

Nebulae

Remnants of a huge explosion that astronomers believe created The Universe some 13-14 billion years ago, is a matter that fills the space between the stars, and is called interstellar medium. This material is formed in a giant gas-dust clouds (burned stellar matter). The outbreak of a very massive and hot stars also contribute to the enrichment of the interstellar medium by burned material.

When the concentration of mass in certain parts of the gas-dust complexes is large enough, these regions begin to collapse under the force of gravity, leading to the formation

of new stars inside. Many stars can be born in a cloud simultaneously - it depends on how massive is the cloud.

Artist Asya Toledo



Where stars are born

One of the greatest discoveries in astronomy in the middle of the last century, when the first large telescopes appeared is that star formation is a process that is repeated continuously and can be observed even in the present epoch .

Star fields are visible because of the light emitted by the stars.

We observe a small part of the interstellar medium which we call nebulae. Nebulae are clouds of gas and dust that we see on astronomical images as lighter or darker areas with a strange shape and blurred.

Photography by Emil Ivanov



Formation

Artist Asva Toledo



Where stars are born

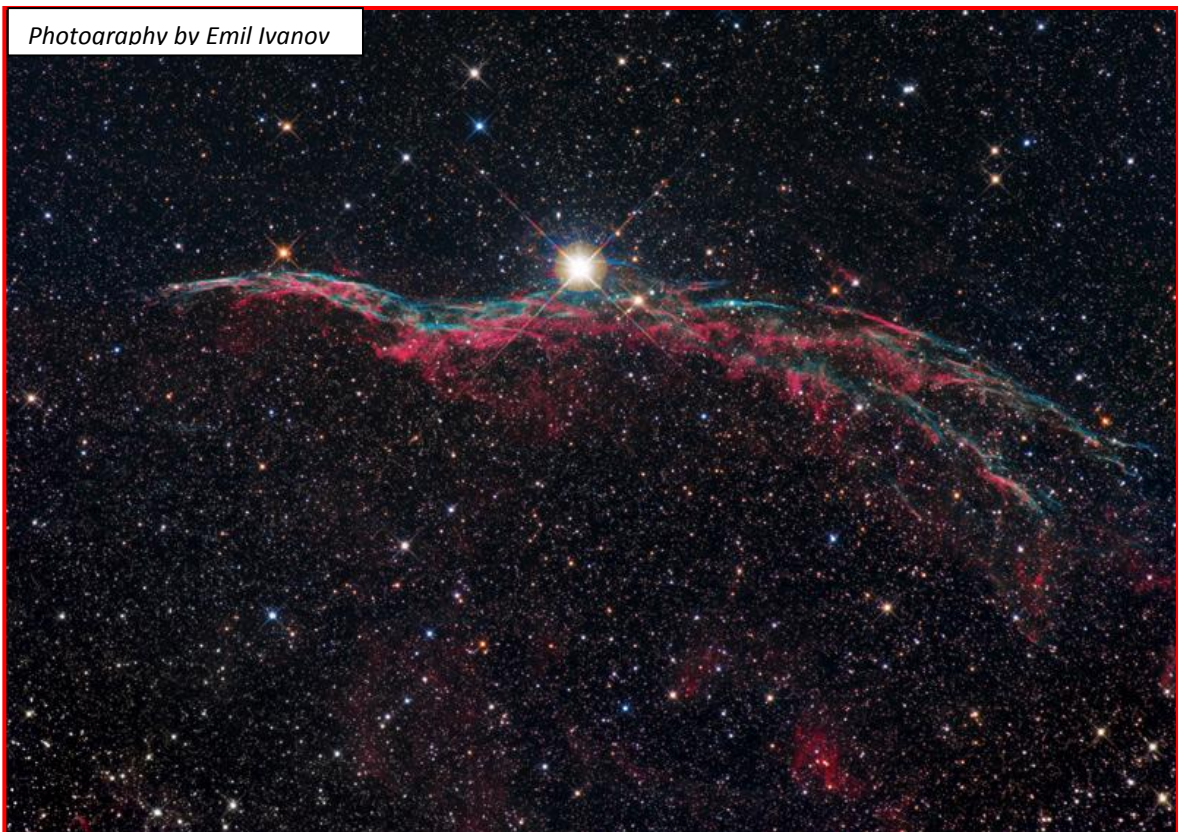
The gas in these clouds is mainly hydrogen (H) and helium (He) in much smaller amount. In general, these clouds are cold and the hydrogen presents in the form of molecules and atoms. These clouds are called HI regions - i.e. clouds of neutral hydrogen. When these clouds are heated by the stars that were formed inside, the gas temperature increases and the hydrogen is ionized (HII). Clouds in which hydrogen ionization prevails are called HII regions.

