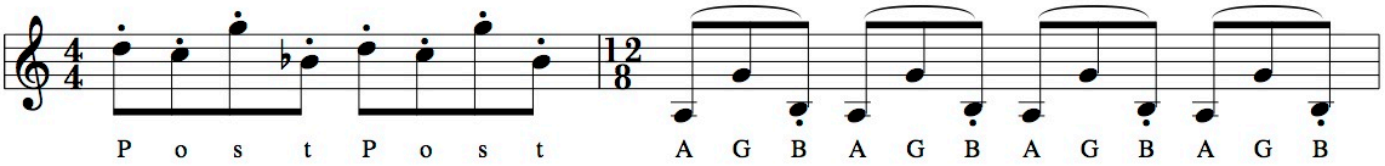
The Object-Types Main-Themes for Piano

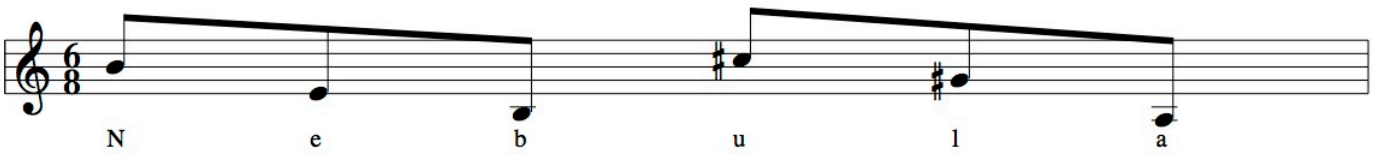
Post-AGB Star

A region of the Hertzsprung-Russell diagram that lies above and parallel to the red giant region.
It is occupied by evolved stars of intermediate to low mass (less than an initial mass of 8 Msun) that have a dormant, helium-filled core surrounded by a helium-fusing shell, on top of which lies a hydrogen-fusing shell.
Initially, the hydrogen-fusing shell produces most of the star's energy output.
However, the hydrogen shell eventually dumps enough helium "ash" onto the helium shell that the latter undergoes an explosive event called a thermal pulse.
Although this pulse is barely noticed at the surface of the star, it serves to increase the mass of the carbon/oxygen core, so that the size and luminosity of the star gradually increases with time.
As the star climbs the AGB, a wind develops in the star's envelope that blows the outer layers into space at a rate of 10-8 to 10-4 Msun per year.
Within this wind, dust particles (crucial to the development of interstellar clouds and, eventually, protoplanetary systems) are formed from carbon material dredged up from the core by convection currents.
Also through this mass loss, AGB stars avoid ending as supernovae.
When the envelope of the star is nearly gone, a time of enhanced loss with a rapid velocity produces a planetary nebula and eventually leaves behind a white dwarf of 0.6 to 0.7 Msun.



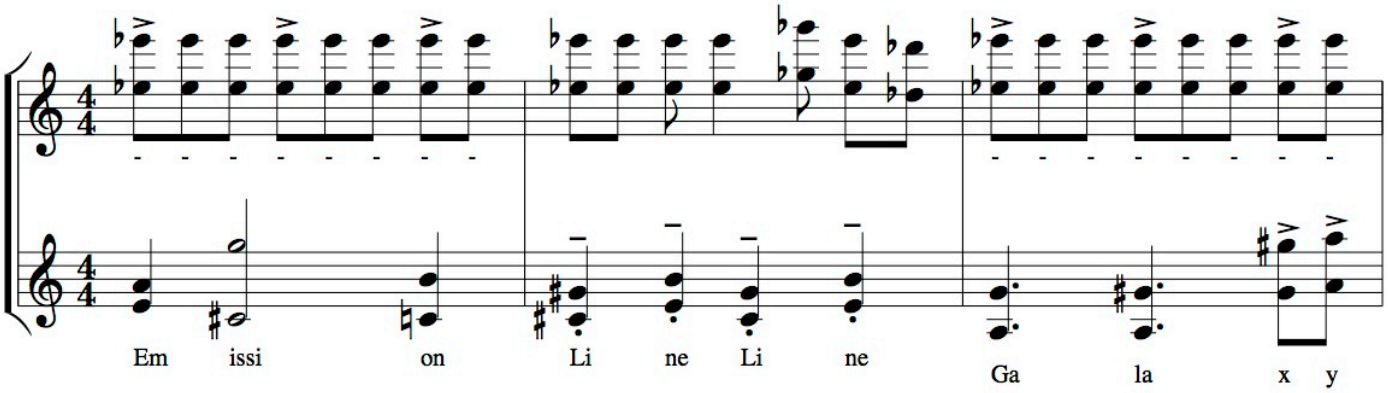
Nebula

A cloud of gas and dust in space.
There are three general types: emission nebulae, which shine by their own light, reflection nebulae, which reflect light from nearby stars,
and dark nebulae, which absorb and appear dark against a brighter background.
When cloudlike material in space is patchy, or of a form that is difficult to categorize as a particular type of nebula, is referred to as nebulosity.



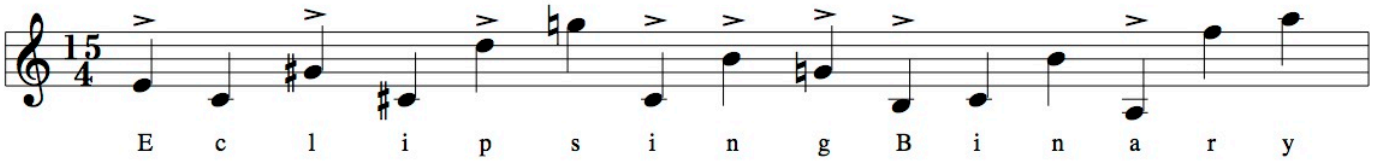
Emission-Line Galaxy

A bright line in the spectrum of a luminous object caused by the emission of light at a particular wavelength.
Emission lines may appear on their own, as in the spectrum of a nebula energized by radiation from a nearby hot star, or they may be superimposed on an absorption spectrum, as happens when a star is surrounded by hot gas.



