Linux for astronomers, physicists and engineers Reference guide

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(Submitted 17.10.2013; Accepted 02.12.2013)

Abstract. The conference talk[1] is a summary of a reference guide book "Linux for astronomers, physicists and engineers" published before the opening the Second Congress of the Physical Sciences, held in Sofia, September 2013. The book was issued by the Marin Drinov publishing House of the Bulgarian Academy of Sciences after the decision of the Scientific council of the Institute of Astronomy and NAO. The book itself consist of three parts: Linux Operational system, Linux Astronomical software and LaTeX in examples.
Key words: Linux: Operational system, Astronomical software. LaTeX: examples

Introduction

Linux for astronomers, physicists and engineers reference guide is designed for scientists, graduate students, students and amateurs in astronomy. It is entirely intended for work with the Linux operating system and it is consistent with the traditions of the Institute of Astronomy. This is a 594 pages book with hundred of illustrations, printed in full color. It consists of three separate parts – Linux Operational system, Linux Astronomical software and LaTeX in examples. Each part includes a references and alphabetical subject index.

Below are some illustrations the of book covers and welcome page of http://baspress.com/book.php?l=b&id=1070 of the reference guide.

Figure 1 is the cover pages of the book.

Figure 2 is a combination of second and forth inner cover pages. ISBN number can be seen on the English version of the page.

Figure 3 is an advertisement of the book on the BASPRESS online e_book store.

1. Linux Operating system

1.1. Introduction

Computers can be seen as a combination of hardware – keyboard, mouse, box, CPU, etc., and the software – i.e. programs that run on it. The operating system (OS) allows the user to interact with the hardware and ensure the implementation of other programs.

There are many operating systems – UNIX, Windows, Mac OS, GNU/Linux, BSD, etc...Each one is designed to meet certain requirements and has its own area of application.

[1] Presented at the Session 08 – Astronomy during the Second Congress of the Physical Sciences, held in Sofia, 25 - 29 of September 2013

1.2. What is Linux?

Linux is a UNIX-like kernel created by Linus Torvalds. Linux kernel is often confused with the GNU/Linux operating system. Linux is the kernel, not the entire operating system. GNU/Linux is composed of GNU software and Linux kernel. That is considered as GNU/Linux operating system, but for brevity and also because of the widespread name we will use everywhere the name Linux .

