Linux Astronomy HOWTO

Elwood Downey

John Huggins

<howto@astronomy.net>

$Revision: 1.48 $

$Date: 2004/02/07 17:58:56 $

This document shares tips and resources to utilize Linux solutions in the pursuit of Astronomy.

Table of Contents

1. Introduction

1.1. Knowledge Required

With all the help from major Linux distributions such as SuSE, Redhat and many others, Linux based systems are becoming easier to use. However, there is still some need of understanding of basic UNIX skills to make the most of Linux. Thus, this HOWTO will assume that the reader has at least a basic knowledge of using a UNIX system including the ability to compile and install programs.

A few resources we have found useful over the years include:

- "A Practical Guide to the UNIX System", Mark G. Sobel
- "Advanced Programming in the UNIX Environment", the late W. Richard Stevens
- "Running LINUX", Matt Welsh et al.
- "LINUX Device Drivers", Alessandro Rubini

Similarly, this is not a tutorial or reference for astronomy principles or astronomical instrumentation. Astronomy is perhaps the grandest of all sciences, employing widely disparate disciplines in a bold attempt to understand nothing less than the universe itself. Your interests will lead in many directions. A few references we have used include:

- "Explanatory Supplement to the Astronomical Almanac", P. Kenneth Seidelmann
- "Astronomy with your Personal Computer", Peter Duffett−Smith
- "Astronomy on the Personal Computer", Oliver Montenbruck et al
- "Textbook on Spherical Astronomy", W. M. Smart
- "The Astronomy and Astrophysics Encyclopedia", Stephen P. Maran, ed.

1.2. Scope

The authors define the scope of this HOWTO as primarily an index to Linux tools applicable in some fashion to the pursuit of Astronomy. It is NOT our intention to list WWW astronomy references in general. Our own interests tend more towards the technology than the pure science and so we welcome contributions from others who have found Linux tools which contribute in other ways to Astronomy. Please contact us at the address above.

1.3. Disclaimer

No liability for the contents of this documents can be accepted. Use the concepts, examples and other content at your own risk. As this is a new edition of this document, there may be errors and inaccuracies, that may of course be damaging to your system. Proceed with caution, and although this is highly unlikely, the author(s) do not take any responsibility for that.

All copyrights are held by their by their respective owners, unless specifically noted otherwise. Use of a term in this document should not be regarded as affecting the validity of any trademark or service mark.

Naming of particular products or brands should not be seen as endorsements.

You are strongly recommended to take a backup of your system before major installation and backups at regular intervals.

1.4. Version

$Revision: 1.48 $

$Date: 2004/02/07 17:58:56 $

The latest version of this document is always available on the Astronomy Net at Astronomy HOWTO.

We eagerly accept suggestions from you. Send them to Astronomy HOWTO Editors.

1.5. Copyright

In short, we wish to promote dissemination of this information through as many channels as possible. However, we wish to retain copyright on this HOWTO document, and would like to be notified of any plans to redistribute this HOWTO. For information about translations of this document, please see below.

1.6. Contributions

As we pursue the goals of the Astronomy HOWTO, we will recogize the contributions of folks who provide us with data here.

- Progga − Helped us get this document into modern times by converting the older linuxdoc to docbook.

1.7. Translations

Since Astronomy is very much an international effort, we encourage translation of this HOWTO into any language. We only ask the following:

- If you are a translator, please contact us at the above address so we may give proper credit here. This way, readers will immediately see what translations are available and see where to get them.
- Please obtain the latest copy of the Astronomy HOWTO from its home at Astronomy Net before you begin your translation effort.

We thank the following for their translation efforts:

- German Translation courtesy of Michael Moltenbrey
- Japanese Translation courtesy of Shouhei Nagaoka

1.8. About the authors

Elwood Downey has over two decades experience in software engineering for various astronomy projects. Learn more about Elwood at Clear Sky Institute.

John Huggins has over fifeteen years years experience in hardware engineering including eight years associated with an astronomy project. Learn more at John's Site.

2. Software

Software Section

2.1. Collections

Here are some links to collections and other indexes of Linux astronomy software.

- The Linux for Astronomy CDROM
- Scientific Applications on Linux (SAL), Physics and Astronomy
- Linux Applications and Utilities Page, Science and Math
- AstroMake is a utility intended to make installations of some common astronomical packages (in binary form) easy.
- The linuxastro mailing list also contains a list of applications and packages. For more information, see linuxastro.
- Astronomy at sourceforge.net

If the above does not appeal to your needs, these links may help:

- Linux Astronomy Software from the Google Search Engine
- Astronomy Software from the Yahoo Listings

2.2. Planetarium Programs

Here is discussion of programs which run on Linux for use in finding objects, natural and man−made, in the sky.