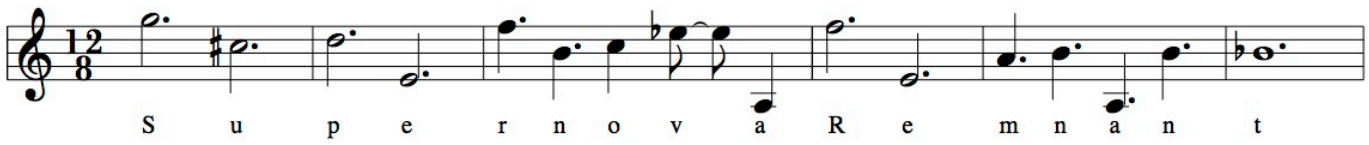
Eclipsing Binary

A binary star system in which the components periodically pass in front of one another as seen from earth.
When this happens the total light received from the system is reduced.
The primary minimum occurs when the component with the higher surface luminosity is eclipsed by its fainter companion.
Three main types of eclipsing binary are distinguished on the basis of their light curves: Algol stars, Beta Lyrae stars, and W Ursae Majoris stars.
Eclipses may also occur in some kinds of cataclysmic binary, including dwarf novae, novae, and symbiotic stars.
Exactly how the light varies depends on the nature of the component stars and their separation.



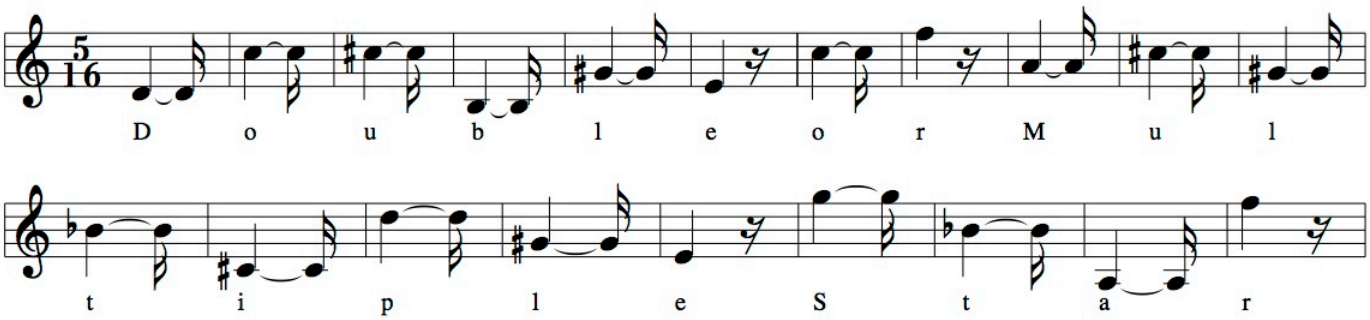
Supernova Remnant

An expanding diffuse nebula that consists of material ejected at speeds of about 10,000 km/s by a supernova explosion together with swept-up interstellar matter.
Supernova remnants are generally powerful radio and X-ray sources, and may or may not be visible at optical wavelengths.
There are several different types.
Shell remnants, of which Cassiopeia A and the Cygnus Loop are well-known examples, radiate mainly from the shell itself.
A shock wave travels out ahead of the ejected material, plows into the surrounding interstellar medium (ISM), heats it to several million degrees, and causes it to emit thermal X-rays.
Electrons accelerated by the shock, emit synchrotron radiation at radio wavelengths.
Filled-center remnants or plerions, of which the Crab Nebula is the prime example, emit the bulk of their radiation from within the expanding shell because of the presence of a pulsar.
The pulsar continuously supplies high-speed electrons which give off intense synchrotron radiation in the inner part of the SNR.
Composite remnants are a cross between the shell remnants and plerions.
They may appear shell-like or filled or both depending in which part of the electromagnetic spectrum they are being observed.
SNR tends to involve three main phases.
During the first, known as free expansion, the front of the expansion is formed from the shock wave interacting with the ambient interstellar medium (ISM).
This phase is characterized by constant temperature within the SNR and constant expansion velocity of the shell.
In the second phase, known as the Sedov or adiabatic phase, the SNR material slowly begins to decelerate and cool.
The main shell of the SNR experiences Rayleigh-Taylor instability,
which causes the SNR's ejecta to become mixed with the gas
that was just shocked by the initial shock wave.
This mixing also enhances the magnetic field inside the SNR shell.
The third phase, known as the snowplow or radiative phase, begins after the shell has cooled to about 106 K, so the shell can more efficiently radiate energy.
This, in turn, cools the shell faster, making it shrink and become more dense,
which cools it faster still.
Because of the snowplow effect, the SNR quickly develops a thin shell
and radiates away most of its energy as optical light.
Outward expansion stops, the SNR starts to collapse under its own gravity,
and, after millions of years, the remnant is absorbed into the ISM.



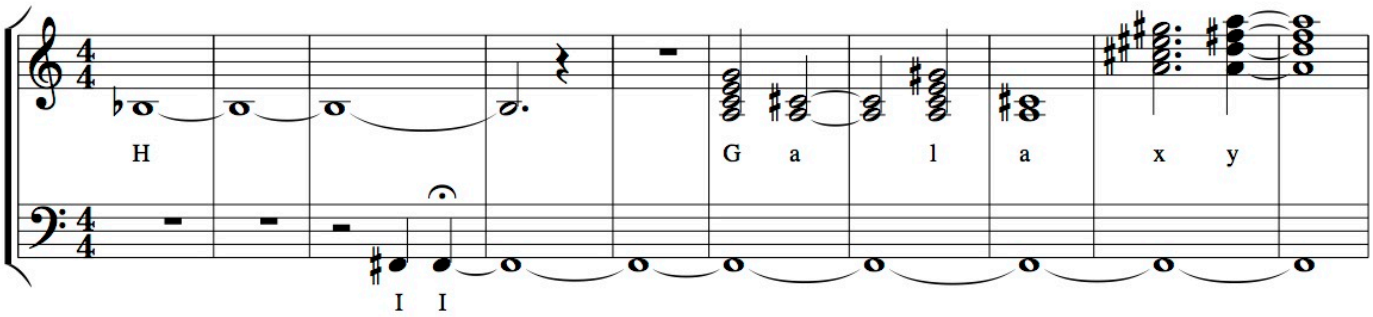
Double or Multiple Star

A pair of stars that appear close to each other in the sky as seen from earth when viewed through an optical telescope.
A multiple star consists of three or more stars which appear from the earth to be close to one another in the sky.
This may result from the stars being physically close and gravitationally bound to each other, in which case it is physical, or this closeness may be merely apparent, in which case the multiple star is optical.



