Standing on their shoulders

by Bob Riddle

In this month's column, I want to pause to say "Happy birthday!" to some of the folks born in October who have contributed to our current understanding of the universe. Having students compile a similar list for each month of the year and asking them to choose a name to research is a great way to help humanize these groundbreaking scientists and explorers. This type of activity also introduces and emphasizes for students the nature of science, particularly the idea that Science Is a Human Endeavor (NGSS Lead States 2013) (also see "Using Biographical Letters to Draw on the Nature of Science," p. XX). With this in mind, students can find examples of a scientific idea that has been revised over time and include the persons who have contributed to the idea. For example, they could study the eventual acceptance of the fact that the planets orbit the Sun rather than Earth. Pin the following list of famous birthdays to your bulletin board to get started, and encourage your students to be as inclusive as possible.

On October 3, one of the *Apollo* mission astronauts, Charles Duke, celebrates his 80th birthday. The youngest of the 12 astronauts who have walked on the Moon, Duke was the tenth to do so as a member of the *Apollo 16* crew. He was a pilot for the mission and safely landed the Lunar Module on the Descartes Highlands with John Young in April 1972.

The first woman from the United States astronaut corps to complete a spacewalk, Kathryn D. Sullivan, also was born on October 3. She flew three space shuttle missions, which included not only the spacewalk but also the deployment of the Hubble Space Telescope on STS-31 in 1990.

Students learning about atomic structure will be familiar with Niels Bohr, the Danish physicist who developed the atomic model that was later named after him. In addition to his work in physics, during the years leading up to World War II, Bohr helped war refugees flee from Nazi-occupied Germany. Were he alive today, October 7 would mark his 130th birthday.

One of the most prolific discoverers of asteroids is Freimut Börngen, a now-retired German astronomer. Although his specialty was studying galaxies, during his career, either independently or with others, he found more than 500 asteroids. On October 17, acknowledge his 85th birthday and consider his contributions to our understanding of many of the asteroids in the main asteroid belts.

October 17 is also the birthday of another NASA astronaut, Mae Jemison, the first African American female astronaut. Jemison flew aboard STS-47 in 1992. With degrees in medical research and engineering, she conducted numerous life science investigations, including a study of how bone cells may be affected by extended stays in space.

This year marks the 195th birthday of Édouard Roche, who was born on October 17, as well. The French astronomer is known for his ideas about the relationship between gravity and orbiting objects and is probably best known for the *Roche limit*, the distance at which an orbiting body is so gravitationally stressed that it is pulled apart by the larger object it orbits. This concept is a possible explanation for how the rings of Saturn formed: A large moon may have come too close to the planet and subsequently been pulled apart due to Saturn's gravitational pull.

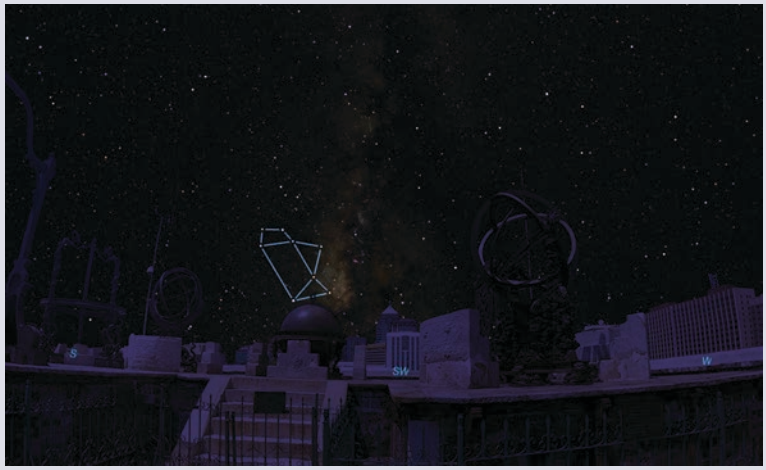
October 19 is the birthday of Subrahmanyan Chandrasekhar, an Indian American physicist who won a Nobel Prize for his work on black holes. The *Chandrasekhar limit* is named after him; this is the theoretical mass limit for white dwarf stars. A white dwarf star is an Earth-sized remnant of a larger star that has collapsed due to an imbalance between the nuclear energy produced in the star's core pushing outward and the gravity from the star's mass collapsing inward. According to Chandrasekhar's work, a white dwarf cannot be more than about 1.5 times the mass of our Sun. If a star has enough mass, it could continue collapsing beyond the white dwarf stage, perhaps becoming a neutron star or even a black hole.

