

The OpenStax Free Astronomy Textbook and Its Open Education Resources Hub

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Conference Strand: *Teaching Introductory Astronomy: What are We Doing Now?*

Abstract. As part of a national project to offer free, on-line, open-source textbooks, three senior authors (A. Fraknoi, D. Morrison, and S. Wolff) have produced OpenStax *Astronomy*. It is an introduction for non-science majors and has already been used by half a million students and over 100,000 independent readers. We describe the book and how it is available and discuss the rich Open Education Resources Hub that goes with it, featuring an array of free ancillary materials produced by both the textbook authors and adopters. The publisher's numbers indicate that the free book is now being used in 40% of the adoptions in North America.

1. The Textbook

The non-profit OpenStax project at Rice University, supported by a number of major US charitable foundations, is working to produce a free, professionally-edited, open-source, on-line textbook in every field in which college students take introductory courses. Currently, they have over 40 such books published.

My coauthors, David Morrison and Sidney Wolff, and I had been writing textbooks for commercial publishers for a while. The publisher of our last book became such a large conglomerate that they found themselves publishing six competing lines of astronomy textbooks simultaneously! Ours was badly neglected and left to wither as a result. So, we were delighted to be approached by OpenStax to spearhead the project to put together their free introductory astronomy textbook.

The book, cleverly entitled "Astronomy," was published in 2017, and despite the fact that our publisher has no money for publicity or sales reps, it has been found by many astronomy instructors, from universities to state colleges, from community colleges to high-schools, looking for ways to reduce the cost of their courses. Today, the book is being used at over 1100 institutions, and has already had over half a million student readers. The publisher calculates that this has saved US students more than \$40

million in astronomy textbook costs so far. Anyone can read or download the book at <http://openstax.org/details/astronomy>



Figure 1. Textbook senior authors (from left to right): Sidney Wolff (NOAO), David Morrison (NASA Ames), and Andrew Fraknoi (Foothill College), seen a few years ago.

The publisher estimates that the book now has about 40% of the market for adoptions in North America, currently making it the most widely used astronomy textbook. In addition, at least 100,000 independent readers have downloaded the book, either from the above website or through such sites as ResearchGate.

In producing the book, we had help from over 60 colleagues in astronomy and astronomy education — both with making sure the science was up to date and with assuring effective pedagogy. Among these colleagues are: Debra Fischer (Yale), Heidi Hammel (JWST), Steve Kawaler (Iowa State), Lloyd Knox (U of California Davis), and Martin Elvis (CfA). Available for on-line reading, and downloadable for all devices (including a free OpenStax phone app), the book is being updated regularly. The nice thing is that updates only require moving electrons around, and not chopping down trees. (Although there is an on-demand printed version available for readers who need to hold the book in their hands.)

Among the features of the book that colleagues have told us they find useful are:

1. mathematical formulas and worked-out examples are in boxes, so they can be included or skipped as the instructor wishes;
2. each chapter includes a summary, plus an array of review questions, thought-provoking questions, numerical problems, and collaborative group activities;
3. recent web resources (including videos, animations, and apps) are provided as live links throughout the book and more are given at the end of the chapter;

4. profiles of astronomers (past and present) are included in the chapters as boxes;
5. short sections point out connections between astronomy and other fields students are studying.

A key aim of the book is to present astronomy in ways that are accessible to non-science majors, who make up the vast majority of the students who take into astronomy in North America. The chapters are filled with analogies taken from the student's own lives; with clear discussions of *how* we know things, not just *what* we know; and with occasional touches of humor.



Figure 2. Cartoon Courtesy of NASA

2. The Textbook's OER Hub

The book¹ has an Open Education Resources hub of free, shared resources. Adopters can join and use this hub to get ancillary materials developed by the authors or by fellow instructors.

Already on the hub are:

- a list of free short videos on the web to go with each chapter of the text,
- PowerPoint slides with all the book figures,
- a guide to free lab manuals on the web for introductory astronomy courses,
- a list of science fiction stories with good astronomy, organized by topic,
- a guide to including more multi-cultural astronomy in your course,
- a primer on things a first-time Astro 101 instructor needs to know and do,
- a resource with many links to the contributions of women to astronomy,
- a guide to how instructors can respond to pseudo-scientific claims brought up by students (such as moon-landing denial, creationism, astrology, UFOs, etc.),
- a summary guide to using the free planetarium software called *Stellarium*,
- Videos summarizing each book chapter by Dr. Lauren Woolsey,
- a sample syllabus, and much more.

A new ancillary resource, listing individual lab exercises available free on the Web, organized by textbook chapter, is being developed. So, for example, you will be able to look up all the free, on-line labs that deal with the H-R Diagram, or telescopes, or galaxies. Registered adopters of the book will be notified when this resource is ready.

3. A Learning Management System for the Textbook

A new Learning Management System, keyed to the free textbook, has recently been developed by one of OpenStax's partner companies. The system, called *Expert TA Astronomy*, includes:

- more than 1300 multiple choice questions,
- more than 1100 true-false review questions,
- more than 500 calculation questions (with different values for different students), and
- more than 450 graphical questions (including ranking, sorting, labeling, and chapter review).

¹https://www.oercommons.org/groups/openstax-astronomy/1283/?__hub_id=27

All of these are automatically graded by the system. In addition, the roughly 800 essay questions from the book are now also included. You have to grade answers to these yourself, but then the grade is added to the gradebook being kept by the system. *Expert TA: Astronomy* has other security and convenience features that make homework, tests, and grading easier to manage.²

4. Conclusion

We encourage you to take a look at the textbook when you have a chance. Even if it is not yet your primary textbook, you may well have students in your class who cannot use that book because it is simply too expensive for their budgets. Listing the OpenStax book as an alternative may at least help them have a reference as they study. While it is only available in English at present, we hope one day to see it translated into other languages and used in other parts of the world. If you have any thoughts about the book and how else it can be useful, please feel free to contact the author at e-mail: fraknoi@fhda.edu

²<http://theexpertta.com/astronomy>