- XEphem has been the pet project of one of us (Downey) for the past 15−odd years. It has grown to become one of the more capable interactive tools for the computation of astronomical ephemerides.
- XSky is by Terry R. Friedrichsen, terry@venus.sunquest.com. XSky is essentially an interactive sky atlas.
- KStars is a Desktop Planetarium for KDE.
- Skymap is an astronomical mapping program written in Fortran and C for unix workstations by Doug Mink of the Smithsonian Astrophysical Observatory Telescope Data Center.
- Xplns reproduces real starry sky on your display of X Window System.
- Nightfall is an astronomy application for fun, education, and science. It can produce animated views of eclipsing binary stars, calculate synthetic lightcurves and radial velocity curves, and eventually determine the best−fit model for a given set of observational data of an eclipsing binary star system.
- NOVA free Integrated Observational Environment for astronomers.

2.3. Portable and Handheld Appications

The advance of palm computers has taken hold. Linux has made its way to this realm.

- Clear Sky Institute brings us the Personal Sky Chart for the Sharp Zaurus PDA.

2.4. Simulators

Programs that classify themselves as simulators.

- Celestia Real−time visual simulation of space for Windows and Unix(Linux)
- OpenUniverse Simulates the Solar System bodies in 3D in Windows and Linux

2.5. Image Processing

- Astronomical Information Processing System (AIPS) is the heavy iron used by professional astronomers. AIPS++ is the place to find out more, but note that AIPS Classic also exists and is actively maintained.
- Good ol' GNU Image Manipulation Program (GIMP) is a fine program to use for processing of digital images of all kinds and can prove useful for astro images as well.

2.6. Sun and Moon

A surprising number of applications deal with just the Sun and Moon.

- wmMoonClock shows lunar ephemeris to fairly high accuracy and is listed at this web site along with several other interesting programs.
- XVMoontool is an XView application which displays information about the Moon in real time.
- XTide is a Harmonic tide clock and tide predictor.

2.7. Libraries

This section discusses bits and pieces of software that can be used to form the basis for specialized projects.

- SLALIB, part of the Starlink Project, is a complete library of subroutines for astrometric computations.
- Astrophysics Source Code Library is a collection of links to numerical astrophysical process models.
- Astronomy and numerical software source codes is a collection of C codes related to astronomy.
- How to compute planetary positions.
- CCD Astronomy on Linux. A library of routines that help control SBIG cameras.

2.8. Games

Yes, games.

- Orbit − Be a space fighter pilot in Windows or Linux.

2.9. Other

Every list needs a miscellaneous section, and this is it for Software.

- IRAF is a gigantic but exceptionally capable astronomical analysis system, shepherded over the past 20−odd years by Doug Tody formally at NOAO. It has accumulated innumerable authoritative contributions from leading astronomers in all areas of astronomical data analysis. If you have a serious interest in astronomical data reduction and significant time to invest, this system will reward you mightily.

- Nightfall Eclipsing Binary Star Program
- Xplanet Very realistic rendering program for Earth and other planets and moons. Uses X Windows and OpenGL.
- StarPlot A 3−Dimensional Star Chart Viewer for Linux. Uses C++ and Gtk+.

3. Online Tools

I know we said we would not start listing Web sites, but here are a few links to sites which offer fully operational tools running online that we feel are especially useful or interesting, from a browser on any platform.

3.1. Traditional Form Based Programs

- Sun and Moon Rise and Set calculator
- Web version of MICA
- JPL Ephemeris Generator
- Solar System Simulator
- Clear Sky Clock will show at a glance when we might expect clear and dark skies for one particular observing site.
- The Simbad astronomical database provides basic data, cross−identifications and bibliography for astronomical objects outside the solar system.

3.2. Java Applets

- GeoAstro Applet Collection by Juergen Giesen
- Aladin Interactive Sky Atlas
- Cluster simulator
- Sky Image Processor
- J−Track 3D − Satellite Tracking

4. Astronomical Images over the web

Much effort exists to allow access to Astronomical image file type such as FITS from any web browser. Here are some pointers.

4.1. List

The folks at harvard have a list of Image Servers and Image Browsers.

- Astronomical Images Over the Web

5. Organizations

- The yearly Astronomical Data Analysis Software and Systems, ADAAS, Conference Series provides a forum for scientists and computer specialists concerned with algorithms, software and operating systems in the acquisition, reduction and analysis of astronomical data. The program includes invited talks, contributed papers and poster sessions as well as user group meetings and special interest meetings ("BOFs"). All these activities aim to encourage communication between software specialists and users, and also to stimulate further development of astronomical software and systems.
- The linuxastro mailing list, linuxastro@majordomo.cv.nrao.edu, is for people who are interested in porting astronomical software to linux. For more information, see linuxastro.

