

Look, Up in the Sky!

THE SOLAR SYSTEM AS SEEN FROM EARTH

by Henri Picciotto

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INTRODUCTION

WEEK 1

1. Moon Calendar
2. Shadows
3. The North Star

WEEK 2

4. Sunset
5. The Sun and the Moon
6. The Moon and the Stars

WEEK 3

7. Midday
8. Moon Words
9. The Zodiac

WEEK 4

10. Astrology Survey
11. Telescopes
12. Orbits

WEEK 5

13. Moon Model
14. Eclipses
15. Scale Models

WEEK 6

16. Moon Questions
17. Moon Predictions
18. The Night Sky

WEEK 7

19. A Tilted Planet
20. The calendar
21. Latitude

BIBLIOGRAPHY

INTRODUCTION

The Solar System is our home. The Sun, the Moon and several planets are there for us to see, yet most of us have lost touch with them. This kit provides an open-eyes, hands-on, and discovery-based approach to this subject, with the help of:

- * A Teacher's Manual outlining 19 lessons.
- * Reproducible pages for the students.
- * The materials needed to carry out the activities.

OBJECTIVES:

The objectives are clearly stated at the beginning of each lesson.

- * First, through observation and record-keeping, the students become familiar with the behavior of the Solar System as seen from Earth.

- * Later on, they achieve a more sophisticated understanding of the system through the building of models.

With the help of this manual, the teacher guides the students' discoveries.

GRADE LEVELS:

Most of the activities in this kit have been developed and tested in grades 4 and 5. Much of the material is unfamiliar to older students and adults, and so can be taught in middle school or junior high.

A few lessons may be too difficult for some fourth and fifth grades. There is a note at the beginning of each lesson, indicating whether it is geared to grades 4 and up, or ^{primarily to} grades 6 and up.

SCHEDULING:

The activities in this kit should be spread over seven weeks or more, with up to three lessons a week. Many activities will take a class period of approximately 45 minutes, and can happen at the time you have scheduled for science. In addition, you will need to assign a small amount of homework every day, and to allot a few minutes daily to discuss it, ~~perhaps at the end of the class period.~~

The observational activities must be timed to correspond to astronomical conditions, such as the phase of the Moon or the presence of planets in the evening sky. They are also contingent on the availability of clear skies. To teach observational astronomy, you must be flexible in your scheduling!

ORGANIZATION:

The 19 lessons are spread over 7 weeks. It may be necessary to take longer to cover them, because of weather conditions or other reasons. However, do not teach any lesson too early: enough time must elapse between lessons to give the students a chance to make and record enough observations.

The Solar System is a "system" and your students will learn most if you do all the lessons in the order suggested. The skills and concepts overlap and reinforce each other. The organization of the lessons is based on an appreciation of the developmental needs of young people when grappling with the rather overwhelming concepts of astronomy. In many ways, this parallels the history of the field: from naked eye observation (Lessons 1 through 9), to optically aided observation (Lesson

11), to increasingly elaborate models (Lessons 12 through 19).

However, if you want to do less than the whole ^{book} ~~unit~~, you can choose among the following subtopics:

- * The Moon (short course): Lessons 1, 8, 13, 17.
- * The Moon (full course): Lessons 1, 5, 6, 8, 9, 13, 14, 16, 17.
- * The Sun (short course): Lessons 2, 4, 7.
- * The Sun (full course): Lessons 2, 4, 7, 18, 19.
- * The night sky: Lessons 3, 6, 9, 11.
- * Making models: Lessons 12, 13, 14, 15, 18, 19.
- * Astrology: Lesson 18.

PREPARATION:

Before you start teaching the units, familiarize yourself with the kit. Look over this manual and the student sheets. When possible, do the activity yourself before asking the students to do it.

To complement the observational, experimental and discovery-based learning offered by this kit, you should make relevant books and magazines available to your students. A visit to your public or school library, or to a museum bookstore will reveal many excellent children's books on astronomy. See also the bibliography at the end of this Teacher's Manual.

STUDENT SHEETS:

Twenty-four sets of the student sheets are included in each class set. If you do not purchase the set, you can duplicate the sheets included in this kit.

The student sheets do not constitute a textbook. They are just one component in an integrated package. This Teacher's Manual explains how each student sheet fits in this program.

MATERIALS:

Included in Basic Kit:

...

Included in Class Set:

...

To be provided by you:

...

REFERENCES:

To teach the observational lessons, you must have information on what's up in the sky on any given night or day. There are many ways to find out. I recommend two inexpensive tools:

* The DAILY PLANET ALMANAC is packed with astronomical information you will need, including the time of sunrise, sunset, moon rise, moon set, and the phase of the Moon for every day of the year.