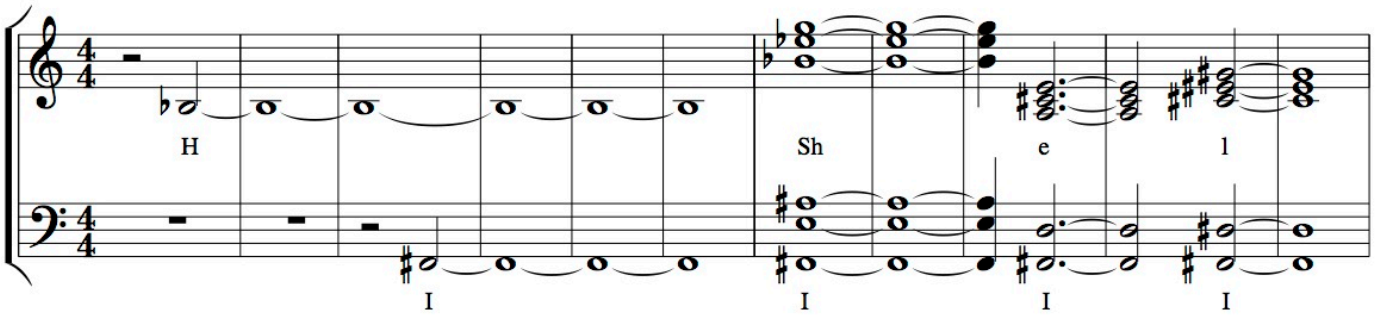
HII Galaxy

Galaxy spectra also clearly show you whether a galaxy contains star-forming regions called HII regions.
HII is a spectral emission line that corresponds to ionized hydrogen;
a hydrogen atom that has lost its electron.
HII regions are areas of a galaxy where hydrogen nuclei and electrons are recombining to form neutral hydrogen.



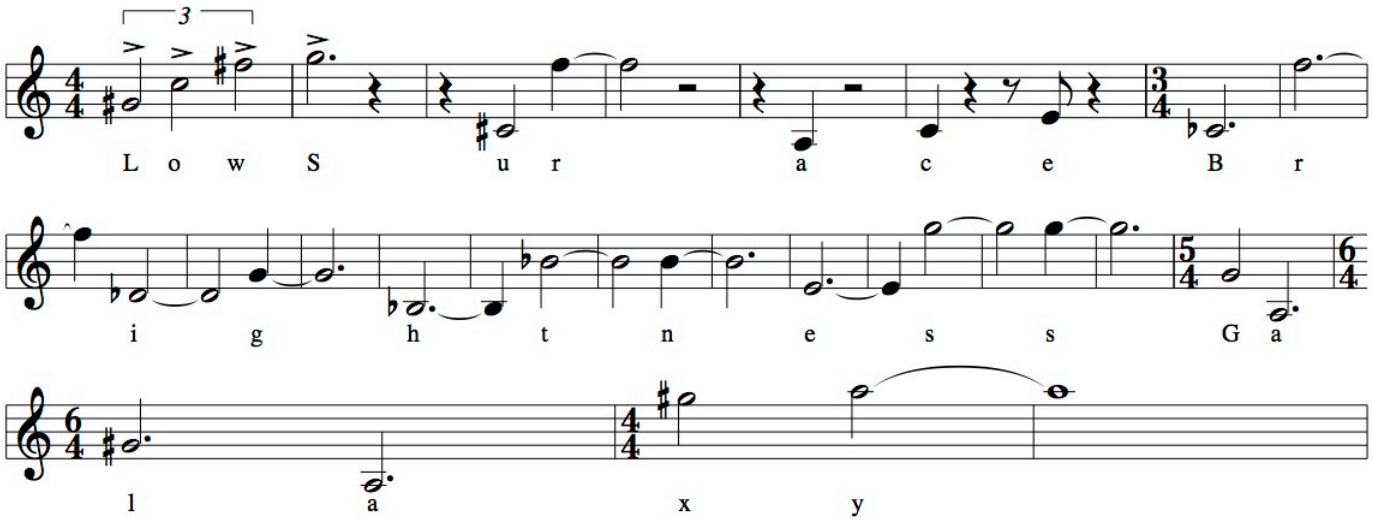
HI Shell

An interstellar cloud composed primarily of atomic hydrogen, detectable by its radio wave emission in the 21-centimeter line.
HI regions have a density of 1 to 10 atoms/cm3 and a temperature of about 125 K (the spin temperature of neutral hydrogen).
At least 95% of interstellar hydrogen is HI.