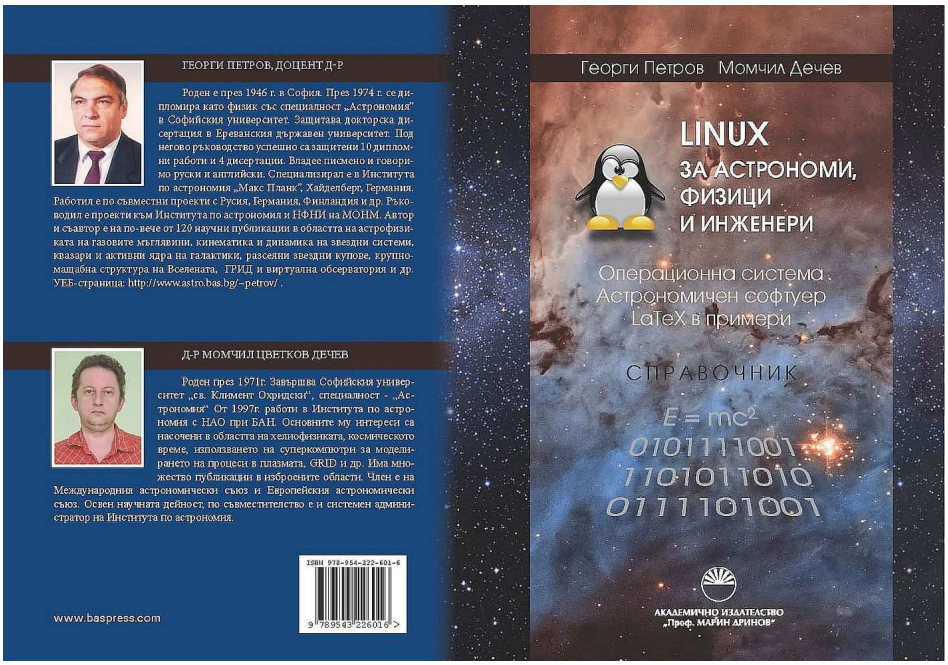
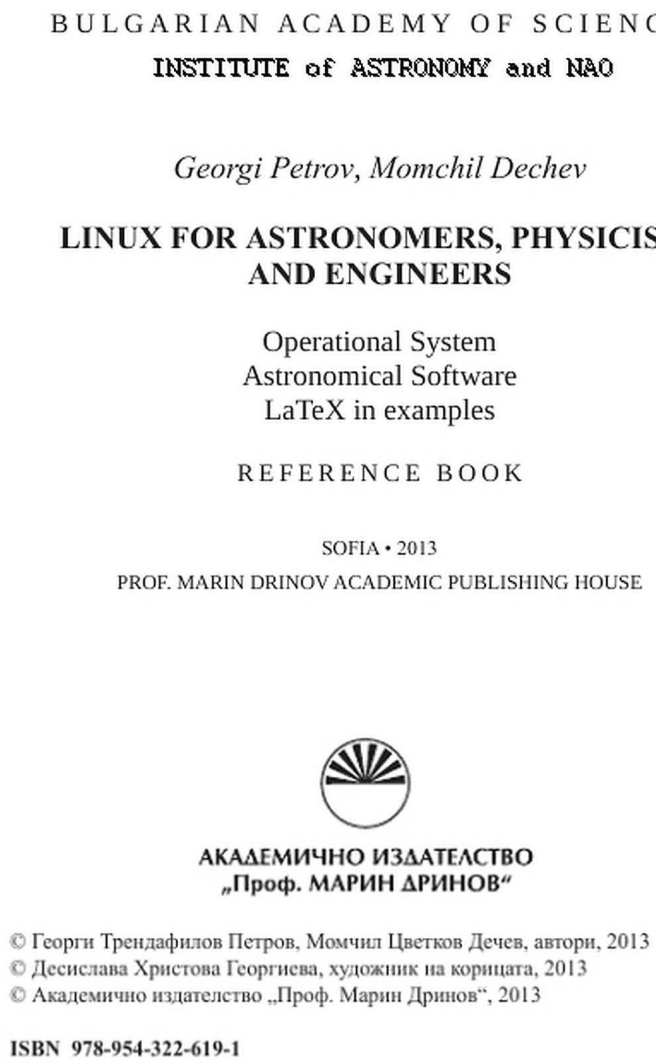


Fig. 1. "Linux for astronomers, physicists and engineers" book cover pages

1.3. A Brief History

As mentioned above, the Linux kernel is UNIX-like. What is UNIX? To explain this, we must go back in time when computers occupied whole rooms, were very expensive and each worked with its own operating system. These operating systems were designed for specific tasks and did not work on system other than that for which they were designed. This was a huge inconvenience. To solve this problem,in 1969, a group of researchers at Bell Labs began a project called "UNIX". UNIX operating system became unique. It is written in C language, unlike its predecessors, which were previously developed in assembler. Assembler language was close to machine code of the processor for which it was intended. That fact greatly hampered the portability of operating systems on different processor architectures. Writing UNIX in C made it portable to carry among hardware architectures and contributed to its great popularity. Based on UNIX occurred multiple clones, some of which exist and are still used today.

In 1984 Richard Stallman began an ambitious project that aimed to create a free UNIX-like operating system. Its name is GNU – an acronym of "GNU is Not UNIX". About 1990 the most important components of GNU OS were written with the exception of the kernel. In 1988 it was decided that the kernel of GNU OS will be Mach 3.0 microkernel, but it was not released under a free license until 1991.


BULGARIAN ACADEMY OF SCIENCES

INSTITUTE of ASTRONOMY and NAO

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LINUX FOR ASTRONOMERS, PHYSICISTS AND ENGINEERS

Operational System
Astronomical Software
LaTeX in examples

REFERENCE BOOK

SOFIA • 2013

PROF. MARIN DRINOV ACADEMIC PUBLISHING HOUSE

АКАДЕМИЧНО ИЗДАТЕЛСТВО
„Проф. МАРИН ДРИНОВ"

ISBN 978-954-322-619-1

Fig. 2. "Linux for astronomers, physicists and engineers" book inside cover pages

At that time, Linus Torvalds, a student from the University of Helsinki, disappointed by limitations of MINIX (a branch of UNIX) and the inability to

use expensive UNIX systems, decided to create its own OS that is compatible with UNIX. It created a Linux kernel and distributed it to many hackers, computer professionals and amateurs. Linus quickly found many supporters who paid support in the kernel for almost all hardware available at the time. So from the GNU OS and Linus kernel was born a new operating system – GNU/Linux. It gained immense popularity and spread rapidly. Today Linux OS is almost everywhere – from supercomputing clusters and personal desktop systems, to embedded devices.