October 21 is the birth date of Ronald McNair, an American physicist and shuttle astronaut who flew aboard the ill-fated *Challenger*. McNair was an accomplished musician and had planned to play a saxophone solo while in orbit. He was the second African American to go into space, and on his second shuttle mission, he lost his life with the rest of the *Challenger*

crew on January 28, 1986.

Karl Jansky was born on October 22, in what was once called the Oklahoma Territories. As a young man working for Bell Laboratories, Jansky studied how the ionosphere would affect verbal radio transmissions across the Atlantic Ocean. Jansky identified three types of radio-static interference and concluded that two of these were the result of thunderstorms, both near and distant. The third form of static had a regular, repetitive cycle that matched the Earth's rotation rate of 23 hours and 56 minutes. Jansky initially concluded that the static interference was from our Sun, but after a few months of data collecting, he realized that the source was slowly moving away from the Sun each day. By comparing his observations with star charts, Jansky concluded that the radio-static source was actually coming from the direction of the center of the Milky Way galaxy, within the constellation of Sagittarius the Archer (Figure 1).

FIGURE 1 Center of the Milky Way



Russell Schweickart, a former F-86 fighter pilot for the U.S. Air Force, turns 85 on October 25. Part of the third group of astronauts selected by NASA, he served as the Lunar Module pilot for *Apollo 9* in 1969, the first manned flight of the Lunar Module.

Another cosmonaut Gennady Strekalov, was born on October 28 and was an engineer who flew five space missions. He logged nearly 300 days in space, living in a series of Russian space stations including the *Salyut 6*, the *Salyut 7*, and the *Mir*. In addition to his time in space, Strekalov is often remembered for surviving a 1983 rocket explosion by using the spacecraft's launch escape system.

My birthday star

Every year, each person has a different birthday star. Your *birthday star* is as many light-years distant as you are years old (Figure 2). The light reaching your eyes left that star the year you were born.

Before looking for their birthday star, students should have an understanding about the speed of light and how that relates to time and distance. The speed of light is about 300,000 km per second (186,000 mi. per second). At that speed, sunlight would take eight minutes to reach Earth, more than five hours to reach Saturn, and reach the next closest stars after four or five years. At that speed, in one year, a *light-year*, light would travel approximately 10,000,000,000,000 km. (approximately 6,000,000,000,000 mi.). With this in mind, your personal birthday star would be a star that has a light-year distance equal to your age, but only for that year, because each year, your birthday star would be one-light year farther than the year before. To find your birthday star, go to the Birthday Star website and match an age with the appropriate star and distance (see Resources). You can then click on a link to go to a star map showing the star's location.

Once they determine the birthday star, students can create a Birthday Star Card that includes some information about the star and a person's birthday

FIGURE 2 Light-years

One light-year is equal to:

- 5,878,625,373,196 mi.
- 489,885,447,766 ft.
- 9,460,730,472,600 km
- 9,460,730,472,600,000 m

(Figure 3). Alternatively, students could put together a time line of the birth dates and historical significance of scientists, engineers, or mathematicians of their choosing; make an infographic highlighting a famous scientist's accomplishments; or even a meme with a quote from the person. A time line could include multiple people, or students can focus on one individual in a biographical time line.

Celestial events

All but one planet visible to the naked eye can be seen in the morning skies this month. The one exception, Saturn, is an evening planet and is somewhat easy to locate over the southwestern horizon at sunset, near the reddish star Antares in Scorpius the Scorpion.

The rest of the visible planets are arranged like steps on the opposite side of the sky before the Sun rises (Figure 4). Observing the planets regularly during this month will allow your students an opportunity to compare how different the orbital speed of an inner planet, Mercury, is to an outer planet, Mars (see "For Students" questions). Each day during October, Mercury seems to rocket upward, moving west away from the Sun and rising earlier, while Mars moves steadily eastward, catching up with and passing a more distant outer planet, Jupiter, which is also moving eastward. ■

Visible planets

Mercury will be visible as a morning planet over the east-southeast horizon as it rises one to two hours before the Sun.

Venus will rise three to four hours before the Sun and will shine brightly over the southeastern horizon.

Mars will rise two to three hours before the Sun and will be visible over the southeastern horizon at sunrise.