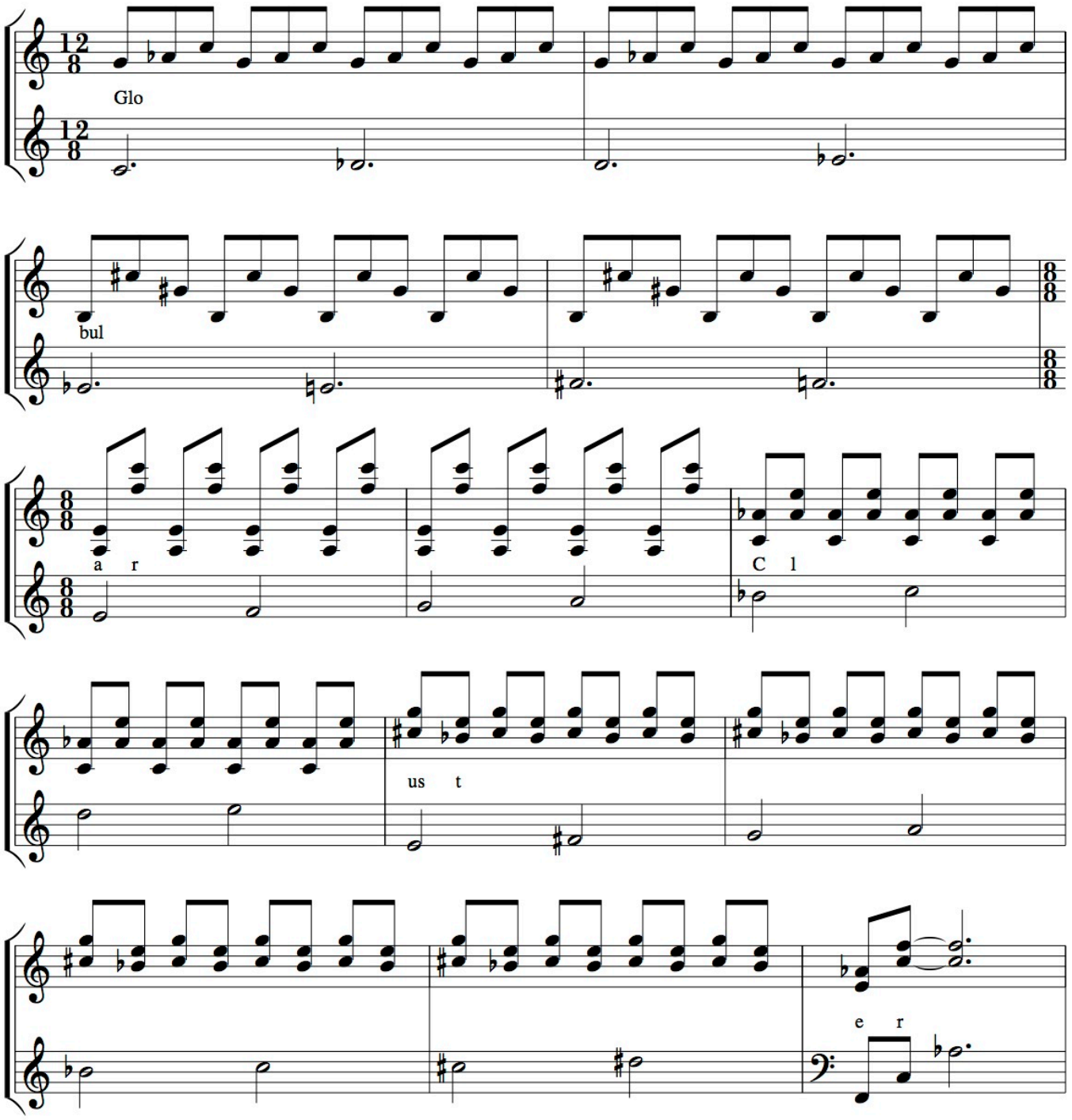
Low Surface Brightness Galaxy

A galaxy that is at most a few percent brighter than the sky background, making it very difficult to see.
The first low-surface-brightness (LSB) galaxy to be found, Malin-1, was discovered as recently as 1987 and it now appears that up to half the galaxy population is of this type and had been missed in earlier surveys.
LSB galaxies have fewer stars per unit volume than normal galaxies, possibly because they are more isolated in space and have not undergone tidal interactions with other galaxies that stimulate bursts of star formation.
Recent photographic and CCD surveys have uncovered large numbers of new small and medium-sized, moderate-to-low surface brightness spiral galaxies; however, LSB giants such as Malin-1 have remained relatively rare.



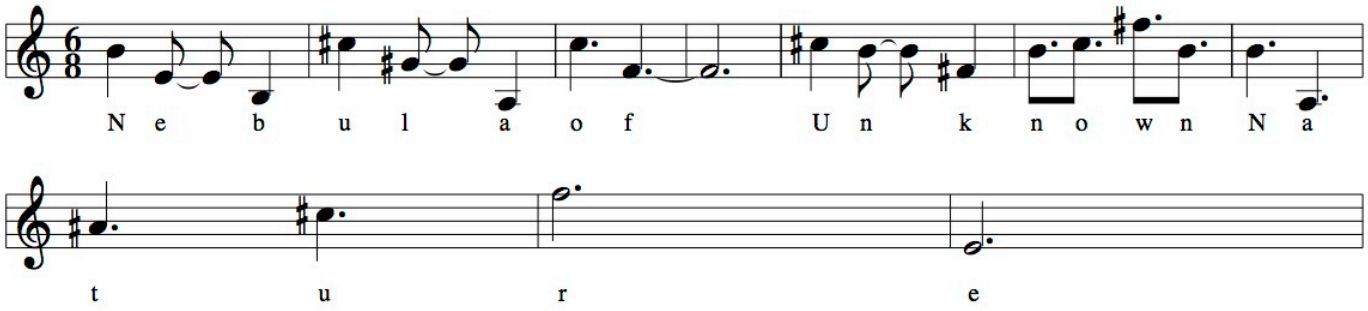
Globular Cluster

A spherically symmetric collection of old stars that share a common origin.
Globular clusters contain from tens of thousands to millions of stars and measure from 100 to 300 light-years across.
Some have been shown, in all likelihood, to contain middleweight black holes in their cores.
Unlike open clusters and stellar associations, which are held together only weakly by gravity and contain Population I objects, globulars are tightly gravitationally bound collections of Population II stars.
They inhabit the galactic halo and galactic bulge, and show significant concentration toward the galactic center.
The Milky Way has about 150 globular clusters, all of them in highly elongated orbits.
They are divided into two broad types, known as Oosterhoff groups after the Dutch astronomer Pieter Oosterhoff (1904-1978) who first identified them.
The main difference between them is that group I clusters have slightly weak metal lines whereas group II clusters have very weak metal lines.
A topic of great interest is the origin of globular clusters.
It had been assumed that the majority of globulars in the Milky Way were ancient native systems that formed around the same time as the rest of the galaxy some 10 billion years ago, though it was known that nearly two dozen group II clusters are prisoners-of-war captured from other, smaller galaxies in the Local Group.
Recent research, however, has shown that even some group II systems,the metal poor variety,have been looted from outside.
These presumed aborigines have, it turns out, come from the Large Magellanic Cloud and are a billion years younger than had been previously estimated.
As a result, astronomers have been forced to rethink their ideas about how the Milky Way evolved and, because globulars are used as a cosmic yardstick, to recheck the distances between galaxies, which might be in error by as much as 7%.
Further evidence that globular clusters are not necessarily relics of the earliest generations of stars in a galaxy comes from observations of galaxy collisions.
These can give rise to ultraluminous clusters, which appear to be globular clusters in the making.
Palomar 5, on the other hand, is a globular cluster in its death throes, being torn apart by tidal forces of the Milky Way.
This ancient object, on the outskirts of our galaxy, some 75,000 light-years from the sun, has only about 10,000 stars left.
All the rest have been stripped away and now lie in two incredibly long tails, strung across 13,000 light-years of space.
In fact, the tails of Palomar 5 delineate the orbital path of this cluster and thus provide a unique opportunity to determine its motion around the galaxy.
Together with the so-called Sagittarius Stream, which emerges from the Sagittarius Dwarf Elliptical Galaxy, there are now two different examples of extended stream-like structures in the galactic halo.
The geometry and the velocities of those tidal streams will become important tools for determining the mass of the dark matter halo that surrounds the Milky Way.
One of the nearest globular clusters, M13 (the great cluster in Hercules), was the target for an early attempt at CETI, though whether planets exist within globulars clusters is still a matter of debate.


