal{C}\mathcal{S}$TUG[17])
Astro	*Astronomical programmes*
Dif2Rat	Difference of Faintnesses / 1 mag → Ratio of Brightnesses
Ecl2equ	Ecliptical length and width → *RA* and declination
Equ2ecl	*RA* and declination → l and b (ecliptical longitude and latitude)
Equ2gal	*RA* and declination → galactic longitude and latitude
F_GCVS	Information on a star from the General Catalog of Variable Stars (GCVS)
Faint	Faintesses of stars from a matrix of their comparisons, rough work
Fai2Bri	Faintness (and distance) → brightness and energy domain
Fourierm	Frequency diagram from data of a special format, in Czech, by Leos Ondra
Grid	Meridians and parallels for a rotational ellipsoid, like Jupiter
Hel_Cor	Heliocentric correction (a quantity used for variable stars)
Lum	Luminance expressed both standardly and in a queer astronomical way
Map_mGSC	Plots a star chart (from the Guide Star Catalog as packed in MegaStar ver. 3)
Map_wire	Length of deformed main circles in "true-polar-distance" maps
Moon	Lunar ephemeris (daily — main phases only — eclipses only)
Mul_fai	Faintness of a group of stars from faintnesses of its members
Nights	Times and azimuth of Sun passing a given angular height
Noci	Times and azimuth of Sun passing a given angular height, a Czech version
Padi	Angular distance of two points (or stars in the Bright Star Catalogue)
Planet	Positions of Planets (in the old sense of word, including Sun and Moon)
Posi	Positions of a body from elements of its heliocentric trajectory
Pre_d_bj	Example of precession from B1950 to J2000, for file Planets.dbf
Pre_g_bj	Example of precession from B1950 to J2000, for file GCVSred.dbf
Preces	Equatorial coord. of a star: original frame (B1950) → new frame (J2000)
Rat2dif	Ratio of Brightnesses → Difference of Faintnesses / 1 mag
Sol_Temp	Radiative balance – temperatures on insolated bodies
Star_pos	Angular height etc. of a point (or star in the Bright Star Catalogue)
Star_tim	Time of reaching an angular height (for fixed stars, planets, Sun, Moon)
Sun	Julian date, sidereal time, position of the Sun
Sun_ph	Equinoxes and solstices
Sundial	Planar sundials and Insolation of collectors and windows
Time2JD	Writes Julian dates (or MJDs) into a dBase file
Tr_bin	Trajectory of a visual binary star
Var_Dif	Writes average departures, their standard deviations and changes into a list of comparison stars and then writes the faintesses into a list of comparisons
\Map_BSC	*Program Map_BSC and the related stuff for bright star maps*
Map_BSC	Plotting Star Maps from B5_cd.dbf, obj.dbf and planets.dbf
Scale	Times versus dates, a scale for zenith star maps (Czech, LaTeX)
Scale_v	Times versus dates, a scale for zenith star maps (*.eps, vertical)

directory\
programme

\CCD	*Programs for Santa Barbara Sci.Instruments Group CCD cameras: five working ones for the ST4 camera (but not much checked) and a draft viewer for the ST7 camera and FITS images.*
FITSstVw	Displays a CCD image from ST7 SBIG camera or a FITS 16-bit image
pCCD1	Draft program showing a CCD image by ST4 and a MegaStar GSC map
S4	Displays an image from Santa Barbara ST4 CCD camera
S4df	Subtracts dark frame from an image by ST4 CCD camera
S4fa	SBIG-like "Flat-field" transformation of an image by ST4 CCD camera
S4fs	Natural "Flat-field" transformation of an image by ST4 CCD camera
S4m	Measures a stellar image from Santa Barbara ST4 CCD camera
\Min	*General program for predicting periodic phenomena, but with just one-purpose data; by Rudolf Novák.*
Min	Times of extrema of variable stars (of eclipses in eclipsing binaries)
Fun	*Programs for J. Hollan's children, demonstration and educational trifles*
Doppl2vs	Conversion of acoustic interval into vehicle velocity (with sound demonstration)
Doppl2v	Conversion of acoustic interval into vehicle velocity
Doppl	Sound of a body on a circular orbit: hearing the Doppler effect
Morse	Beeps letters in the alphabet of Morse
P	Screen writing with script letters (scaled by + or − key); Czech code
Piano	Plays tones given by keys; <Shift> makes them a halftone higher, <Ctrl> lower
Play	Plays a melody from a simple text file (see Melodie.txt)
S	Screen writing with SansSerif letters (scaled by + or − key); Czech code
Tada	Adding and subtracting excersizes, conversating in Czech
TadaN	Multiplying and dividing excersizes, conversating in Czech
Screen	*Setting video modes, various tests and operations with graphic screens. The most useful programs are:*
Vmod	Setting video modes of VGA cards (standard, VESA 6a, card-specific ones). A crazy screen can be often cured by: VMod 3
VmodV	Setting video modes of VESA-obeying SVGA cards
Tisk	*Czech and graphic print on an old large dot printer CS 212-25, controling Epson printers (in Czech). The only program for standard printers is:*
Setlpt	Controls printers using Epson language, in Czech
Units	*Units for programs used by Jan Hollan*
Angles_O	Angular and matrix operations, Opening text files
Binaries	Information on a binary star from Binaries.dbf

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-

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.