Dust component of the interstellar medium is stellar ash and consists of tiny solid particles - solid fractions of carbon, silicate compounds and frozen gas or water. In years when astronomers did not have enough and high quality telescopes and used them just to watch the night sky, these huge clouds of gas and dust

are seen as fuzzy patches of scattered light, whose nature was not clear for astronomers then.

Using larger telescopes and applying spectral analysis to study starlight in greater details astronomers found that various nebulae actually are interstellar clouds of gas and dust and that their appearance on the snapshots depends on how the light from neighboring stars highlighted them.

Photography by Emil Ivanov



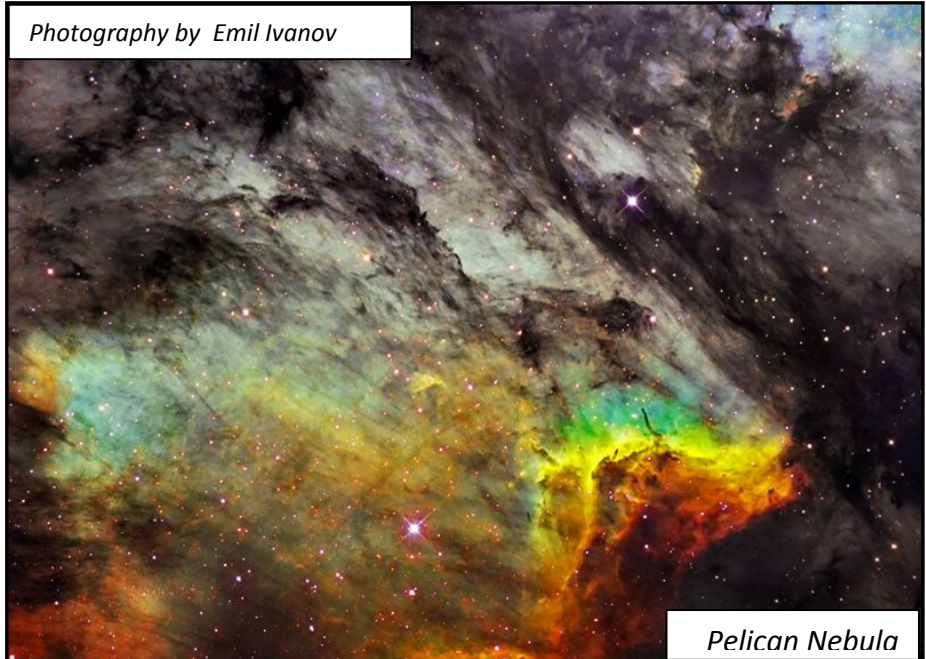
This gives rise astronomers to classify them as: emission (light), reflective (reflex) and dark.

Types

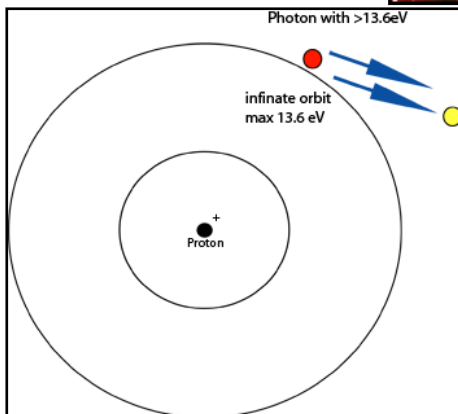
Emission Nebulae

Emission nebulae are one of the most colorful and spectacular astronomical objects. They are visible thanks to the light emitted by the stars born inside the nebula. Some cloud regions are with low density and there happens re-emission of the star light. In some regions electromagnetic radiation from hot stars heats the cloud up to 10,000 Kelvin. This causes ionization of the