Glo
bul
a r
C l
us t
e r

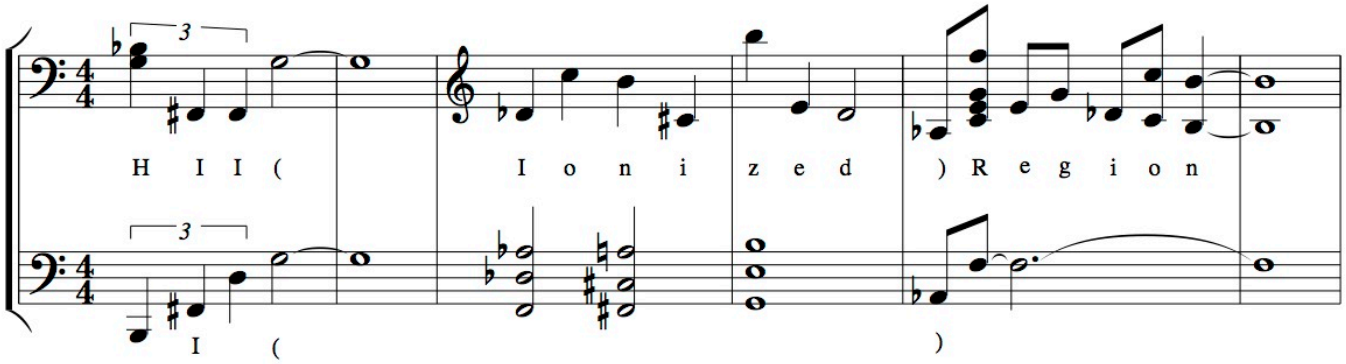
Nebula of Unknown Nature

The nature of nebulae was unknown until the first spectroscopic observations were made in the mid-19th century.
Towards the end of the 20th century, technological improvements helped to further the study of nebulae.
Space telescopes allowed astronomers to study light emitted beyond the visible spectrum which is not detectable from ground-based observatories (because only radio waves and visible light penetrate the earth's atmosphere).
Infrared and ultraviolet studies of nebulae allowed much more accurate determinations of nebular temperatures, densities and abundances.
Charge-coupled device technology allowed much fainter spectral lines to be measured accurately than had previously been possible.
The Hubble Space Telescope also showed that while many nebulae appear to have simple and regular structures from the ground, the very high optical resolution achievable by a telescope above the earth's atmosphere reveals extremely complex morphologies.



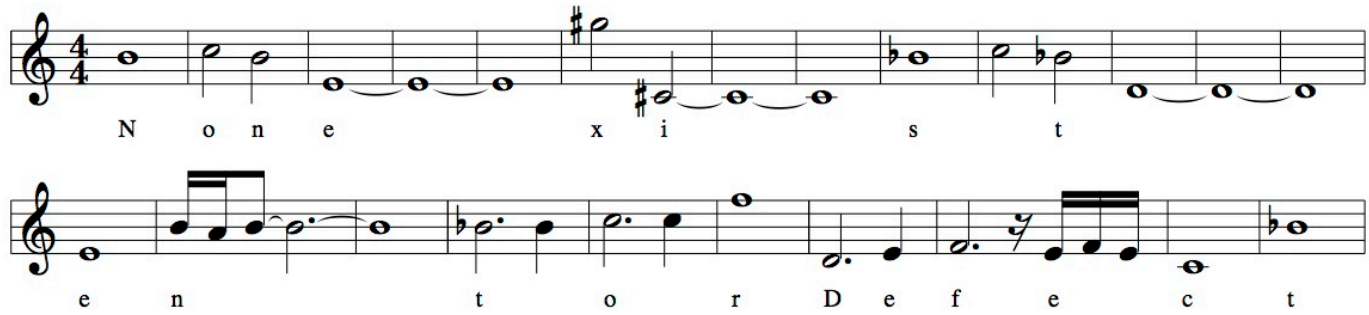
HII (Ionized) Region

A volume of space where the hydrogen in the interstellar medium is in an ionized rather than a neutral state.
Generally, these are regions where hot, blue OB stars are pouring large amounts of ultraviolet radiation into the surrounding cloud from which they were recently formed.
Such stars can ionize all the hydrogen (and other atoms) for dozens or even hundreds of light-years in every direction.
The ultraviolet light strips electrons away from hydrogen atoms by the process known as photoionization.
Then as the electrons recombine with protons (hydrogen nuclei) they emit a characteristic series of emission lines as they cascade down through the energy levels of the atom.
The visible radiation in these lines imparts to HII Regions their beautiful colored glows.
HII Regions have typical kinetic temperatures of 10,000 to 20,000 K, and a density of about 10 atoms/cm3.
The most famous of them is the Orion Nebula.
Compare with HI Region.
Ionized atomic hydrogen clouds with temperatures of K.



