

Welcome to Amateur Astronomy!

You can be an astronomer! You don't need to have a college education or be particularly scientific. All you need are your interest, your eyes, some time and a little help from other astronomers.

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The steps in pursuit of astronomical observing:

Be interested in something in the sky.

Study up on that something with books or talking with knowledgeable people.

Figure out where in the sky this thing should be with planisphere or star charts.

Actually find the thing in the sky with your eyes and star chart.

Observe the thing, look at it, note details, record observations.

Learn from your observation. Indoors, later read your notes, compare your observations to what the book says, talk with friends, think about what to do next time.

Go to step 1.

Realities of Personal Astronomical Observing:

Observing means that you are outside at night, in the dark, fighting dew and mosquitoes, tripping over things, losing things, and maybe alone with the willies.

Finding things in the sky is hard at first

Observing the sky with a telescope and binoculars is awkward and uncomfortable at first.

Objects in the sky don't look as pretty as their pictures in the magazines.

Every time you go out to observe, your skills improve!

Warning! Never look at the sun with a telescope, binoculars or your naked eyes! This can cause permanent damage to your eyes! Before studying the sun, consult an experienced astronomer or observing guide.

If you are thinking about buying a telescope or other astronomical stuff, call Orion Telescope Center for their free informative catalog (1-800-447-1001). Their catalog is a great source of information and a good introduction to amateur astronomical equipment.

Choosing a starter telescope

Choosing your first telescope is like buying your first car. You ought to know a little about the machine and have at least a learner's permit before you fill out the loan application. I received my first telescope from Santa Claus and was satisfied merely owning it, although I never once saw Jupiter, the Moon or a star. Thirty years later, I finally stepped outside at night to look through a friend's telescope. The joy of personal astronomy is in the finding of faraway lights using knowledge and skill. The telescope is just a tool to help the eyes to see faint tiny objects as if they were brighter and closer. Get some experience before getting your own telescope.

TELESCOPE "DRIVER'S ED"

Where do you find "Driver's Ed" for astronomy? Find some amateur astronomers and they will show you their telescopes. Most cities have astronomy clubs that put on public star parties to show off their telescopes. Go to meetings and join because most astronomers enjoy helping new people and some clubs loan telescopes. Your local high school or scout troop may be able to put you in contact with a club. Go to the library and check out a book on astronomy; you don't have to understand everything but study the parts that interest you. Pay attention to astronomical items in the news. Finally, to get your learner's permit you must go out and study the sky with your own eyes. Use the star maps in this magazine to recognize the constellations and locate a bright planet or star cluster. If you cannot locate and identify bright objects with your eyes, you will not find dim ones with a telescope.

PLEASE CAN I BUY THE TELESCOPE NOW?

Close your checkbook. Even if you are lucky enough to find a showroom crowded with telescopes or cars, you wouldn't buy the first one with a shiny paint job. Your telescope should suit your needs, abilities, and budget. You should be able to carry it around, set it up, operate it, and take it down. Consider these factors especially if you are buying the telescope for a child. Buy within your budget but avoid telescopes that cost less than \$250 or come from a department store. Buy the largest aperture (the diameter of the main optical element) you can afford and conveniently carry.

TYPES OF TELESCOPES

Cautious people often buy a **refractor telescope** because it looks like a traditional telescope, you know, the kind pirates use. Refractors have a long tube on a tripod and you look into the eyepiece at one end through the bigger lens at the far end of the tube. Small refractors are easy to carry and set up.

The **Newtonian reflector telescope** is more popular and a better dollar value. Light enters the tube, reflects off a parabolic mirror at the bottom, up the tube to a second mirror that squirts the light out to the eyepiece on the side near the top of the tube. People new to astronomy sometimes avoid the reflector because it doesn't look like it really works. It does and almost all professional telescopes are refractors, pirate imagery notwithstanding.

The **catadioptric telescopes** are combinations of refractor and reflector technologies and are more expensive. Schmidt-Cassegrain and Maksutov arrangements are most popular. Using more optical elements, they are able to squeeze more telescope into a compact package.