Photography by Emil Ivanov



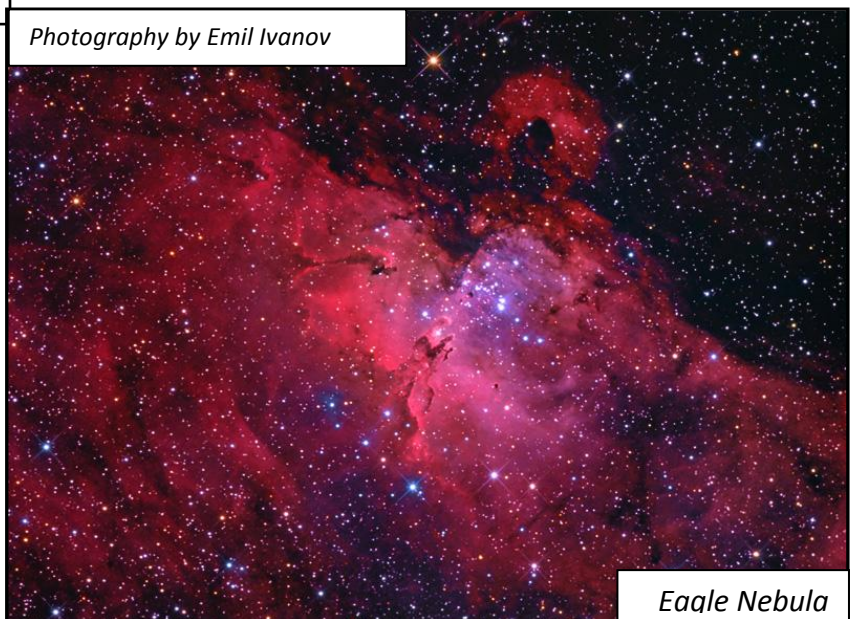
Pelican Nebula



hydrogen atom there. Ionization means that the electron is released from the atom. These vast regions of ionized hydrogen, are called in astronomy HII regions (HII means ionization state of hydrogen). In the heated clouds happens also the opposite of the ionization process - the recombination, in which the hydrogen nuclei "wrap back" electrons. During recombination every electron releases energy in different wavelengths and the cloud begins "to shine". Under certain conditions of the cloud matter - the temperature and density - the hydrogen atom gets

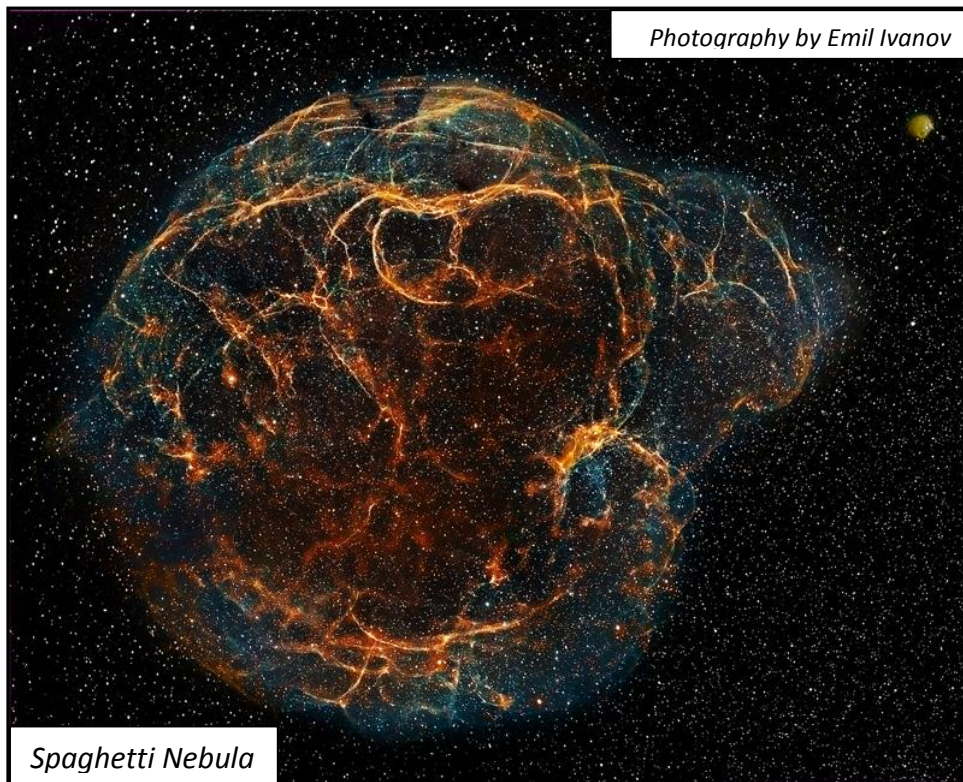
not ionized but only "excited" - the electron takes a photon with a certain portion of energy and jumps to a higher energy level in the atom. Coming back to its base condition the electron emits this energy. There is such energy portion in the visible spectral region corresponding to 6562 angstrom which is well known in spectroscopy - the so called H_{alpha} line. Based on atom physics investigation on hydrogen atom the emission in this wavelength tells astronomers many things about interstellar matter condition.