Fig. 3. "Linux for astronomers, physicists and engineers" book from BASPRESS e_books store

1.4. Distributions

Linux operating system comprises a plurality of components. The most important of these is the kernel, but also drivers for hardware devices, programs for managing file systems, user programs, etc. should be available.

Unlike other OS (e.g. Windows, Solaris etc.) components of Linux OS are not developed and maintained by a single company. Most of the developers are independent groups of fans. This allows different sets of software around the Linux kernel to be created. This set of user and system software and the kernel

is called distribution. Definition of the distribution is given at www.linux-bg.org: " Linux distribution is a set of programs including the essential components of the operating system, a set of application programs and program for installation, allowing the installation of GNU/Linux on the user's computer".

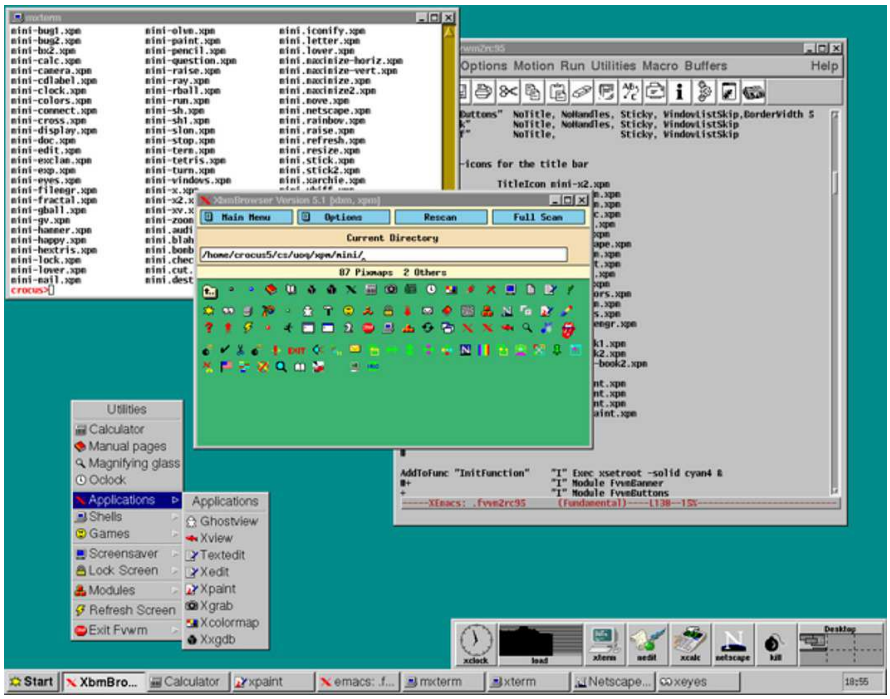

Fig. 4. Linux desktop with some applications

The first distribution appeared almost immediately after Linus Torvalds released the kernel under the GPL license. The first distribution was established in England in 1992 by Owen Le Blanc and it was called the MCC Interim Linux. In 1992 the distribution of Peter McDonald Softlanding Linux System (SLS) appeared. It included the first X-Window System (GUI) and TCP/IP (network support). At the end of 1992, Patrick Volkerding created a distribution based on SLS - Slackware, which is still the oldest active maintained distribution nowadays.

At present it is difficult to say how many distributions exist. Every day there is newborn distributions and others that cease to exist.

The site www.distrowatch.com can list about 400 distributions.

The first part of the book explains 110 Linux commands in details with 87 figures and 6 tables. References to this part are 28.

Here we put some illustrations from the Part 1 of the reference guide as an example. Figure 4 shows Linux desktop with different applications and panels.

Figure 5 shows the welcome screen of Slackware installation.

