The Winter Sky

by Dr. Whitney Shane, MIRA's Charles Hitchcock Adams Fellow

Fixed Stars

During the winter months, while the Milky Way is still in view, we can continue our thoughts on the interstellar matter. This can be observed in many ways, the most obvious of which is extinction by the dust, which we discussed in the fall *Newsletter*. But spectroscopic observations, although more difficult, are even more rewarding. The most striking objects are the emission nebulae, of which the Orion Nebula is a famous example. These are huge gas clouds, heated by embedded hot stars. The light of these stars excites and even ionizes the gas atoms, and they then release energy, each atomic sort at its characteristic wavelength. The hydrogen atoms, which are the most plentiful, radiate strongly in the H-alpha line, giving these objects their red color. Weaker radiation from other elements is also observed. In planetary nebulae, where the densities are much lower, the processes are quite different and the so-called forbidden lines of elements like oxygen and nitrogen tend to dominate.

Dr. Mary Lea Shane, 1897-1983

Further from the very bright stars, the temperatures are much lower and the gas is not excited by radiation from stars, so that it cannot shine at optical wavelengths. It can, however, absorb light from background stars. Unlike the dust, it does this only at the wavelengths at which the atom has a spectral resonance. At this wavelength some of the starlight will be absorbed and we will see a dark line in the spectrum. If an atom has no resonance in the optical part of the spectrum, we will be unable to observe it in this way. Hydrogen and helium, the two most abundant atoms, are like this. The strongest lines come from certain metals, which are present as atomic gasses. Ionized calcium was discovered by Hartmann in 1904. Starting around 1920 more elements were discovered, as well as certain simple molecules such as CH and CN. It is probable that some of these lines which turn out to be rather broad, and are thus called diffuse interstellar bands, may be due to much more complex molecules. These and certain other lines have, after nearly 100 years, yet to be identified with certainty.

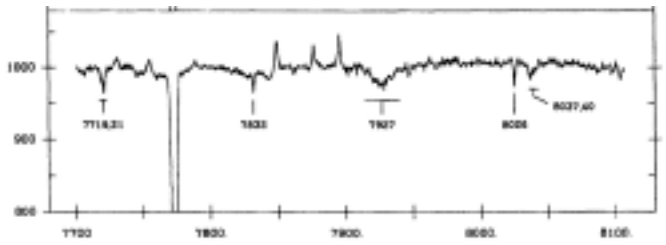
MIRA astronomer Dr. Ana Torres-Dodgen added to this uncertainty by discovering two new, strong diffuse interstellar bands in the spectra of stars in the cluster of hot, young stars called Cygnus OB2.

The interstellar lines are most easily discovered by observing bright stars with variable velocity, such as spectroscopic binaries. The lines of stellar origin move back and forth as the velocity of the star changes, but the interstellar lines remain stationary. We often find one line broken into several components at slightly different velocities, showing that the lines originate in clouds with different motions. This gives us important information about the structure of the interstellar medium and helps us to map the region of the Galaxy close to the Sun.

Throughout most of the Galaxy the temperature is too low to excite atoms enough so that they can radiate in the optical range. This is why we observe only absorption lines. However, in the radio and infrared parts of the spectrum the photon energies are much lower so that we can observe emission lines from many parts of the Galaxy. The best known example is the 21-centimeter line of neutral hydrogen, which is observed strongly in every direction. However, most of the spectral lines found in this part of the spectrum come from a vast variety of molecules, most of which are found only in dense clouds, such as the Orion molecular clouds. Deciphering the complex molecular spectra, which extend from the short-wavelength radio to the near infrared, is an intriguing puzzle. Most of the infrared observations have to be made from space because the Earth's atmosphere absorbs so much of this radiation.

Many constituents of the interstellar material have now been identified. Some atoms, such as sulfur and oxygen, have been observed in infrared emission. Molecular hydrogen and the hydrogen-deuterium molecule are

plentiful. Many other molecules, both simple and complex, have been observed as gasses. The spectra of material in solid form have also been observed. These include heavy



This spectrum in the red region shows one of the two diffuse interstellar bands discovered by MIRA astronomer Dr. Ana Torres-Dodgen with the now-retired MIRA Reticon spectrograph. The broad band labeled 7927 is one of these. Its cause has yet to be identified.

complex organic molecules, such as polyaromatic hydrocarbons (complexes of benzene rings), silicates and other inorganic particles, which would form the nuclei of the interstellar grains, and various ices, including water ice, which would form the mantles of these grains.

Planets

After being briefly visible low in the southeastern morning sky at the beginning of the year, Mercury will disappear behind the Sun. It will reappear at the end of February and be easily observable in the western evening sky during the first half of March. This will be the best opportunity in 2005 for northern observers to see Mercury.

At the beginning of the year Venus will still be visible low in the southeastern sky, but it will soon disappear into the morning twilight and not reappear until May. Mercury and Venus will be in conjunction on January 14.

Mars will remain low in the southeastern morning sky during the whole quarter, rising less than 3 hours before the Sun. Its visibility will not improve substantially until July.

Jupiter starts out as a morning-sky object, rising about midnight at the beginning of the year. However, as it approaches opposition in April it will rise earlier and by late March will be visible during most of the night. Jupiter will be occulted by the Moon four times during the quarter, but these occultations will be visible only from various locations in the southern hemisphere.

Saturn will be in opposition on January 13 and thus visible during the whole night. As it is winter, it will also be far north of the equator and well located for observation. At the end of March it will be mainly an evening object, but still visible for most of the night.

Meteor Showers

This will be a poor season for meteor observation. The only winter meteors of much consequence are the Quadrantids, which reach a sharp maximum during the early morning hours of January 3. Unfortunately a last quarter Moon will largely spoil the show. The delta-Cancrids, which are both faint and infrequent, can be observed until late January, with a maximum on January 17. With new Moon on January 10, this is a good year to look for these objects.

The alpha-Centaurids, which sometimes produce very spectacular meteors, and the gamma-Normids are both southern hemisphere showers and thus of little interest to northern hemisphere observers.

Comets

According to current expectations, the brightest comet visible during the winter quarter will be 2004 Q2 (Machholz). This comet will move north from Taurus, where it will be an evening object in January, to within 5 degrees of the pole in March. It should be easily observable with binoculars and perhaps even with the naked eye.

Comet 9P/Temple will become observable in Virgo in February, although it will still be rather faint. This comet is of particular interest as it will be the target of the Deep Impact spacecraft, which is scheduled to disturb it on July 4. MIRA astronomers are planning to observe the impact.

The interesting comet 29P/Schwassmann-Wachmann will be observable in Pisces until February. This comet, although seldom brighter than magnitude 12, is subject to frequent outbursts, and it is currently more often active than not, so it is worth the trouble to observe it.

Eclipses

There will be no eclipses during the first three months of 2005. We will have to wait until April, when there will be two, one of which will be visible from our neighborhood.

Editor's note: It was Dr. Mary Lea Shane, Dr. Whitney Shane's mother, who discovered diffuse interstellar bands in 1921, while a graduate student at UC Berkeley/Lick Observatory. She noted bands at 5780 and 5797 Å in her work on spectroscopic binaries.