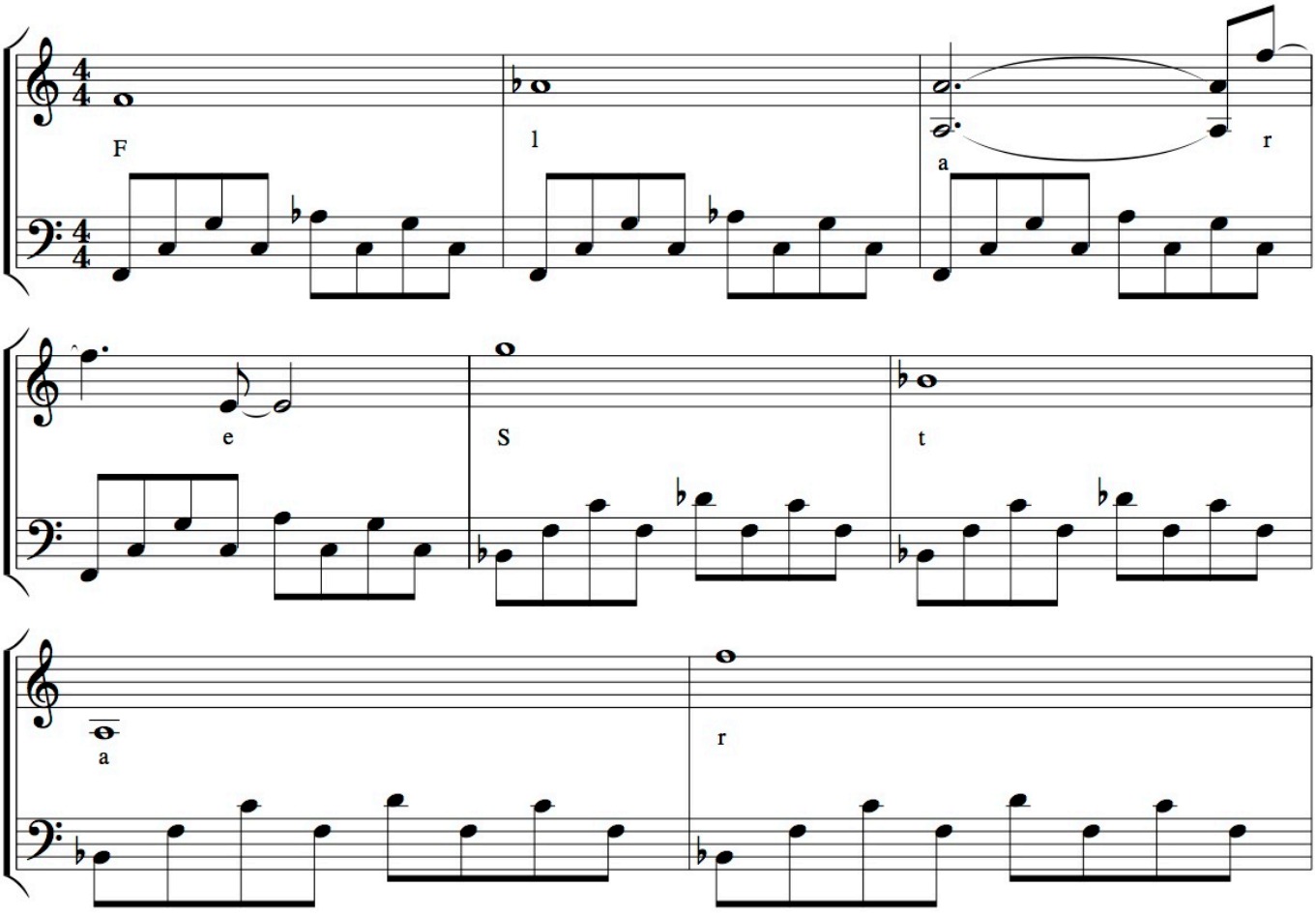
Nonexistent or Defect

Objects that where earlier discovered and catalogued but which supposedly can't be found in the sky today.