Photography by Emil Ivanov



Eagle Nebula

Observing interstellar matter in different spectral bandpasses astronomers make conclusions concerning physical characteristic – the volume, temperature, density and composition of these regions.



Laguna, Orion, Carina
Eagle emission nebula known.

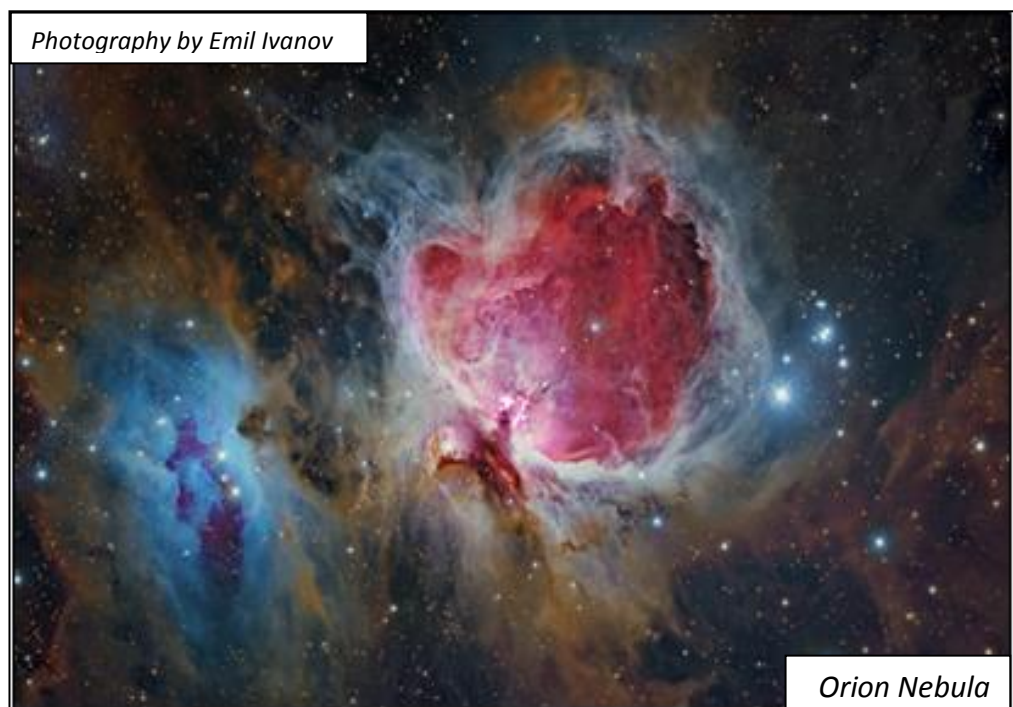
Messier 8 or Lagoon Nebula is five thousand light-years away in the constellation Sagittarius. Observing interstellar matter in different .

Orion is one of the first observed nebula in antiquity, and the first photographed nebula (Henry Draper, 1880). Orion is visible to the naked eye. It is located 1500 light years from

Earth.

Astronomers are interested in the Orion Nebula, because it is one of the closest star forming region whose stars are hot enough to heat the surrounding gas and make it to shine. Pictures from Hubble reveal about 300 stars of various sizes.