* The SKY CALENDAR is designed with you, the teacher, and your students in mind. It features a beautifully simple monthly star chart and a daily description of notable celestial events, including the position of the Moon, and plenty of planet information. You will find it a tremendous help in planning your students' observational homework.

Use these references to prepare your lessons and assignments, but do not feel you need to necessarily show them

to your students.

Other good sources of information on the sky are ASTRONOMY and ODYSSEY magazines. They feature monthly information on the sky, complete star charts, gorgeous photographs, interesting activities, and telescope tips. Back issues are great for students to browse through when looking for information on astronomy.

NOTE ON LATITUDE:

Many lessons in this kit, like the references mentioned above, assume that you are in the Northern hemisphere. In fact some comments are only accurate if you live between the Tropics and the Arctic Circle. (This need not, ~~and should not~~ be discussed with the students.)

The kit can be used anywhere in the contiguous 48 states.

DISCOVERY TEACHING:

In addition to learning about the Solar System, your students will be learning about the scientific method. The science of astronomy involves the interplay of observation and modeling. For this process to happen in your classroom, you will need to gather a lot of observational data, record it, save the records, discuss them, and draw conclusions. (The records of your own observations can be included among the information accumulated by the students.) Later, you will make models that will throw light on the data you accumulated.

Accept your students observations, even if they seem inaccurate. As the data accumulates, it becomes obvious that certain observations are mistaken, and the students will

discard them. The following anecdote illustrates the kind of learning process that can take place while carrying out the activities.

One morning, only two students saw the Moon. Both saw it in the East, but while one of them said it was full, the other saw only a crescent. I accepted both observations, neutrally. Later, by comparing these sightings with the ones made the following and previous days, it became clear to the class that the crescent was more likely. Later still, the students realized that the Full Moon always rises when the Sun sets, and sets when the Sun rises. (In other words, it is never visible during the day -- particularly in the East.) Still later, some students saw the Sun shining through the fog during recess. It looked like the Full Moon to some of them. As the fog cleared, everyone agreed that it was the Sun and not the Moon, and someone pointed out that this may have been the source of the erroneous "Full Moon" sighting. The mystery of the two conflicting observations was solved and the students learned a lot. In contrast, not much would have been gained if I had "taken sides" with one sighting and against the other.

In the course of carrying out the activities, the students' understanding grows, and they are more open to genuine learning of concepts. The written activities at the end of the units can serve to clarify and summarize what was learned. Class discussions should also be used for the same purpose.

A lot can be learned about the Solar System using a very

limited amount of instrumentation and almost no calculations. Much of that knowledge is accessible to your students. A solid grasp of "flat earth" astronomy, and then of Sun-centered astronomy, is a foundation on which to build a more sophisticated understanding.

INVOLVING GIRLS:

The activities in this kit can involve boys and girls equally. Do not assume that because boys are "into spaceships" that girls will not be interested in astronomy. In my classes I have found that some of the most enthusiastic Moon-starers are girls. While some boys are better model-builders, some girls are neater and more accurate observers and record-keepers. All these skills are important in learning astronomy --all your students can participate and contribute.