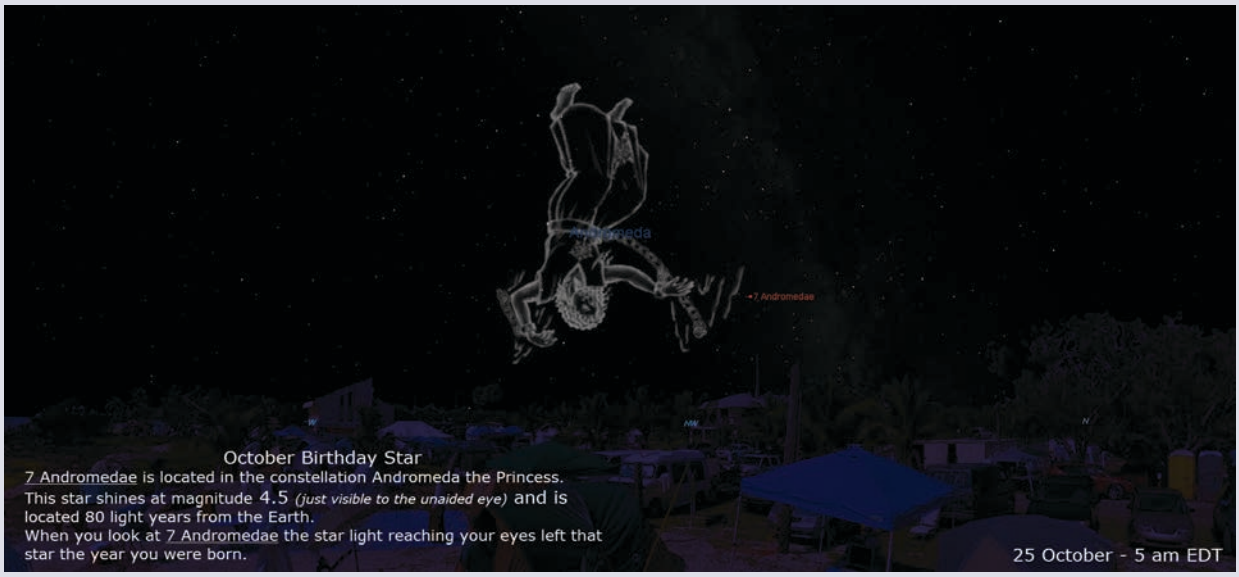
Jupiter will rise at about the same time as Mars, and the two will come very close during the middle of the month.

Saturn will be visible near the reddish star Antares over the southwestern horizon, where both set about two hours after the Sun sets.

October

2	Moon near Aldebaran
3	Charles Duke's 80th birthday
	Walter Alvarez's 75th birthday
4	Last quarter Moon
4–10	World Space Week
7	Niels Bohr's 130th birthday

FIGURE 3 Birthday Star Card for an 80-years-young person



8 Moon near Venus and Regulus
9 Moon near Mars and Jupiter
11 Moon at ascending node
Moon at apogee: 406,400 km (243,840 mi.)
Uranus at opposition
12 New Moon
13 *Cassini* flyby of Titan and Enceladus
15 Mercury at west elongation
16 Moon near Saturn
17 Mars near Jupiter
Dwarf planet Eris at opposition
20 First quarter Moon
21 Orionids meteor shower
Ronald McNair's 65th birthday
22 Karl Jansky's 110th birthday
25 Moon at descending node
Venus very near Jupiter

For students

1. What is meant by a *visible planet*? *(This could be defined two ways, with* visible planet *referring to any planet above the horizon and therefore visible, or as those planets visible to the unaided eye. The latter, with regard to observing, is the definition I use.)*
2. How does the orbital speed of Mercury compare with the orbital speed of Mars? *(As an inner planet relative to Mars, Mercury orbits the Sun more quickly than Mars. In terms of degrees, Mercury moves approximately 4° per day [360°/88 Earth days = 4.09°]; Mars moves approximately 0.5° per day [360°/689 Earth days = 0.52°].)*
3. Where did the phrase "standing on the shoulders of giants" come from, who is credited with saying this, and what did the person mean by it? *(Often attributed to Isaac Newton, this quote may have come from John of Salisbury, a 12th-century theologian and author [see Resources]. I think of this phrase as meaning that we can learn about the knowledge our predecessors have given us and subsequently add to that knowledge through our own explorations.)*

FIGURE 4 Lineup of planets at 6:30 a.m. EDT on October 15

Rusty Schweikart's 80th birthday
26 Venus at western elongation
Moon at perigee: 358,500 km (215,100 mi.)
Gennady Strekalov 75th birthday
27 Full Moon
28 *Cassini* flyby of Enceladus
Edward Ney's 95th birthday
29 Moon near Aldebaran

Resources

Birthday Stars—*www.pbs.org/seeinginthedark/explore-the-sky/birthday-stars.html*
Cassini Solstice mission—*http://saturn.jpl.nasa.gov*
Space calendar—*www2.jpl.nasa.gov/calendar/calendar.html*
Standing on the shoulders of giants—*www.phrases.org.uk/meanings/268025.html*
Technology time line—*www.datesandevents.org/events-timelines/12-technology-timeline.htm*

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