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ASTRONOMY 113
Laboratory

Introduction

Astronomy is an observational science. Astronomers cannot create a star in the lab and study it, walk around it, tweak it, dissect it, or explode it. Astronomers can only observe the sky as it is, and from their observations deduce models of the Universe and its contents. Remember this as the Universe is laid out before you in Astronomy 103 - the story begins with only points of light in the sky. From this perspective, our understanding of the Universe is truly one of the greatest intellectual achievements of mankind.

The exploration of the Universe is also a lot of fun, an experience that is largely missed sitting in a lecture hall or doing homeworks. The primary goal of these labs is to bring you closer to the reality of astronomical research, and in so doing to the experience of science. Of course this would best be done at night with real telescopes, but the vagaries of Madison weather make this impractical with large classes. Fortunately, computer simulation software does remarkably well in recreating the experience of working at telescopes, including some of the largest in the world. (And we will get you to a real telescope at Washburn Observatory, promise!)

We emphasize that these labs are designed to provide you with opportunities to explore and discover. Always remember that this is your exploration - different students may follow different paths, all of which can lead to interesting results.

We are very anxious to have your feedback, opinions, and suggestions. Send us e-mail, stop by our offices, put notes in our mailboxes, whatever. Any part of the course is open for improvement, even during the course of the semester. Your ideas will make a difference!

The next three pages have important information on administration of the labs - please read them carefully. Then enjoy the Universe!

Laboratory development funded by the University of Wisconsin - Madison College of Letters & Science Excellence in Undergraduate Education program, the National Science Foundation, and the Wisconsin Space Grant Consortium.
LOCATION AND SCHEDULE

- Lab sessions will be held in 4421 Sterling Hall (4th floor). This computer laboratory has 12 Macintosh iMac computers. Students will work in pairs at each computer.

- **Labs will begin the week of September 2.** Lab sessions are 2 hours long, with most labs taking 2 sessions.

- The times of lab sessions can be found in the Timetable or at www.astro.wisc.edu/undergrad_info.html. Presumably you have registered for one of these times.

- Office hours are 1:00 - 3:00 on Friday in 4421 Sterling, the computer lab. The computers are open for your use then, and possibly at other times to be announced. You also may use the computers during another lab session if they are available. Additional office hours for answering questions, etc. are by appointment.

- The program of labs is given in the course syllabus. Our intent is that you will have sufficient time to complete the labs during the lab sessions; you should not have to do lab work at home.

WHAT YOU NEED TO BRING TO THE LAB

- **This lab manual.**

- **A lab book,** specifically Science Notebook 77-610 (Roaring Springs) available at the University Book Store, main floor. Each page is lined on one side and has graph paper on the other. Your name and laboratory session time should be prominently displayed on the front cover.

- **Completed pre-lab assignment.** If you don't have it, you will have to leave and return to another lab session.

- **Pencils or erasable pen.** Unless you never make mistakes (!), being able to correct errors neatly can save you a lot of rewriting.

- **Scientific calculator.** You don't need the state-of-the-art, one-million-function, graphical display model. But you will have to occasionally compute a tangent or a logarithm, and having a function to compute a standard deviation will be useful.

- **A straight edge.** A clear plastic ruler is best.

- A textbook will sometimes be useful, but is not required. Textbooks are available in the lab.
LAB BOOK

Think of your lab book as a journal of your explorations. Throughout the semester you will be making sketches, recording tables of data, creating graphs, answering questions, and writing short essays in the lab manuals. While there are certain entries in your lab book that are required for successful completion of the lab, you shouldn't feel restricted to these. Feel free to add thoughts, wonderings, musing, notes, etc. as you wish. Write everything in your lab book as you work - don't write on loose pieces of paper.

At the same time, your lab book is the means by which you communicate your results to others in the future, most importantly yourself. Research scientists must often refer to their lab books to both recover results and remind themselves of details of a procedure. You too will have to refer to your lab books, although for the somewhat less inspiring reason of answering questions on open-lab-book quizzes.

Therefore your lab book needs to be neat and reasonably well organized. This can be achieved without rewriting if you take care as you go along. This takes patience and some discipline, but it will save you time in the end. Some hints include:

• Organize your workspace. If you reserve space on the counter for your lab book and manual, and put your other things elsewhere, you will find it much easier to work.

• Use titles or headings to organize your lab book. Section numbers and titles from your lab manual are a natural for this.

• Write neatly, including when entering measurements into data tables.

• When the lab manual tells you to tape a table or graph into your lab book, do it right away.

• Above all else, take your time.

Below is a sample first page for a lab. This format isn't required, but it's one possibility.

Lab 1: Celestial Rhythms - An Introduction to the Sky

January 23, 2000

Lab partner: Dylan Sierra       Computer #4

Section 1: Sunset

Learned how to move around in the Voyager sky.

Section 2: Figures in the Sky

Looked at constellations. Those Greeks had vivid imaginations, or lots of wine!
Section 3: Coordinates in the Sky, Take One

Q1: End star in the Big Dipper's handle  Altitude 25°  Azimuth 334°

   The constellation Aquila is near azimuth 90°, altitude 0°

   The constellation of Hercules is near altitude 90°  This is overhead!
HOME WORK

Our intention is that you should only need to do two things outside of lab: read the lab manual in advance, and complete the pre-lab assignment prior to the first session of each lab. It is essential that you read the lab manual \textbf{before} coming to the lab. Each year there are always a few students who ignore this advice and “wing it”. They are always behind in the lab, get less out of the labs, and receive poorer grades. Perhaps most importantly, they are a burden to their partners.