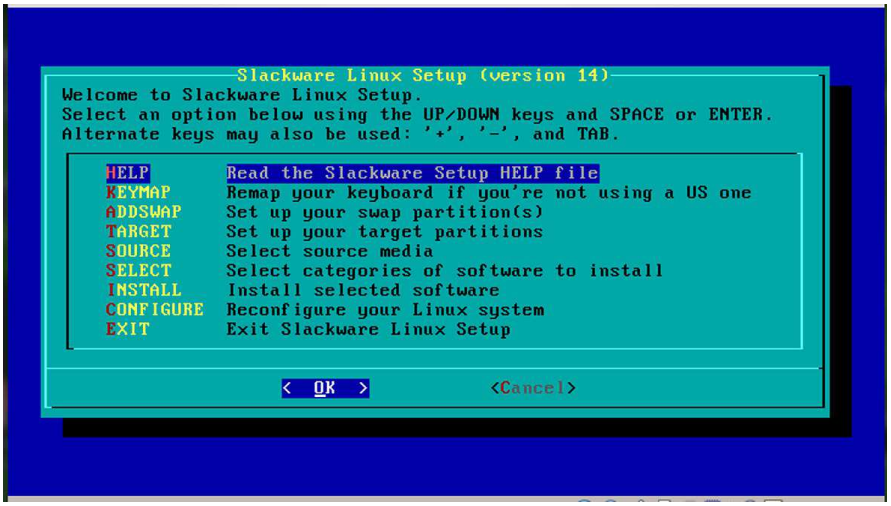

Fig. 5. Slackware setup screen

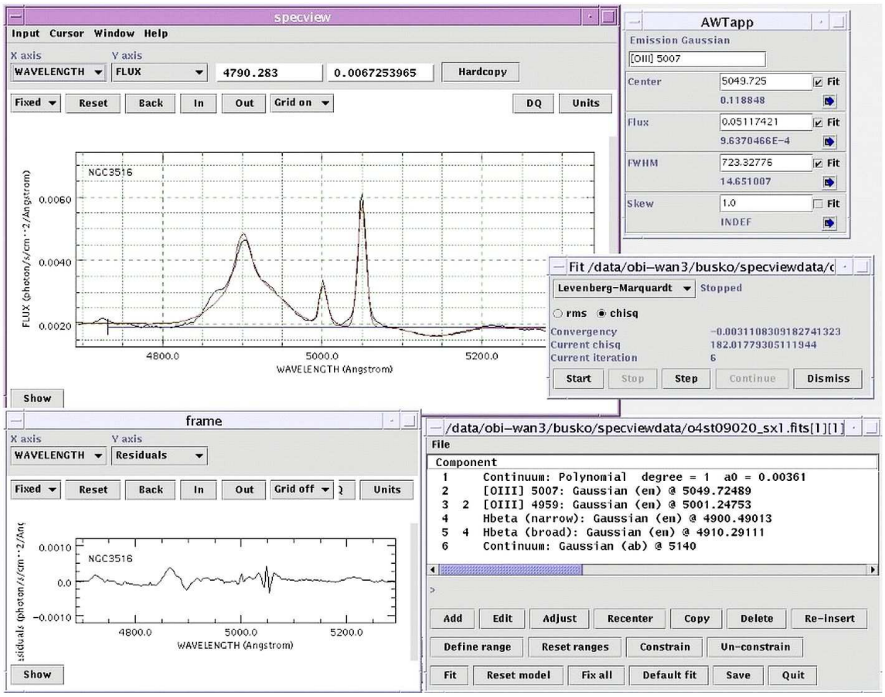

Fig. 6. SpecView possibilities

2. Free Linux astronomical software

The rapid development of astronomy, construction and commissioning of new telescopes and new equipment, as well as a huge amount of astronomical data often require astronomers (professionals and amateurs) to know and use many different, sometimes very complex or specialized astronomical software.