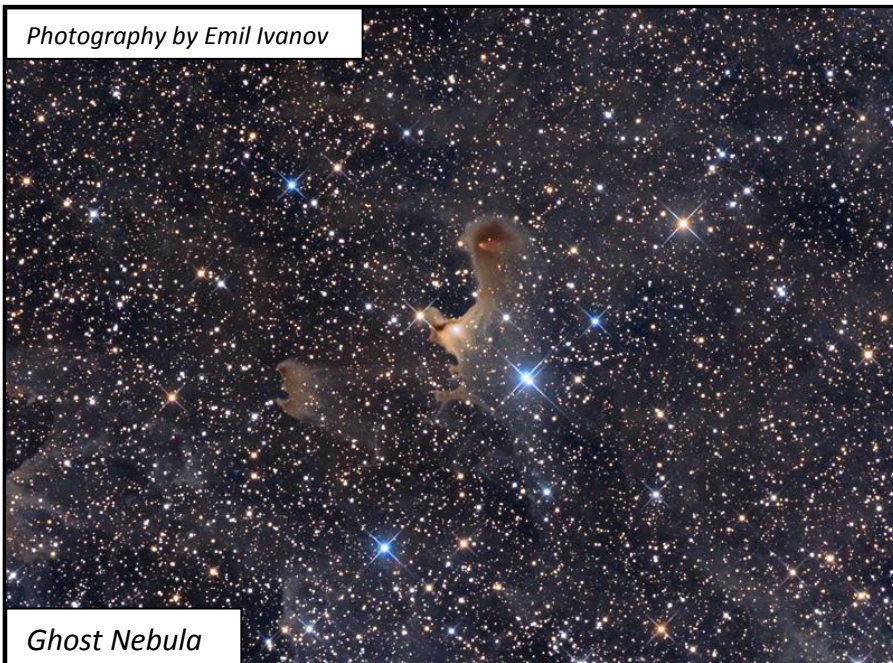
The Orion Nebula, is



populated with relatively young hot stars. Interestingly here is that astronomers have observed two different disc-like objects - one of them located near the brightest stars in the cluster, and others not associated with visible stars. In the first case the star heats the gas and we observe a disc-like object while the remote disc-like objects do not “receive” enough radiation from the star and they appear as dark disc-like images on a bright background of the nebula. It is assumed that in such an environment are formed Premium systems similar to ours.

Reflecting Nebulae

Photography by Emil Ivanov



Ghost Nebula

Objects around us are visible due to the fact that their surfaces reflect or scatter the light fallen upon them. Thanks to this physical mechanism we can observe and explore some areas of the interstellar medium known as reflecting nebulae – cloud patches which reflect and scatter the light from stars close enough to them. The dust component of these nebulae is mainly a mixture of silicon,

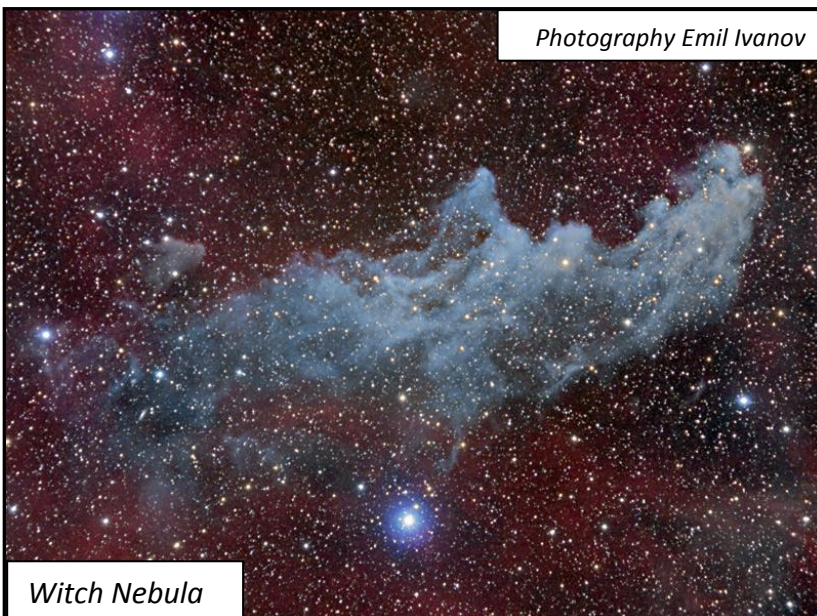
iron and magnesium oxides, solid carbon (soot) and crystals of frozen water and gas. These very small grains of a solid matter reflect and disperse light.

Unlike emission that glow in the reddish color, reflecting nebulae glow in blue color.

The energy from nearby stars is not enough to ionize the gas and form emission nebula, but enough to make the dust visible.

Unlike emission that glow in the reddish color, reflecting

ЦВЯТ	ДЪЛЖИНА
червен	700-630 nm
оранжев	630-590 nm
жълт	590-560 nm
зелен	560-490 nm
син	490-450 nm
виолетов	450-400 nm



Photography Emil Ivanov

Witch Nebula

nebulae glow in blue color. The reason for this is the way starlight is being distracted by small dust particles. Since blue light has a shorter wavelength, it is dissipated more efficiently from that particles than red light, which has a longer wavelength (this is the same process that causes Earth's blue sky during the day and red sunsets).