The week prior to the first meeting of each lab you will be given a pre-lab assignment; these will be posted on the class web page. The goal of the “pre-lab” is to get you to think about the essential issues in the upcoming lab and to practice some of the skills that you will need. To do the pre-lab will require that you read the lab manual, which you should be doing in advance of the lab anyway, and occasionally read a unit or two from your 103 textbook.

At the beginning of each lab, the instructors will look over your assignment to insure that you have completed it and to provide guidance if necessary on any difficult points. To get a credit, the pre-lab \textbf{must be completed with meaningful effort}. If you do not complete the pre-lab you will be asked to leave the lab and return at a later time with the completed pre-lab assignment.

GRADING

Each lab will have an assessment component. For some labs it will be a review of your lab book; for others it will be an in-class assessment. The assessment will be based entirely on what you accomplish in lab. All of the quizzes will be open (lab) book.

Because these labs are meant to be a time of discovery and exploration, your work cannot be assessed solely on the basis of whether answers are correct. The basis for grading will be a \textbf{combination} of:

\begin{itemize}
  \item \textit{Depth of thought} - careful thinking, thoughtful interpretation, creative ideas
  \item \textit{Quality of results} - this reflects care and effort as well as technical proficiency
  \item \textit{Neatness and organization} - clear communication of results is essential to the scientific process
\end{itemize}

Each individual assessment will be based on a 0-5 scale. It is our desire to promote collaborative learning in the lab. Hence the course grade scale is set in advance, as defined in the syllabus. The course is not curved - every student can receive an A. So you are not in competition with your classmates and \textbf{we strongly encourage working together}, except of course during quizzes.

On weeks when lab books will be reviewed for evaluation, we prefer that they be turned in at the end of the lab. You don’t need to take them home and rewrite or improve them. However, should you choose to make use of the Friday open lab, lab books must be turned in by 4:00 of the week they are due. \textbf{Lab books turned in late will not be graded}.
IMPORTANT ADVICE

- **Read the lab manual carefully before coming to the lab.** When you sit down at the computer terminal, you should be familiar with the overall goals and strategy of the project. The pre-lab assignment will help you in identifying the more important issues. **NOTE: Pre-lab assignments will be reviewed by your instructor at the beginning of lab. If your pre-lab does not show quality effort, you will be asked to leave the lab and return at another lab session.**

- Don't hesitate to ask questions of the instructor, your lab partner, or anyone. That's how you learn!

- **Relax and have fun!** The labs are designed to be completed within the lab sessions, typically with no further work outside of lab. If you have extra time, your instructor can show you other software to explore with.

- If you aren't experienced with computers, don't panic! The software is very user-friendly and the lab exercises are designed to ease you into computer usage. We've also included in this introduction a primer to some computer terminology called **Macintosh Basics.**

- If you have any questions or comments on the labs, don't hesitate to drop by my office (3311 Sterling) at any time, or send me an e-mail (sstanimi@astro.wisc.edu). I'm happy to help in any way, and will be very grateful for any opinions, advice, etc.
Macintosh Basics

Macintosh computers are among the easiest computers to use. Even so, there are a few bits of jargon that you will need to know in order to understand the lab manuals.

**Cursor:** The small, black arrow (usually) on the computer screen that moves when you move the mouse.

**Clicking:** To click on something, move the mouse until the cursor is over the object. Then press and release the mouse button. The term "click" comes from the sound the mouse button makes when it is pressed and released. **Uses:** pressing buttons and icons.

**Double-Clicking:** This is when you click on something twice in rapid succession. It is most commonly used to start programs. If you double click an icon, it will either start a program, open a file or open a folder, depending on what kind of icon it is. **Uses:** starting programs, opening files and folders.

**Dragging:** To drag something, move the mouse until the cursor is over the object. Then press and hold the mouse button, move the mouse a little ways, and then release the button. It is as if you are "grabbing" something when you press the button, pulling it along as you move the mouse, then releasing it when you release the button. **Uses:** moving windows, selecting items from menus.

**Windows:** Windows are rectangles on the screen that can be "opened" or "closed" (created or destroyed) to show different information. They typically have the same border around them: a "titlebar" on top to identify the window, a "close box" in the upper left to make the window go away, and a "zoom box" in the upper right to make the window large or small. Many windows also have scrollbars (described below) and resize boxes. Resize boxes are in the lower right corner; if you drag it, you can make the window larger or smaller.

**Scrollbars:** The scrollbars are gray strips with arrows on each end located on the right and bottom sides of a window. They are used when the window is too small to allow you to see all of its contents at once. Pressing the scrollbar arrows allows you to move around within a window. In the middle of each scrollbar is a button with a few lines on it. You can drag this button back and forth to scroll more quickly than with the arrows. The location of this button tells you how much you can scroll in each direction. When the button disappears and the scrollbar turns light gray, the whole window is being displayed.

**Menus:** On the top of the screen is a row of words. If you position the cursor on one of the words and press and hold the mouse button, a short window with a list of options (called a menu) is opened. If you drag the cursor to one of the options and release the button, the option will be activated. For example, you can usually quit a program using Quit in the File menu.

This summary makes the most sense if you read it while you are sitting in front of the computer!