Many telescopes come with a choice of mount, the mechanism that allows you to move the tube around freely and hold it in place when you have found the celestial object you seek. The mount can be as expensive as the telescope itself and if you have ever used a poor mount, you will understand why. The altitude-azimuth mount is the simplest and easiest to operate, just swing it left or right and up or down. A special form of the "alt-az" for Newtonian reflectors is the "Dobsonian" mount that relies on gravity and Teflon bearings to create a very stable and inexpensive mount. The equatorial mount is more expensive but helps the observer deal with the Earth's rotation. The sky appears to rotate, moving your target across the field of view. The equatorial mount compensates for this rotation, often using an electric motor.

WHICH WAY TO THE TELESCOPE SHOWROOM?

Most large cities have actual telescope stores with showrooms and salespeople for the complete consumer experience. However, many astronomers buy their telescopes through the mail. Popular astronomy magazines feature many pages of ads for mail order telescope companies. A stack of mail order catalogs will offer a lot of variety and some catalogs are excellent sources of information. A growing number of amateur astronomers build their own telescopes. You can build a Dobsonian telescope with basic woodworking skills and there are several books on the subject. If you are a skilled machinist or interested in grinding your own optics, the sky is the limit. Like a car, however, the telescope is for driving. Don't let it sit in the garage.

GOOD CHOICES FOR A FIRST TELESCOPE

- A Six to eight inch Dobsonian Newtonian reflector
- An 80mm refractor on a sturdy mount
- Four to eight inch Schmitt-Cassegrain on an equatorial mount

Organized Observing Programs

You can learn more and have more fun if you add a little discipline and approach observing with a plan.

Observe what is in the sky tonight.

- Sitting and waiting for satellites and meteors.
- Looking at the right place at the right time: constellations, planets, deep sky objects.

Observe and draw the planets and their moons. This can be scientifically beneficial. Contact the Association of Lunar and Planetary Observers (ALPO).

Observe stars. Double stars are fun. Variable stars are interesting and your observations have scientific value. Contact the American Association of Variable Star Observers (AAVSO).

Observe the Messier List of Clusters and Nebulae

- 110 star clusters, nebulae, and galaxies catalogued in 1780's.
- "Non-comets" observed by French Naval Astronomer, Charles Messier.
- You can see all of them in the smallest telescopes in dark sky.
- You can see all of them with larger telescopes from town.
- You can see many of them with binoculars.
- Earn a certificate for observing and logging them - see your local astronomy club.

Observe the Herschel 400

- 400 brightest star clusters, nebulae and galaxies observed by Sir William Herschel
- Herschel and his family catalogued the whole sky after Messier.
- You can see all 400 with an eight-inch telescope in dark sky
- Earn a certificate for observing and logging them -- see your local astronomy club.

Predict and observe the appearance of satellites - computer programs

Discover a nova, supernova or comet - study the sky diligently. You may search for years and not find anything. If you discover one, you may become famous and have it named after you.

Make up your own plan. This is a fun thing!

Remember:

- Study before you observe
- Make a plan: where can you see it and can you see it with your instrument?
- Keep a log of your observations - do it while observing.
- Study your observations after observing
- ***Celebrate*** your observing accomplishments!