It is interesting to note that due to the heterogeneous distribution of gas and dust

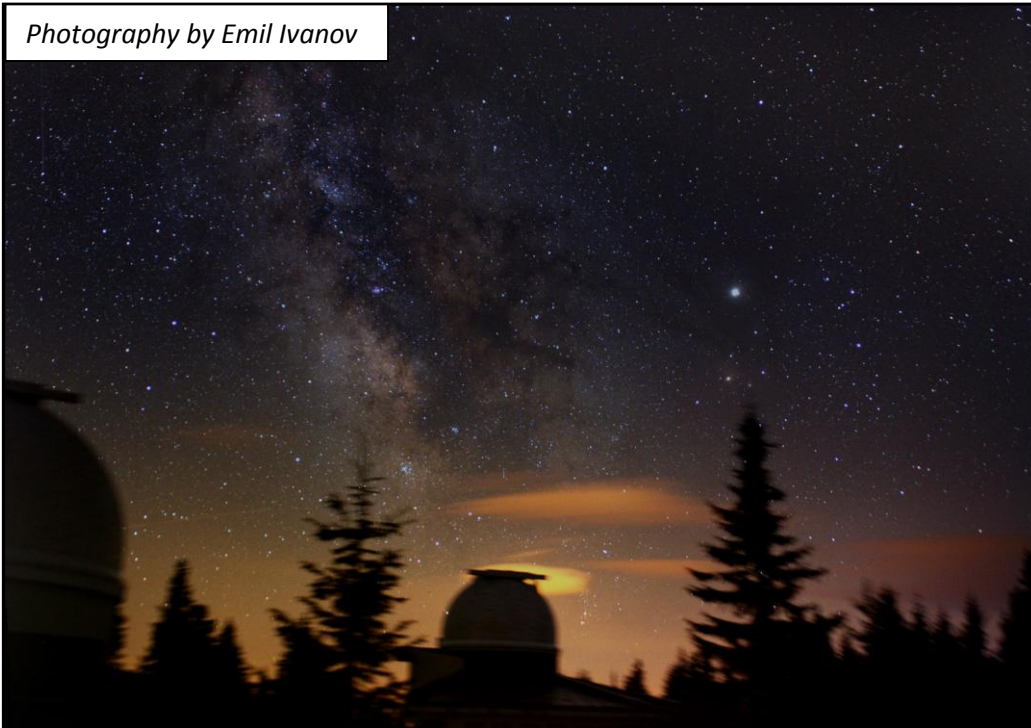
components the same nebula can be seen as both emission and reflecting. Areas with a high concentration of gas cause lighting of these parts of the nebula, while others with higher concentrations of dust reflect and scatter the starlight.

„Witch“ is a reflecting nebula that shines with reflected light of the bright star Rigel in the constellation Orion.

Dark Nebulae

When the light falls so that reflection couldn't be observed (stars that shine are behind these nebulae) dark spots are visible on astronomical images. Unlike the bright nebulae, in which the heated

Photography by Emil Ivanov



hydrogen gas is shining, the dark nebulae do not light but absorb (shade) light from stars located behind them. Dark nebulae are seen as black spots with clear outlines on the background of the illuminating areas around them. The effect is the same as backlight.