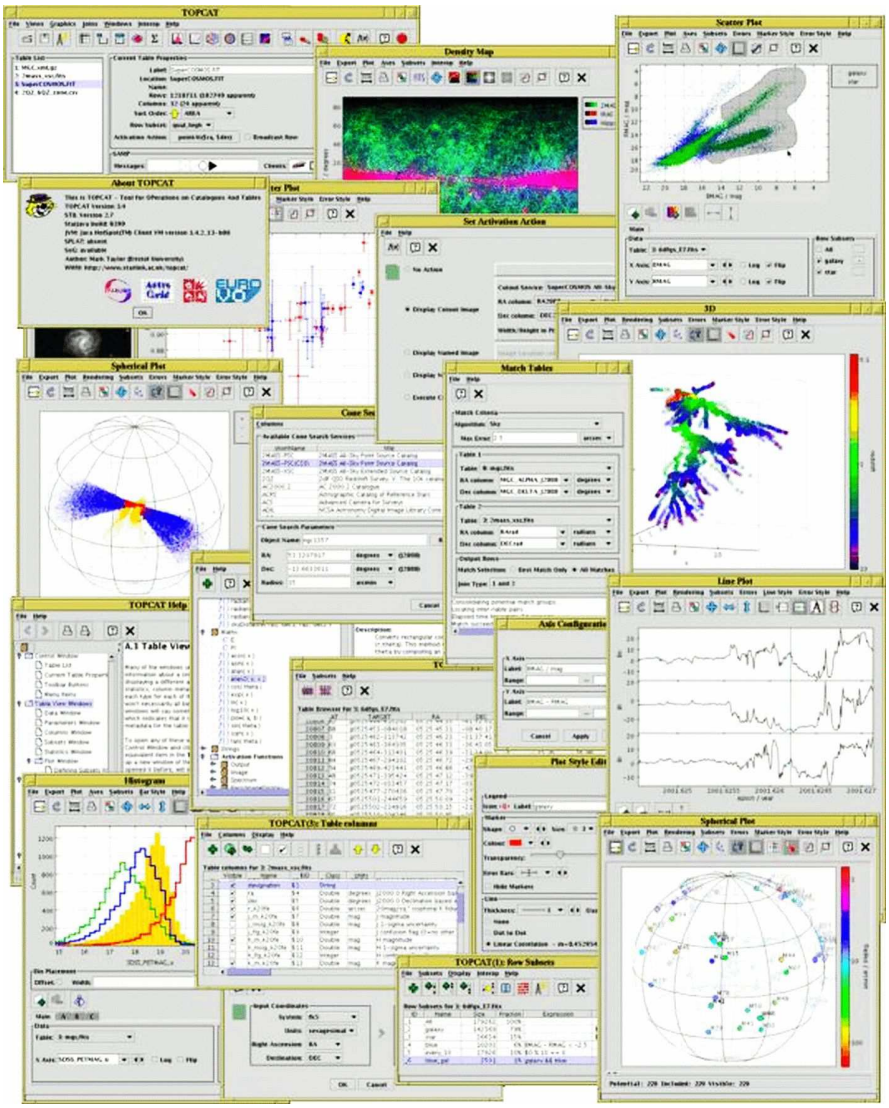

Fig. 7. TopCat software possibilities

Sometimes it is not easy to decide which package will give you the best solution to the problems you are interested in. There are offered many free specialized astronomical software, and many paid packages. Here we describe

152 free astronomical software packages for the Linux operating system. Included programs and packages of programs are freely distributed with GPL license or a license to the authors that allows free use of the software for teaching and research but not for commercial purposes. The exception is the prepaid software product IDL because its special status in the astronomical community – astronomers have developed a rich set of specific astronomical packages that run in the environment of IDL. Some of these packages, not included in the basic freely distributable archive ASTRO.IDL, are presented in this manual. Similarly, some IRAF's software packages, which are not distributed with the basic version, are included separately in the book.

$$\frac{1}{1+\cfrac{e^{-2\pi\sqrt{5}}}{1+\cfrac{e^{-4\pi\sqrt{5}}}{1+\cfrac{e^{-6\pi\sqrt{5}}}{1+\ddots}}}} = \left(\frac{\sqrt{5}}{1+\sqrt[5]{5^{3/4}\left(\frac{\sqrt{5}-1}{2}\right)^{5/2}-1}} - \frac{\sqrt{5}+1}{2}\right) e^{2\pi/\sqrt{5}}.$$

```
$$
  {1 \over\displaystyle 1 +
   {\strut e^{-2\pi\sqrt{5}} \over\displaystyle 1 +
   {\strut e^{-4\pi\sqrt{5}} \over\displaystyle 1 +
   {\strut e^{-6\pi\sqrt{5}} \over\displaystyle 1 +
   {\rule{0mm}{2mm} \makebox[5mm]{} \atop \ddots}%
}}}}
=
\left(
{\sqrt{5} \over
1 + \sqrt[5]{5^{3/4} \left(
{\sqrt{5} - 1 \over 2} \right)^{5/2} - 1}} -
{\sqrt{5} + 1 \over 2} \right) e^{2\pi / \sqrt{5}}.
$$
```

Fig. 8. LaTeX presentation of a quite complex formula

The programs are divided into 10 groups. All the programs are presented in alphabetical order within their groups. Of course, some programs can be assigned to more than one group – such as GADGET, ISYS for X_ray and some of GRID applications. E.g. SPLAT program is presented in two sections – Section 7.14 – spectral analysis and SPLAT-VO in Section 9.9 – VO-software due to the specificity of its two applications. In any case, a reference index, applied at the end of this part of the book presents all the programs under their original names along with information about the chapter and page they can be found. Names of the authors, programs and program packages are generally not translated.