SKY CALENDAR AUGUST 1984

An aid to enjoying the changing sky

CURRENT SKY INFORMATION:
Call (517) 332-STAR

Use this scale to measure angular distances between objects on diagrams below.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
<p>PLANETS (in evening): VENUS sets early, so look soon after sunset. On Aug 1 Venus is 13° upper left of setting sun and sets in WNW 40 min after sundown. By Aug 31 it improves to 21° upper left of sun and sets in W 50 min after sundown. MERCURY on Aug 1 is 15° upper left of Venus; use binoculars. Mercury quickly fades and gets lower each day. By Aug 10 it sets 10° to left of Venus. THREE BRIGHT OUTER PLANETS are easy: locations in mid-twilight, about ¼ hour after sunset: JUPITER, brightest, is in SSE to S. MARS, next in brightness, is reddish in SSW. Antares is fainter than Mars and to its left; see diagrams. SATURN is yellowish in SW, to right of Mars and upper left of Spica.</p> <p>Sunday Aug 5, evening: Moon, Mars, Antares, Spica</p>	<p>PLANETS (in evening): VENUS sets early, so look soon after sunset. On Aug 1 Venus is 13° upper left of setting sun and sets in WNW 40 min after sundown. By Aug 31 it improves to 21° upper left of sun and sets in W 50 min after sundown. MERCURY on Aug 1 is 15° upper left of Venus; use binoculars. Mercury quickly fades and gets lower each day. By Aug 10 it sets 10° to left of Venus. THREE BRIGHT OUTER PLANETS are easy: locations in mid-twilight, about ¼ hour after sunset: JUPITER, brightest, is in SSE to S. MARS, next in brightness, is reddish in SSW. Antares is fainter than Mars and to its left; see diagrams. SATURN is yellowish in SW, to right of Mars and upper left of Spica.</p> <p>Monday Aug 6, evening: Moon, Antares, Spica</p>	<p>With each passing night, Mars appears ½° farther east. Look nightly, and watch for next week's interesting conjunction.</p> <p>Tuesday Aug 7, evening: Mars, Antares, Spica</p>	<p>This morning and tomorrow, there is a brief interval of dark moonless sky, good for viewing the Perseid meteors. Look after moonset and before morning twilight, 2-3 hours before sunup today.</p> <p>Wednesday Aug 8, evening: Moon, Antares, Spica</p>	<p>This is the last morning with a dark "window" for seeing the Perseid shower, without interference from moonlight or twilight. Observe from a dark site two hours before sunrise.</p> <p>Thursday Aug 9, evening: Moon, Antares, Spica</p>	<p>Moon rises at about sunset tonight and remains in view until nearly sunrise tomorrow. Too bad for the Perseids!</p> <p>Friday Aug 10, evening: Moon, Antares, Spica</p>	<p>Full Moon rises shortly after sunset. Perseid meteor shower, at maximum late tonight, will be spoiled by bright moonlight. See Aug 8 and 9.</p> <p>Saturday Aug 11, evening: Moon, Antares, Spica</p>
<p>Antares</p> <p>Sunday Aug 12, evening: Antares, Spica</p>	<p>Antares</p> <p>Monday Aug 13, evening: Antares, Spica</p>	<p>Antares</p> <p>Tuesday Aug 14, evening: Antares, Spica</p>	<p>Antares</p> <p>Wednesday Aug 15, evening: Antares, Spica</p>	<p>Antares</p> <p>Thursday Aug 16, evening: Antares, Spica</p>	<p>Antares</p> <p>Friday Aug 17, evening: Antares, Spica</p>	<p>Antares</p> <p>Saturday Aug 18, evening: Antares, Spica</p>
<p>Morning (mid-twilight): 19 Pleiades approaching Last Quarter</p>	<p>Morning Aug 20, evening: Pleiades, Moon, Hyades, Aldebaran</p>	<p>Mars 0.4° S of Delta Scorpii — a pretty sight for naked eye and binoculars.</p>	<p>Regulus in conjunction (beyond Sun) today. It will emerge into morning sky, near Mercury. See next month's Sky Calendar.</p>	<p>Moon now rises after end of twilight, allowing dark evening skies and excellent Milky Way viewing.</p>	<p>Have you seen Sirius yet in morning sky? Look very low in ESE 45 minutes before sunup, below Orion.</p>	<p>Morning: 25 Old Moon</p>
<p>New Moon Sunday Aug 26 3:26 p.m. EDT (12:26 p.m. PDT). This is the only date this month the Moon can't be seen.</p>	<p>Monday Aug 27, evening: Venus, Young Moon, Spica</p>	<p>Mercury at inferior conjunction, between Earth and Sun. Evening: Moon, Venus</p>	<p>Evening: 29 Spica</p>	<p>Evening: 30 Alpha Lib, Saturn, Moon, Spica</p>	<p>Mars, Antares, Fri Aug 31, evening: Mars, Antares, Spica</p>	<p>In Sept Sky Calendar Mars passes "rival of Mars" and approaches Jupiter. Venus overtakes Spica and approaches Saturn. Mercury excellent in morning. To subscribe, see information below.</p>

Magnitudes: Venus - 3.9; Jupiter - 2.6 to - 2.4; Mars - 0.4 to 0.0; Mercury (Aug 1) + 0.5; Saturn + 0.6 to + 0.7; Uranus 5.6; Neptune 7.9. Motions Aug 1 - Sept 1: The Sun, going 30° east, crosses from Cancer into Leo Aug 10. Mercury on Aug 1 is 27° E of Sun; see Aug 28. Venus improves from 13° to 21° E of Sun, and ends August 24° W (lower right) of Spica. Mars goes 16° E, from Libra through head of Scorpius (see Aug 21) into Ophiuchus. On Aug 31 Mars is 2.7° NW of Antares. The planet will pass

only 2¼° N of that star Sept 3. Jupiter goes 1.3° W until ending retrograde 4° NW of 3rd-mag Lambda Sagittarii (the top of the Teapot) on Aug 29. Saturn goes 1.6° E, ending month 4° NW of 3rd-mag Alpha Librae (Zubeneigenub). Uranus: Locate 4.5-mag Omega Ophiuchi 5° N of Antares. Uranus is a magnitude fainter, and within 0.5° south and slightly east of Omega all month.