A Brief History of Human Astronomy

- 40,000 years BC - Human language begins
- 20,000 years BC - Humans invent agriculture, map seasons with the sky
- 5,500 years BC - Writing developed
- 2,500 years BC -- Stonehenge built
- 2,000 years BC -- Systematic astronomy in Egypt, Babylonia, India, China
modern astrology and the zodiac defined
- 1,500 years BC - First sundial
- 400 years BC - Heraclides proposes the earth rotates
- 300 years BC - Greeks catalog 45 constellations
- 260 years BC - Aristarchus proposes sun centered theory
- 200 years BC -- Hipparchus catalogs 850 stars, models planetary epicycles
- 170 years AD - Ptolemy publishes fixed earth-centered theory,
lists 1028 stars
- 400 years AD - Dark Ages begin
- 800 years AD - Arabs have named the stars and start scientific astronomy
- 963 years AD - Al Sufi publishes Book of Fixed Stars, mentions nebulae
- 1000 years AD - Arabs find flaws in Ptolemy's predictions
- 1054 years AD - Many societies observe Crab Nebula Supernova
- 1066 years AD - Norman conquest presaged by a comet
- 1540 years AD - Copernicus proposes sun-centered solar system
- 1600 years AD - Kepler determines planetary orbits are elliptical
- 1603 years AD - Bayer publishes Uranometria, the first modern star chart
- 1610 years AD - Galileo first uses the "spyglass" for astronomy
moon craters, sunspots, moons of Jupiter,
stars in milky way
- 1670 years AD - Newton and Cassegrain propose reflecting telescope design
- 1675 years AD - Roemer discovers speed of light observing Jupiters moons
- 1687 years AD - Isaac Newton unifies mathematics and astronomy
- 1755 years AD - Immanuel Kant proposes "island universes" (galaxies)
- 1758 years AD - Comet returns as Halley predicts, named in his honor
- 1781 years AD - Sir William Herschel discovers planet Uranus
Starts first telescopic survey of sky,
catalogs 2500 nebulae
- Messier catalogs non-cometary nebulae
- 1810 years AD - Fraunhofer observes solar and stellar spectra
- 1834 years AD - Comet Halley returns (Mark Twain born)
- 1846 years AD - Many people discover planet Neptune
(mathematical prediction)
- 1850 years AD - Harvard makes first astronomical photograph: the Moon
- 1859 years AD - Rev. Webb Publishes Celestial Objects for Common Telescopes
- 1888 years AD - Dreyer publishes
New General Catalog of clusters and nebulae
- 1906 years AD - Henrietta Leavitt observes Cepheid variable stars
in near galaxies
- 1910 years AD - First parallax measurement of the distance to close stars
- Norton's Star Atlas first published
- Comet Halley returns (Mark Twain dies)
- 1916 years AD - Albert Einstein publishes General Theory of Relativity
- 1918 years AD - 100-inch telescope on Mount Wilson Observatory
- 1924 years AD - Edwin Hubble identifies nebulae as remote galaxies
- 1928 years AD - IAU establishes official 88 constellations
- 1930 years AD - Clyde Tombaugh discovers Pluto
- 1931 years AD - Edwin Hubble proposes Hubble law (expanding universe)
- 1937 years AD - Reber builds and uses first practical radio telescope
- 1938 years AD - Bethe demonstrates stars glow with nuclear fusion
- 1940 years AD - Big Bang Theory emerges
- 1948 years AD - 200-inch telescope on Mount Palomar
- 1963 years AD - Schmidt discovers Quasars are very remote
- 1979-89 years AD - Voyager spacecraft tour outer solar system
- 1986 years AD - Comet Halley returns (no big deal)
- 1990 years AD - Hubble Space Telescope launched
- Today AD - You are studying astronomy on the internet

The Structure of the Universe

Our Earth is a planet orbiting the sun which is a star.

Our star (the sun) is very far from other stars.

Stars sometimes clump together in tens and hundreds to form star clusters.

Hundreds of billions of loose and clustered stars sometimes clump together to form a galaxy.

Galaxies are very very far apart.

Tens to hundreds of galaxies sometimes clump together to form galaxy clusters

Galaxy clusters are really far apart.

Galaxy clusters sometimes clump together to form superclusters, the largest structure we know about today.

At the edged of what we can see are quasars (really far away really bright things that we really don't know what they are) and the cosmic background radiation (faint glow of the big bang)

The Origin of the Universe

There are many beliefs and theories about the origin of the universe. Many systems of religious belief include a faith-based explanation. The scientific method leads us to new and improved theories. Every so often, new evidence requires that the theory be changed. The theory you believe is the most important to you and I encourage you to reflect on it and share the discussion with your friends and family.

The Standard Model, the current Big Bang Theory

Perhaps 16 billion years ago, the universe was nothing and nowhere and started to become.

There was no space, time, matter or energy. This nothing started to expand into somethingness.

A teeny bit later ($10E-34$ to $10E-30$ seconds), the universe inflates at an exponential (really accelerating) rate. At the end of this inflation, the first atomic particles start to form.

A teeny bit later ($10E-11$ second) the laws of physics stabilize. The universe is still expanding (but more slowly) and is starting to cool.

About four minutes later, simple atomic nuclei form (a few neutrons and protons make hydrogen and helium nuclei).

About a year later, the whole universe is still as hot as the center of a star (still expanding and cooling).

About a million years later (still a long time ago) normal atoms form and start to condense into stars (still expanding and cooling).

About a billion years later (still a long time ago) galaxies are forming out of stars and dust (still expanding and cooling)

About ten billion years later (still a long time ago) our sun and planets congeal from gas and dust from supernovae in the milky way galaxy (still expanding and cooling).

About five billion years later (right now) you are studying astronomy on the internet (still expanding and cooling).

Ten billion years in the future... Nobody knows. What do you think?