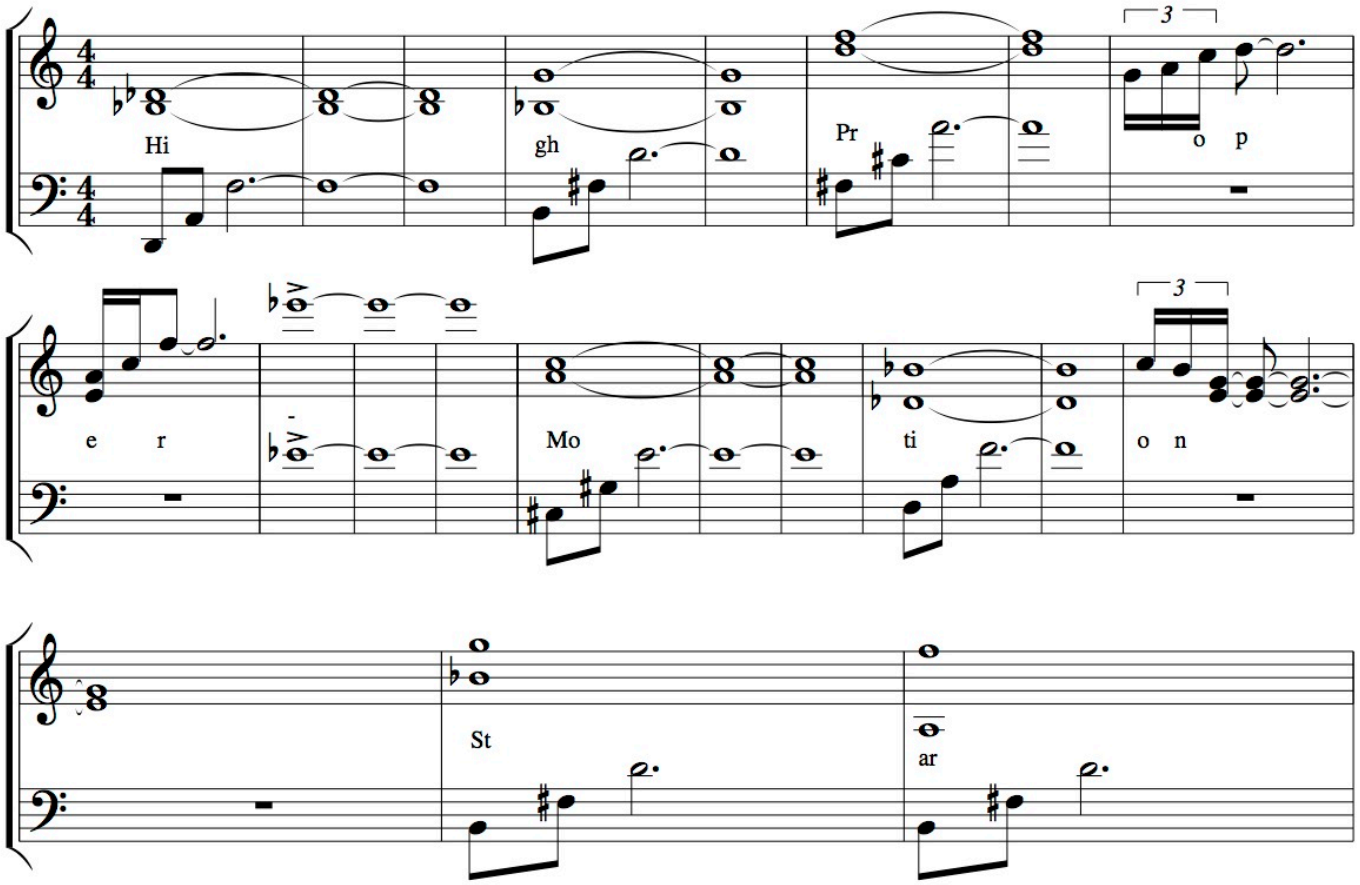
Flare Star

A red dwarf that displays sudden and unpredictable changes in light output lasting for a few minutes.
The flares are believed to occur in the star's chromosphere and to be similar in nature to solar flares but much more energetic.
The nearest star to the sun, Proxima Centauri, is a flare star as is one of the components of the nearby binary star system, Luyten 726-8, also known as UV Ceti.
Although the terms flare star and UV Ceti star are sometimes used synonymously, BY Draconis stars also show flare activity.



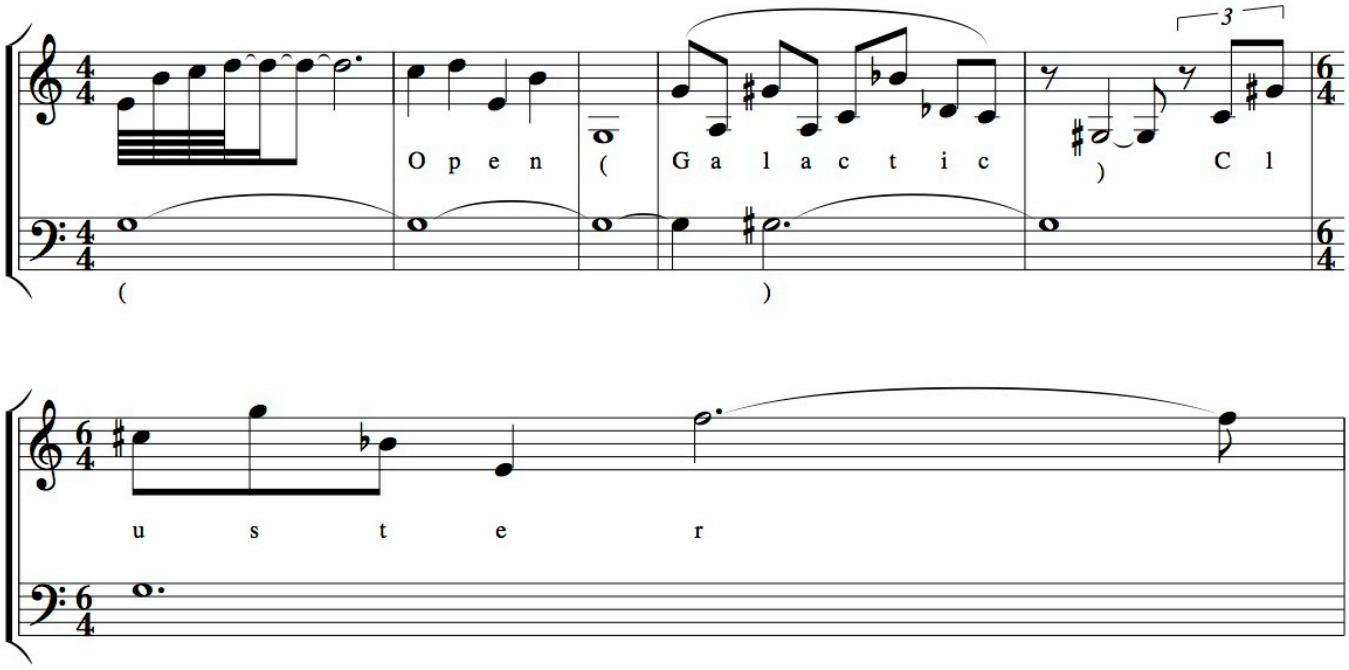
High Proper-Motion Star

The velocity of a star relative to the sun can be broken down into perpendicular components: the radial velocity and transverse velocity.
The transverse velocity results in a change of angular position, which can be measured in arc seconds per year.
This is called the proper motion of the star.