Subscription: \$5.00 per year, from Sky Calendar, Abrams Planetarium, Michigan State University, East Lansing, Michigan 48824-1324. ISSN 0733-6314

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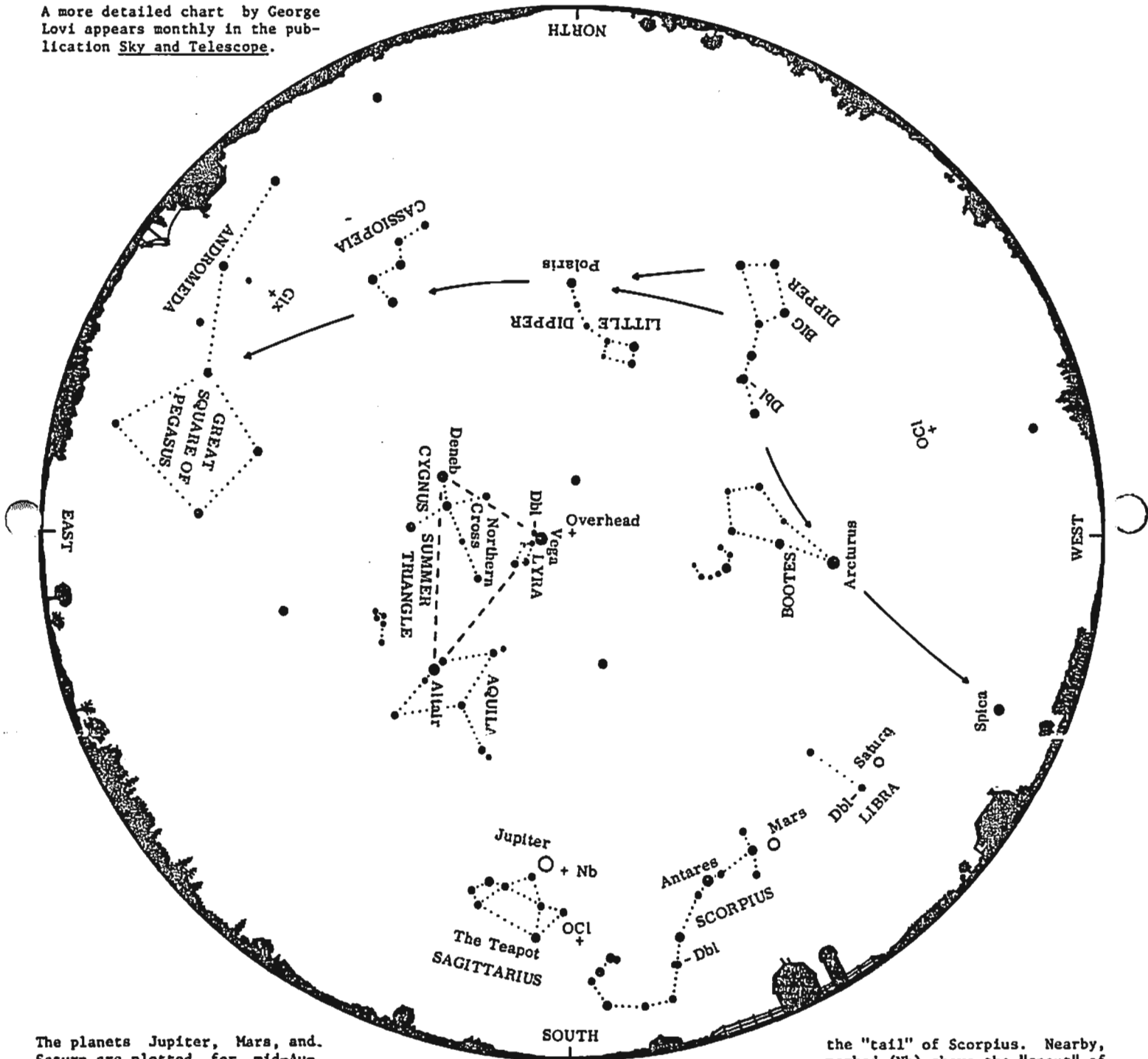
August Evening Skies

This chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

Late July 11 p.m.
Early August 10 p.m.
Late August 9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.

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The planets Jupiter, Mars, and Saturn are plotted for mid-August, 1984. At chart time 9 objects of first magnitude or brighter are visible. In order of brightness they are: Jupiter, Mars, Arcturus, Vega, Altair, Saturn, Antares, Spica, and Deneb. In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Db1) at the bend of the handle of the

Big Dipper is easily detected. The double star in Scorpius is somewhat harder. Much more difficult is the double star near Vega in Lyra. The open or galactic cluster (OC1) known as Coma Berenices, "The hair of Berenice", is located between Leo and Boötes. A more compact open cluster is located between Sagittarius and

the "tail" of Scorpius. Nearby, marked (Nb) above the "spout" of the "Teapot," is the Lagoon Nebula, a cloud of gas and dust out of which stars are forming. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (G1x). Try to observe these objects with unaided eye and binoculars.

--D. David Batch