Astronomers couldn't hardly

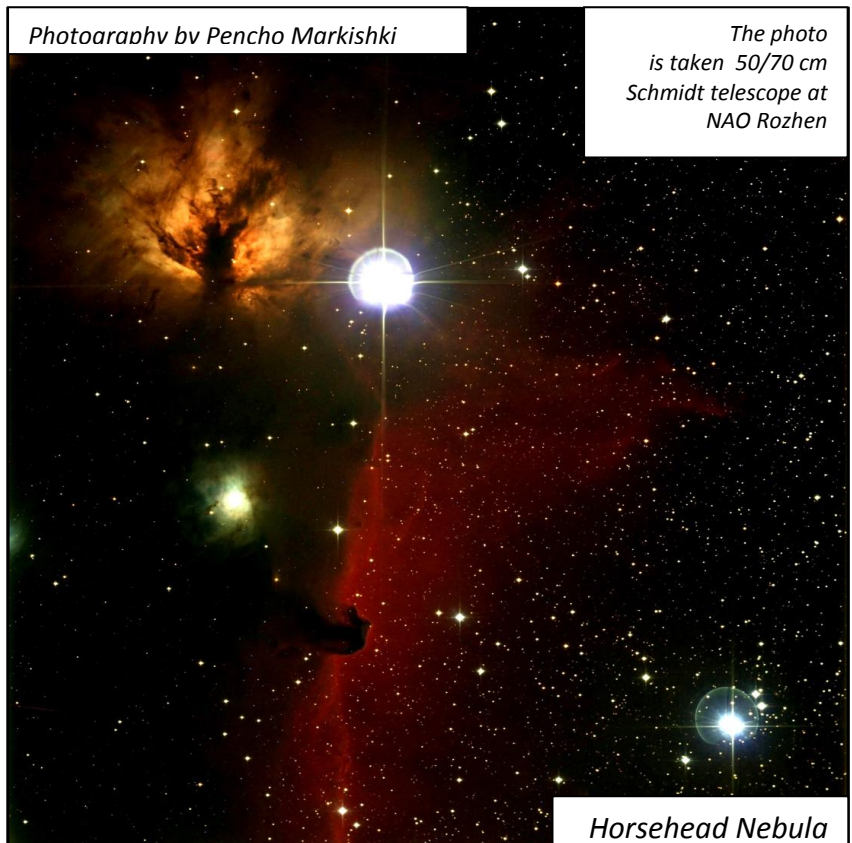
penetrate to the center of our galaxy, because dark nebulae are a barrier to their learning. A lot of similar areas are seen towards the center of our galaxy and they are known as "the coal sacks."

Clusterings of dust and cold gas in the galactic spiral arms, such as the glowing gas clouds allow to outline how the matter in galaxies is structured.

There are also areas of cold hydrogen gas (H I areas) in "Dust Bunnies" of the Milky Way (as dark nebulae are sometimes called). Hydrogen in these areas is neutral - in the form of molecules or atoms if the temperature is less 100 K. These areas do not emit light.

Horsehead is a dark nebula in the constellation Orion - vast region of dust and cold gas, which hides the background light from the bright nebula IC 434. Horsehead is located 1,600 light-years away

Photography by Pencho Markishki



The photo is taken 50/70 cm Schmidt telescope at NAO Rozhen

Horsehead Nebula

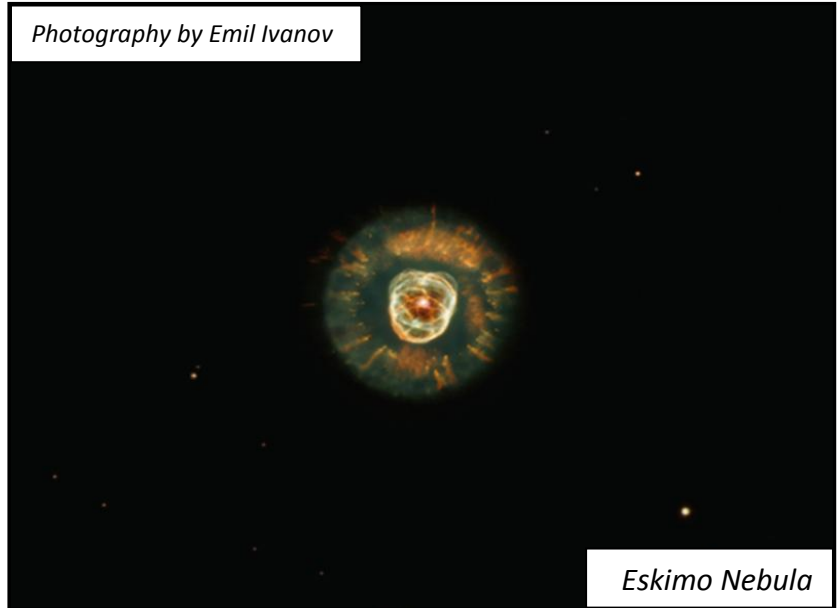
Planetary Nebulae

Planetary nebulae in their physical nature are different from nebulae discussed above and being essentially gas-dust clouds. Planetary nebula is an evolution phase of stars with masses 7-8 solar masses and greater.

