Celestial grid system

March is a month of transition between winter and spring in the northern hemisphere that is marked by the astronomical position of the Sun with respect to other stars. On March 21st, the Sun is in the boundaries of the constellation Pisces. At approximately 8:03 PM Eastern Standard Time (EST), the Sun, in its apparent motion along the ecliptic, will have reached the astronomical coordinate position of 0 hours and 0 degrees.

The "coordinate system" in the sky is essentially an extension of the Earth's surface-based system of latitude and longitude. There are celestial poles and a celestial equator and, just like parallels of latitude on Earth, objects are measured in degrees of declination north or south from the celestial equator. Unlike the longitude system, however, celestial objects are measured in only one direction, rather than using east and west as we do with longitude. The sky is still divided equally into 24 segments that are 15 degrees apart and, like meridians of longitude, taper together at the poles. These meridians are known as *hour circles of right ascension*, or simply *hour circles*, and are typically numbered from 0 to 23.

Along the ecliptic

While the celestial grid system gives us the coordinates for any object, it is the *ecliptic path*—the Sun's apparent path throughout the year—which delineates the position for the ending and beginning of each season. The ecliptic path is a curved line that crosses the celestial equator twice—once as it moves northward toward a maximum distance from the celestial equator, and again as it moves south of the celestial equator toward its maximum distance south. Picture a curved line wrapping around the Earth that goes from the equator to the Tropic of Cancer, back down to and across the equator to the Tropic of Capricorn and then back up to and crossing the equator to the Tropic of Cancer. This is a visualization of the

All things being equal...or are they?

You may have heard that the word equinox means "equal night," which is a reference to the idea that the length of the night is the same as the length of day on the equinox date. But do we really have a day when there is an equal amount of day and night?

The chart below lists the time for sunrise and sunset on the day of the equinox, for various latitude locations between the north and south poles. Even though we say this is the day with equal lengths of day and night, a glance at the table shows the amount of time for daylight is not exactly the same as the amount of time for night on the equinox date. This leads to an interesting investigation for students based on questions such as, "Is there actually an equinox day?"; "Will all locations on Earth experience the same amount of daylight/night?"; "Where on Earth does this happen and what causes the differences?"; and "What does the Sun's apparent path from east to west look like and how does this compare with other locations?"

Lat/Long=0°	Sunrise time	Sunset time
90° S	up all day	up all day
60° S	06:00 AM	6:14 PM
30° S	06:03 AM	6:11 PM
0°	06:04 AM	6:10 PM
30° N	06:03 AM	6:11 PM
60° N	06:00 AM	6:13 PM
90° N	up all day	up all day

Author note: This table shows sunrise and sunset times for the same longitude, along the prime meridian, and is set for different latitudes. All of the times are considered local time, but by staying at the same longitude, in this case the prime meridian, there is no need to convert to local time. The point is to establish a reference for seeing how the length of daylight compares with different locations and to introduce questions like those in the previous paragraph.

Sun's apparent path along the ecliptic throughout the year. The Sun, from our perspective, appears to be moving eastward relative to the stars in the background, following the curving path of the ecliptic. The Sun must reach a particular set of coordinates along the ecliptic, at which time the time the change of seasons is marked.

Excellent, free star charts are available from the Stephen F. Austin University Observatory (see Resources), which may be downloaded from their website and used by your students as they work with the celestial coordinate system and the Sun's apparent path along the ecliptic.

Beyond the ecliptic

As your students become comfortable with the celestial coordinate system, introduce them to the Star Chart Viewer program used with the Stephen F. Austin Observatory star charts. This program shows the current position of planets as well as the location of many galaxies and nebula. With an Internet connection, students may even download a regional image of the sky that they click from the star chart. These images are a collection of 6.5 x 6.5-degree images of the entire sky taken with ground-based telescopes from the Space Telescope Science Institute online database (see Resources). Requests may be made directly from the user-friendly web interface or from the Star Chart Viewer program. Students, for example, are able to locate and download an image of the "star factory" known as the Great Orion Nebula, or an image of the remnants of star that exploded in 1054 A.D. known as the Crab Nebula.

Internet resources

Vernal Equinox—*www.equinox-and-solstice.com/html/vernal_equinox.html*
Sunrise/setcalculator—*www.sunrisesunset.com/custom_srss_calendar.asp*
U.S. Naval Observatory data services—*aa.usno.navy.mil/data*
Star charts from Stephen F. Austin Observatory—*observe.phy.sfasu.edu*
Space Telescope Science Institute—*archive.stsci.edu/cgi-bin/dss_form*

Visible planets

- Mercury is visible but very low over the southeastern horizon at sunrise.
- Venus is visible but very low over the southeastern horizon at sunrise.
- Mars is over the southeastern horizon at sunset.
- Jupiter is high over the southeastern at sunset and is visible most of the night.
- Saturn is high over the southwestern horizon at sunset and sets before sunrise.

Moon phases

March

New Moon	3/03
First quarter	3/11
Full Moon	3/18
Third quarter	3/25

Celestial events

- 3/21 Vernal Equinox, 8:03 PM EST

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