References to this part are 218, all the 152 program packages are illustrated with 87 figures.

Here are two examples from Part 2 of the reference guide.

Figure 6 shows some of SpecView possibilities.

Figure 7 shows extremely rich options of work with TopCat software package.

3. LaTeX in examples

3.1. Introduction

The third part of "Linux for astronomers, physicists and engineers" is dedicated to a particular application for preparation and publication of scientific papers (mainly for mathematics, physics, chemistry, etc.) software package LaTeX. It is assumed that the user have a general idea what this application is about, but the basic rules are given in the first two chapters. The idea is this book to be an assistant in your work mainly through detailed examples, of which there are hundreds aligned. It is not important to read the chapters sequentially – in the end of the book there is a reference tool. One has to read carefully the examples throughout the book, because a large amount of information is contained in them. The last chapter is essentially a fictitious astronomical article with complex formulas, tables and graphs. It is the sum of the real parts of the posts, but can not serve only as an example. The index will help to find quickly all mentioned commands.

3.2. What you will not find in this book?

In practice, this book will not deal with BibTeX – neither in detail nor in examples. Similarly, the generation of the MetaFonts is rarely mentioned. LaTeX allows you to build charts and figures with graphics capabilities of the program, but we think it is more practical to create graphs and/or figures with specialized software and following the instructions and examples in Chapter 4, include them in your document. We do not discuss the special features of LaTeX for preparing presentations – packages Beamer, Prosper etc.

3.3. Historical remarks

LaTeX is a system that can be used for the preparation of high-quality printed materials – books, letters and other publications. LaTeX is based on TeX, specialized programming high-level language that was developed by Donald Knuth (Donald E. Knuth). LaTeX is a set of macro-packages, allowing the authors to process and print documents with high typographical quality, using a predefined, professional models. LaTeX is written by Leslie Lamport. As processing mechanism it uses TeX. Nowadays LaTeX is conducted by Frank Mittelbach. LaTeX is not working as WYSIWYG ("what you see is what you get") word processor for preparing documents as most people are used to. With LaTeX you do not have to worry about the formatting of the document, but only for its creation. In LaTeX environment LaTeX system plays the role of the book designer, using TeX as a technical artist. But LaTeX is only a program

and therefore needs explicit instructions. The author has to provide additional information describing the logical structure of his document. This information is stored in the body in the form of LaTeX commands. LaTeX files are plain text files that contain LaTeX macros. Filename extension of the standard TeX and LaTeX files is .tex.

Author index to this part includes 68 references, all the examples are explained in details with 119 figures and 132 tables. Subject index contains 277 positions.

Bellow are some illustrations from different chapters. Figure 8 demonstrates how to input quite complex formula.

```
\begin{figure}[htb]
   \begin{minipage}[b]{0.5\linewidth}
      \centering
      \includegraphics[width=0.8\linewidth]{graphic}
      \caption{This is a Figure by a Table}
      \label{fig:by:table}
   \end{minipage}%
   \begin{minipage}[b]{0.5\linewidth}
      \centering
      \begin{tabular}{|c|c|} \hline
         Day &  Data \\ \hline\hline
         Monday    & 14.6 \\
         Tuesday   & 14.3 \\
         Wednesday & 14.2 \\
         Thursday  & 14.5 \\
         Friday    & 14.9 \\ \hline
      \end{tabular}
      \captionof{table}{This is a Table by a Figure}
      \label{table:by:fig}
   \end{minipage}
\end{figure}
```

use a figure environment to create Figure 71 and Table 23.