When a star forward in its evolution, layers where it is burning hydrogen began to move upward the star's core and cause strong radiation pressure on the outer parts of stellar structure. Star increases its radius and its surface temperature decreases. Such stars

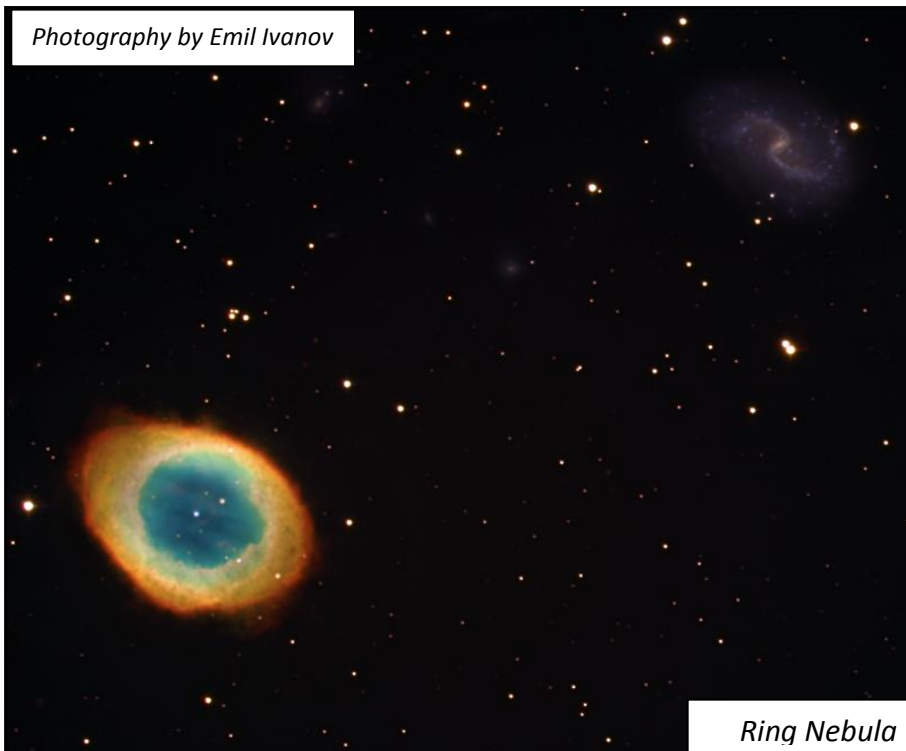
are called red giants. At certain stage the gravity can not keep expansion of the outermost regions of the star, and the stellar matter runs away forming an expanding bubble in the space surrounding the star. The density of these outermost regions decrease with time - the star is seen as a planetary nebula.

Photography by Emil Ivanov



Eskimo Nebula

Photography by Emil Ivanov



Ring Nebula

Some time ago, the first telescopes, people likened these astronomical with the planets of the solar system giving them this name. In fact, this is a beautiful gas cloud with typical dimensions of 1-2 light years away, in which center resides a hot star. Due to the decreasing density of the expanding matter with typical velocities of several kilometers per second the stellar envelope gets less prominent with years and

for observation and study one needed more powerful telescopes. Approximate duration of visibility of the planetary nebula is several thousands of years. In fact, these objects explain the mechanism of enrichment of the interstellar medium with burned stellar matter. Examples of a planetary nebula are Eskimos, Red Spider, Cat's Eye, Butterfly, Hourglass, Ant.

Star formation

The study of the nebulae is interesting because it has become clear that these gas-dust clouds

are „kitchens“ of star formation. The clouds have large sizes and are spread over several light years. If the density in some parts of the nebula is large enough, there began a process of contraction of the matter. In this process particles heat up due to friction



Photography by Emil Ivanov

The Pleiades

between them, leading to strong heating of these clouds. Temperature rises continuously leading to ignition of hydrogen - a new star is born.



Artist Asya Toledo

Star birth

Usually many stars are born simultaneously in a in a same cloud. Such processes have been observed in the Orion Nebula, so there are now seeing many bright and hot stars.

Evidence of star formation in the same place are stellar clusters. The Galactic Stellar Clusters have a relatively small number (a few hundreds) of bright hot stars. These astronomical objects are observed in the spirals of the galactic plane and are realtively young – hundred millions years. Oposite to them are Globular Clusters found as a rule cx the spherical component of galaxies. They are populated with hudge number (many thousands to million) of old low mass stars. These clusters are dust and gas free which indicates that the star formation process is gone. Two types of star clusters have a specific composition, size, age, stellar population and are placed in different places of the galaxy structure.

All this tells us that the conditions of formation of the interstellar medium and its position in the galaxy are very diverse. This makes the interstellar medium very interesting research

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<http://fusedweb.pppl.gov>

<http://www.eso.org/public/>

images:

Tunes: Asya Toledo - http://nao-rozhen.org/galleries/asya_toledo/main.htm

Pictures: Emil Ivanov: <http://www.emilivanov.com>

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