6. Hardware Control

More folks are using Linux to control equipment. Users range from amateur astronomers in the field to professional observatories.

6.1. Telescope Control

- KTelescope is a robust Client/Server control library for Meade's LX200 based telescopes. Is uses the Instrument Neutral Distributed Interface (INDI) protocol.
- Talon, formerly OCAAS, is a complete observatory control and astronomical analysis system for Linux.
- XEphem has the capability to communicate with a telescope control daemon process.

6.2. CCD Camera Control

- Apogee Instruments Inc supports their line of professional CCD cameras under Linux.
- Finger Lates Instrumentation Manufacturer of CCD cameras and filter wheels and include drivers for Linux.
- SBIG offers some assistance with operating their ST7 and ST8 CCD cameras under Linux.
- CCD Astronomy on Linux These pages describe a number of facets of using astronomical CCD cameras for image acquisition and processing under Linux.
- Gccd is a gnome−based CCD camera and filter wheel control program.

7. Installation Help

You need to know what you're doing with Linux and installing programs, but help is available for some programs. Here are some ways to make life easier.

- AstroMake is a utility intended to make installations of some common astronomical packages (in binary form) easy.
- XEphem requires several elements to exist on your machine. Life is much simpler with the CDROM version of the program as it contains an installation script which loads the appropriate precompiled binary for most systems and places all auxiliary files to the correct spots. See XEphem CDROM

---

8. Projects using Linux

Here is a list of astronomy projects using Linux in whole or in part of their instrumentation:

- The CHARA Array is an optical interferometer project using Linux in their control system.
- CAOS Club of Amateurs in Optical Spectroscopy.