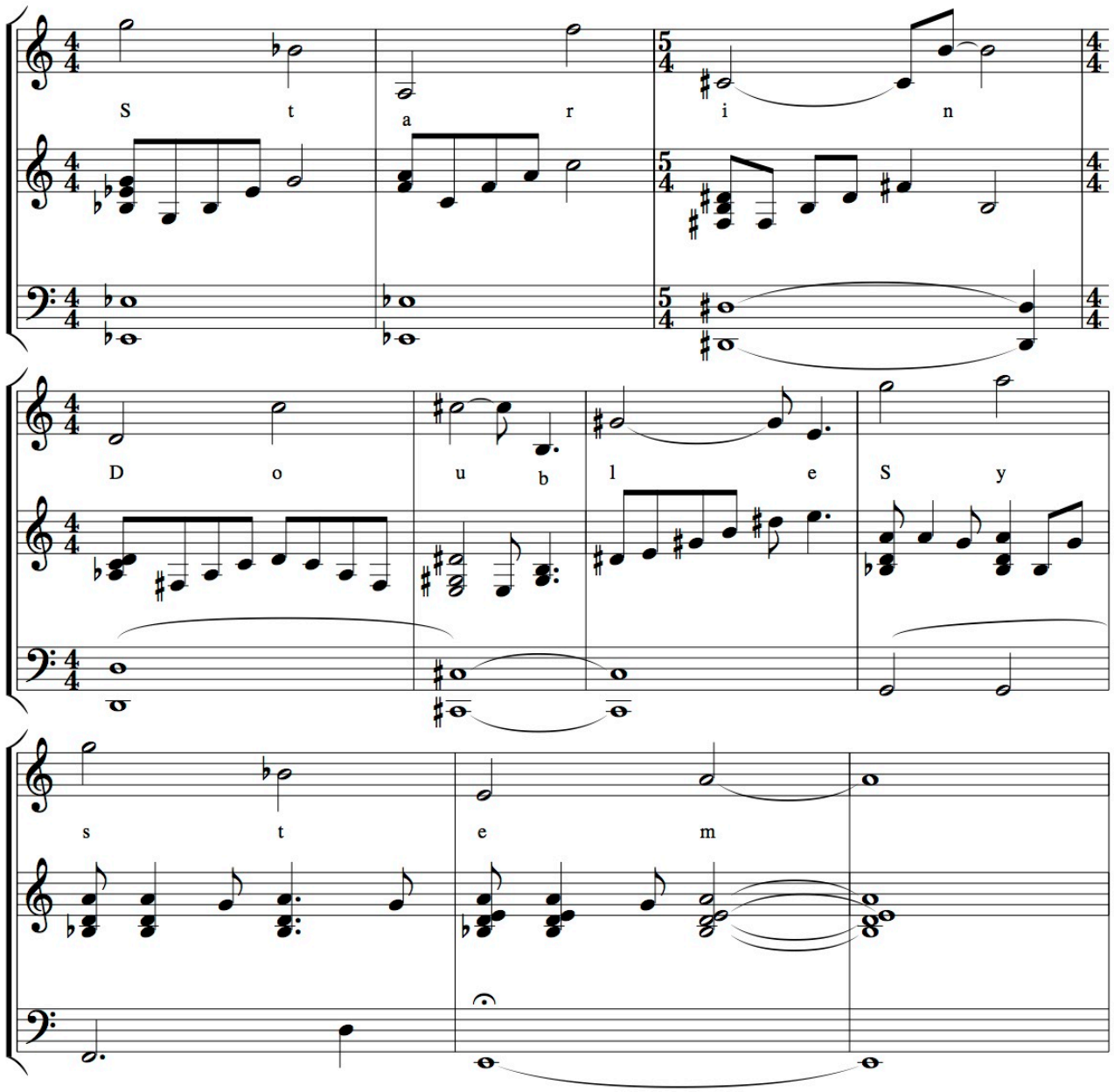
Open (Galactic) Cluster

A loose aggregation of dozens or hundreds of young stars, in a volume of space typically less than 50 light-years across, that is only weakly held together by gravity and is fated to disperse over a period of several hundred million years.
An older name for such groupings is galactic clusters because they are found mostly in the disk, and especially the spiral arms, of this and other galaxies.
The stars in open clusters have formed together within the same interstellar cloud; indeed, in many diffuse nebulae, the birth of new open clusters can be seen taking place.
As open clusters drift along, some of their members escape due to velocity changes in mutual closer encounters, tidal forces in the galactic gravitational field, and encounters with field stars and interstellar clouds passing their way.
Well known examples include the Pleiades and Hyades.
Open clusters (also called galactic clusters) are loose, irregularly shaped groups of stars which are still recognizable as a connected group.
In this respect, astronomers find it safe to assume that stars in the same cluster formed from the same material.
In addition, observations have shown that open clusters vary in diameter from about 1.5 parsecs to about 15 parsecs in diameter.
From this we can estimate that stars in an open cluster are all at the same distance from us.
Because of this, astronomers have been able to deduce much about the composition and evolution of stars in general.
Three quite notable open clusters are the Pleiades, Hyades, and Beehive clusters. As opposed to globular clusters, which form a halo around our galaxy, open clusters tend to lie mostly near the plane of the galaxy.



Star in Double System

Stars that are held together by their mutual gravitational attraction and revolve about their common center of mass.
In 1650 Riccioli made the first binary system discovery, that of the middle star in the Big Dipper's Handle, Zeta Urase Majoris.
True binary stars are distinct from optical doubles; pairs of stars that lie nearly along the same line of sight from the earth but are not physically associated.
Binary stars are grouped into three classes.
A visual binary is a pair of stars that can be seen by direct telescopic observation to be a distinct pair with shared motion.
A spectroscopic binary cannot be seen as two separate stars, even with the most powerful telescopes, but spectral lines from the pair show a periodic Doppler effect that indicates mutual revolution.
Some lines indicate motion toward the earth while others indicate motion away; later, as the stars revolve around in their orbit, this pattern reverses.
An eclipsing binary has the plane of its orbit lying near the line of sight, and shows a periodic fluctuation in brightness as one star passes in front of the other.
The more massive star (A) of a binary is called the primary, and the less massive (B) is called the secondary.



Wolf-Rayet Star

A hot (25,000 to 50,00 K), massive (more than 25 solar masses), luminous star in an advanced stage of evolution, which is losing mass in the form of a powerful stellar wind.
Wolf-Rayets are believed to be O stars that have lost their hydrogen envelopes, leaving their helium cores exposed, often in a binary system, and that are doomed, within a few million years, to explode as type Ib or Ic supernovae.
There are two spectral subclasses of Wolf- Rayets: type WN, which have prominent emission lines of helium and nitrogen, and type WC in which carbon, oxygen and helium lines dominate.
They are named after the french astronomers Charles Wolf (1827-1918) and Georges Rayet (1839-1906) who studied the first example in 1867.
A Wolf-Rayet phase is also present in some central stars of planetary nebulae.
In these stars, which have lower masses and will evolve into white dwarfs, the outer envelope has been expelled in the red giant phase, exposing the hot core.
Such stars show many of the characteristics of standard Wolf-Rayet stars and are referred to as Wolf-Rayet type stars.