Figure 71: This is a Figure by a Table

Day	Data
Monday	14.6
Tuesday	14.3
Wednesday	14.2
Thursday	14.5
Friday	14.9

Table 23: This is a Table by a Figure

Fig. 9. How to include a figure and a table together

Figure 9 illustrates how to include a figure and a table in one picture. The figure itself consists of part of LaTeX listing, showing how the figure environment and minipage could be used to include in one figure two different things – a figure and a table. The references of the figure and the table used in the example 9 are absolutely conditional – e.g. here Fig.71 and Tab.23. As one could see no references in the LaTeX listing are used and captions and labels have been used only for clarity . These exemplary figure and table are without any special meaning here.

Finaly fig.10 summarizes some often used astronomical symbols.

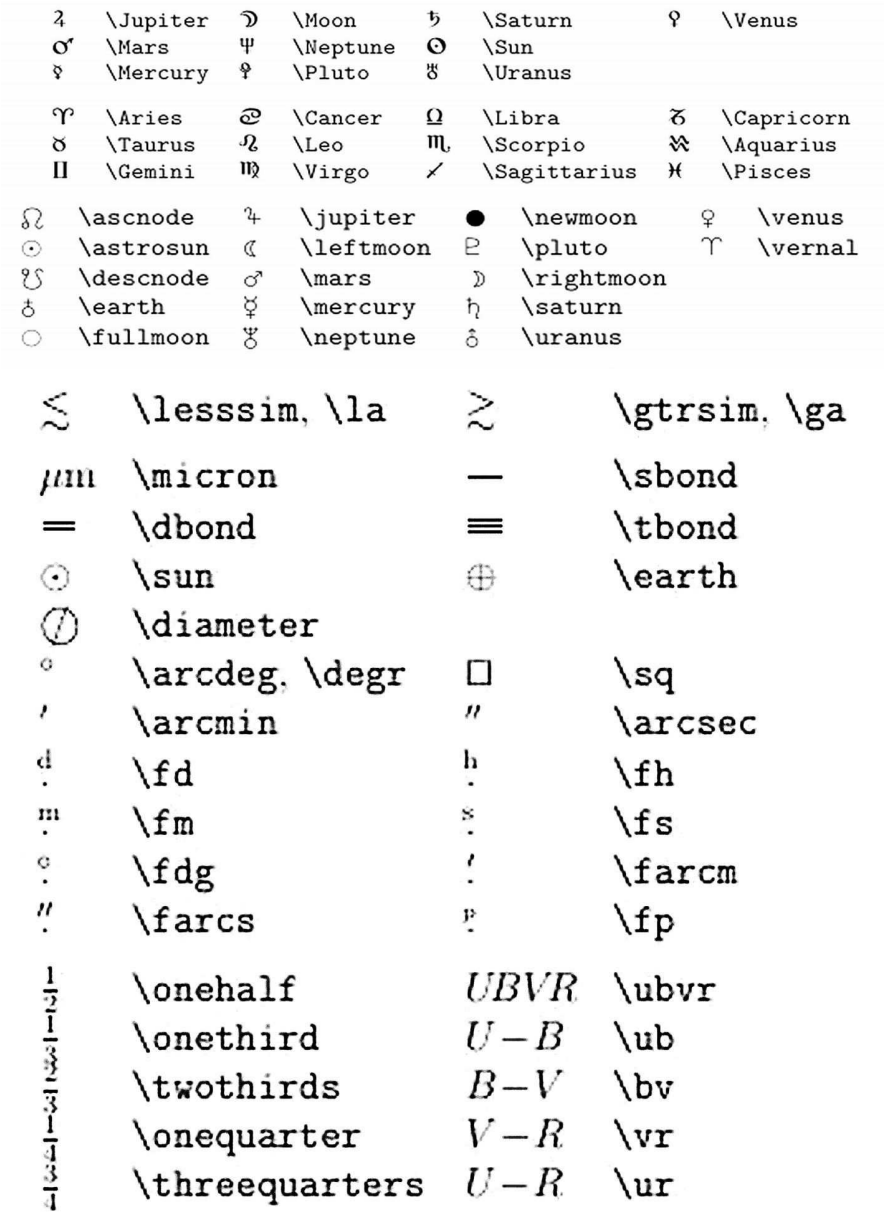

Fig. 10. Often used astronomical symbols

Acknowledgments

Authors are thankful to the referee of the book assoc. prof. I. Stateva, the graphical designer and the editor D. Georgieva and the text editor B. Kremenski from the Marin Drinov Publishing House.

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