8.2 Assembling a pair of planispheres

If you happen to live near the latitude 49.2°, you can use the prepared maps in the `astro\map_bsc\maps` directory. Otherwise, you should run the batch `mb_ns_ch` with appropriate latitude parameter. Take the four resulting sheets and view them. To save you experimenting with proper cuts, folds and gluing, I recommend you the following procedure.

First, your printer may distort the picture, what is bad especially in the case of the border circle. To correct or check it, take a compasses and make a circle centered at the pole; the circle should be just slightly smaller than the printed one.

The hole you have made in the pole will then help you to align the two maps back to back properly. Properly, it means with the stars to opposite directions. Stack the maps on the window and match the poles; the rims of paper should remain parallel. Press the left half of stacked sheets firmly against the window, bend the right half ot the top sheet left and put some glue sparsely on the the bottom sheet, just a band some one centimeter wide along the border circle. Press the top sheet quickly there, so that the bottom sheet gets no more wet than the top one. When it holds after some five or ten seconds, repeat the procedure with the other half of the sheets. Then you may cut it along the border circle.

The two masks should be handled differently. The southern one (stereographic, with all curves being circular arcs) should be cut along the straight lines, and then along the horizon (or very slightly outwards). The "clock face" will remain on the resulting part.

The northern mask should be not cut but folded around these straight lines. Cutting the northern mask is a bit more complicated. Cut it along the other straight lines, prolong cutting along the border circle, and continue along the curve of an angular height of -30 degrees. Then the inside part of the mask is to be cut away: along the horizon, of course, so that the "clock face" will be discarded; you may wish to cut a bit more inside, to leave azimuth marks intact.

The two masks are then to be glued together in an obvious way: put the southern one inside the folded northern one, center it properly (to compensate for possible printer distortions), and glue the folded part of the northern mask onto the southern one.

Then you can insert the two-sided map into the pocket formed by the masks (northern map should be under the northern mask), align the month (or its proper part) on the map with the time (local, not "summertime") on the mask, and you will see which stars are over horizon.

If you prefer to join the pair of maps with their masks permanently, print the four sheets once more, and cut the northern mask along four tangents * of the marginal dashed circle. Cut it in the cusps till that circle, and fold the halved cusps over the inserted pair of maps. Gluing the halves of cusps together will make the charts permanently masked.

Of course, hard paper will do a better job than an ordinary one; laser printers are adapted in seconds to print without bending the paper, and can tolerate quite

thick sheets (consult the manual) — they should just have smooth surface to accept the paint.

8.3 Stereoscopic maps

Parameters `s` and `sc` or `sm` enable generating pairs of maps, which can produce an illusion of a 3-dimensional scene: just one map, showing the various objects in various distances. However, if you are not experienced in viewing stereo images, you may find it difficult to reach such view at all, not to speak about viewing the 3-D image comfortably.

The impression of the depth is attained in such a way, that the stars in maps for the left and right eye are shifted in various extent with respect to each other, according to their distance from the Earth. The lines connecting the stars with the appropriate eyes are to be more convergent for the near stars. This convergence is called parallax. 'Astronomical parallax' concerns the case, that the 'eyes' are one 'astronomic unit' apart, or some 150 Gm. Astronomical parallaxes of fixed stars are smaller than one arcsecond. For the stereomap to work, the plotted parallaxes are to reach some tenths of a degree for your true eyes.

A comfortable view can be attained in such a case, that the convergence of the eyes corresponds to their focusation (accomodation). A perfect match can hold just for the only apparent distance, preferably for distant stars with almost zero astronomical parallaxes. Stars with a larger parallax seem to be closer, but the eye accomodation is unchanged, as in reality all stars are plotted in the same plane. This is the reason why no stereogramme reaches the quality of a hologramme, and why viewing means always some eyestrain.

The match of convergence and accomodation for distant stars can be reached by using suitable glasses. For example, if the distant stars are plotted in the same distance from each other as the mutual distance of your eye pupils is (say, 65 mm) and your face is some half meter from the screen, you need to strengthen the dioptric power of your eyesight by two diopters. You should use glasses with convex lenses of this power, or with the focal length of fifty centimeters. Such glasses are common, quite a lot of elderly people use them for reading. If you would have just glasses having four diopters, you should watch the maps from a distance of a quarter meter. Majority of stars would appear in a large distance and just the closest stars would emerge as near to you.

If you take glasses having two diopters (or, as myopists, you put off your glasses of -2 D) and you want to watch the map from a distance less then 50 cm, you have to use another base shift of star pairs. For a viewing distance of 25 cm the shift should be just half of your eye baseline (just some 32.5 mm), otherwise the view would be painful. In such a situation you have no impression of a distant universe, but you see most stars as if being in a plane half a meter from you, and just some dots are perceived nearer. These are more difficult to see, due to the non-matching convergence and focusation. You can see them better, if you get close, but then the view of the more distant stars becomes less pleasant.

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`).

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

[15] ScreenThief, a program by Villa Software, available, e.g., at http://www.simtel.net/simtel.net/msdos/graphics-pre.html as st201f.zip. A local copy is ftp://astro.sci.muni.cz/hollan/programmes/st201f.zip

[16] See pages of TEX Users Group, http://www.tug.org

[17] Československé sdružení uživatelů TEXu, see http://www.cstug.cz

[18] Examples of screens captured from star-mapping programmes `map_bsc` and `map_mgsc` can be seen at http://astro.sci.muni.cz/pub/hollan/programmes/images.

[19] Twocolor glasses for viweing anaglyphs (as well asl polarization and diffraction ones) sells, e.g., http://www.rainbowsymphony.com

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