9. Revision History

In an effort to record a history of the evolution of this document, we maintain it within a CVS repository. What follows is the steps to today's document.

```
$Log: Astronomy-HOWTO.sgml,v $
Revision 1.48  2004/02/07 17:58:56  jhuggins
Another ulink fix removing expired attribute 'name.'

Revision 1.47  2004/02/07 17:55:24  jhuggins
Fixed a ulink issue with the Talon link.

Revision 1.46  2004/02/05 01:22:32  ecdowney


Add entry for Talon now that it is GPL

Revision 1.45  2004/01/20 13:51:17  jhuggins
Changed URL of German translation and changed the copyright date.

Revision 1.44  2003/04/21 11:44:17  jhuggins
Adjusted the name of a contributor.

Revision 1.43  2003/04/21 01:58:59  jhuggins
Wholesale changes including several new links, several new sections and a
few corrections to previous information.

Revision 1.42  2003/04/20 19:26:09  jhuggins
Testing CVS keywords in docbook tags.
Revision has no : at the end.

Revision 1.41  2003/04/20 15:45:12  jhuggins
Placed the CVS Log keyword within the screen parameter to avoid troubles.

Revision 1.40  2003/04/20 15:42:13  jhuggins
Added a revision history to the tail end of the document to avoid it cluttering the top.

revision 1.39
date: 2003/04/20 03:58:00;  author: jhuggins;  state: Exp;  lines: +540 -264
First conversion to Docbook.  No content was changed, only the tags.

revision 1.38
date: 2001/08/27 20:45:52;  author: astro;  state: Exp;  lines: +4 -4
Added Michael Moltenbrey's german translation to the list of translators.

revision 1.37
date: 2001/08/19 18:24:25;  author: ecdowney;  state: Exp;  lines: +8 -3
Add gccd

revision 1.36
date: 2001/07/25 19:58:54;  author: astro;  state: Exp;  lines: +26 -7
Added Translator information and fixed a few text format lines.

revision 1.35
date: 2001/06/18 18:48:42;  author: astro;  state: Exp;  lines: +5 -3
Fixed a few more sgml bugs.

revision 1.34
date: 2001/06/18 18:43:42;  author: astro;  state: Exp;  lines: +12 -5
More errors fixed.
```

```
revision 1.33
date: 2001/06/18 18:23:11;  author: astro;  state: Exp;  lines: +6 -5
Fixed a few bugs in 1.32.  John

revision 1.32
date: 2001/06/18 18:11:39;  author: astro;  state: Exp;  lines: +19 -4
I added a simulation and games section with a few new links.  I also corrected a few spacing issues.  John.

revision 1.31
date: 2001/06/15 13:37:58;  author: astro;  state: Exp;  lines: +13 -6
Change the working of the Online Tools section, divided up the tools into form based and Java Applet based and added a few new listings.

revision 1.30
date: 2001/06/14 20:17:26;  author: astro;  state: Exp;  lines: +4 -4
Added a space between link for CAOS and its name.

revision 1.29
date: 2001/06/14 20:07:08;  author: astro;  state: Exp;  lines: +5 -5
Removed the word "Linux" from the Yahoo link as this is just Astronomy Software.

revision 1.28
date: 2001/06/14 20:03:18;  author: astro;  state: Exp;  lines: +4 -4
Fixed missing quote in the Yahoo Astronomy Software link.

revision 1.27
date: 2001/06/14 19:59:33;  author: astro;  state: Exp;  lines: +5 -4
Added link to the Yahoo Astronomy Software directory.

revision 1.26
date: 2001/06/14 19:34:32;  author: ecdowney;  state: Exp;  lines: +16 -9
*** empty log message ***

revision 1.25
date: 2001/06/14 18:48:10;  author: astro;  state: Exp;  lines: +47 -49
Changed htmlurl to url so the links appear in the txt file along with the html files. htmlurl suppresses the links in the text.

revision 1.24
date: 2001/06/14 18:29:25;  author: astro;  state: Exp;  lines: +3 -10
Fixed a few links.

revision 1.23
date: 2001/06/14 18:19:24;  author: astro;  state: Exp;  lines: +8 -4
Added a few more general search engine links for specific queries about Astronomy Software Linux

revision 1.22
date: 2001/06/14 18:14:34;  author: astro;  state: Exp;  lines: +13 -3
Added some general search engine links for specific queries about Astronomy Software Linux

revision 1.21
date: 2001/06/13 22:06:47;  author: ecdowney;  state: Exp;  lines: +4 -4
*** empty log message ***

revision 1.20
date: 2001/06/13 18:11:27;  author: ecdowney;  state: Exp;  lines: +5 -5
*** empty log message ***

revision 1.19
date: 2001/06/13 18:05:05;  author: ecdowney;  state: Exp;  lines: +42 -4
*** empty log message ***

revision 1.18
```

```
date: 2001/06/13 16:49:06;  author: astro;  state: Exp;  lines: +4 -4
Changed the Copyright to include the year 2001.

revision 1.17
date: 2001/04/10 21:47:17;  author: astrohowto;  state: Exp;  lines: +4 -4
Changed www.astronomy.net to astronomy.net.

revision 1.16
date: 2001/04/10 21:43:43;  author: astrohowto;  state: Exp;  lines: +0 -2
Removed log message.

revision 1.15
date: 2001/04/10 21:42:56;  author: astrohowto;  state: Exp;  lines: +5 -3
Added Log information.

revision 1.14
date: 2001/04/10 21:40:14;  author: astrohowto;  state: Exp;  lines: +4 -4
Changed main HOWTO web site to howto.astronomy.net.

revision 1.13
date: 2000/11/28 15:23:37;  author: astrohowto;  state: Exp;  lines: +6 -4
Revised the Author information.

revision 1.12
date: 2000/11/21 22:00:45;  author: astrohowto;  state: Exp;  lines: +16 -4
Added Projects section and added CHARA to it.

revision 1.11
date: 2000/11/21 21:39:11;  author: astrohowto;  state: Exp;  lines: +14 -7
Added several links and removed one bad one for AstrHorloge.

revision 1.10
date: 2000/11/07 17:22:16;  author: astrohowto;  state: Exp;  lines: +220 -225
Removed a few more text line ending problems.

revision 1.9
date: 2000/09/21 15:55:48;  author: astrohowto;  state: Exp;  lines: +4 -4
Changed the link to XSky after receiving an email from terry Friedrichsen.

revision 1.8
date: 2000/08/14 18:33:47;  author: astrohowto;  state: Exp;  lines: +12 -3
Added Nightfall to plantarium programs.

revision 1.7
date: 2000/08/14 18:16:28;  author: astrohowto;  state: Exp;  lines: +38 -62
Removed line feeds from several of Elwood's paragraphs.
Also added a few suggestions from emails received.

revision 1.6
date: 2000/05/03 22:01:25;  author: astrohowto;  state: Exp;  lines: +15 -3
Added Copyright text.

revision 1.5
date: 2000/05/02 11:59:19;  author: astrohowto;  state: Exp;  lines: +8 -4
Added Linux to the Title and added some contact information. JSH.

revision 1.4
date: 2000/05/02 09:05:20;  author: astrohowto;  state: Exp;  lines: +224 -110
Elwoods additions.

revision 1.3
date: 2000/04/30 15:14:25;  author: astrohowto;  state: Exp;  lines: +4 -3
```

```
More RCS

revision 1.2
date: 2000/04/30 14:45:16;  author: astrohowto;  state: Exp;  lines: +5 -0
Added some RCS keywords.

revision 1.1
date: 2000/04/30 14:43:43;  author: astrohowto;  state: Exp;
Initial revision
```