Interstellar Clouds

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Although the space between stars in our galaxy appears to be completely empty of matter, there exists a very dilute gas even in "empty" space. This **interstellar** (meaning "between the stars") **medium** varies in **density** (the amount of matter within a certain volume). Typical densities in the interstellar medium are one particle per cubic centimeter. Since hydrogen is the most single common element in the universe, chances are, if you were to select a box of space one centimeter wide on a side, there would only be one hydrogen atom inside that box. There are some regions known as **molecular clouds** where densities are 10,000 times greater than average. These are dark clouds of gas where it is cold enough for hydrogen to exist mostly in the form of molecules, and where young stars or **protostars** can form. In a cubic centimeter box here, you'd find 10,000 hydrogen molecules (H_2). Although this sounds like a lot of material, a cloud like this resembles the best vacuums that we can generate here on Earth. In contrast, the air that you are breathing contains 10^{19} molecules per cubic centimeter—that number is 1 followed by 19 zeroes!

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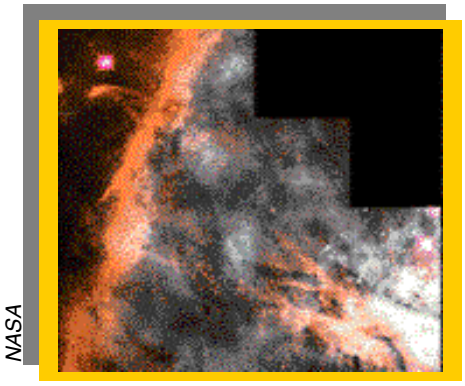
Horsehead Nebula is Dust Cloud

In addition to gas, the interstellar medium also contains **interstellar dust grains** composed of clumps of atoms and molecules. These grains are microscopic, about 10^{-5} cm across, making them comparable in size to particles of smoke or soot. (The dust particles in your house are much larger than interstellar dust.) Interstellar dust grains are even less common in space than atoms or molecules of gas. There is 1 dust grain for every 1 trillion gas particles. However, considering the vast distances between objects in space, the total number of dust particles between two stars can be considerable. One particle of dust on an otherwise clean windshield would not prevent you from seeing the traffic light. However, if you looked through 10^{12} clean windshields, each with one speck of dust, you would be looking through 10^{12} specks of dust, and that might obscure your view of the light. Interstellar dust has the same cumulative effect on light or radiation that passes through the vast distances of space. Just as you have trouble seeing very far in a thick fog here on Earth, interstellar dust can make it impossible to see light from distant stars. The intensity of the star's light is reduced significantly. You can observe dark patches in telescope pictures of parts of the sky. These dark regions are not devoid of stars; they're simply places where there is so much dust in dark dust clouds that the starlight coming from more distant stars is completely blocked out.



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Orion Nebula

Another type of feature found in interstellar space is the **emission nebula**. These appear to the naked eye to be fuzzy patches of brightness in the nighttime sky. When examined with a telescope, they show up as spectacular clouds of gas lit up by nearby stars. Ultraviolet radiation from stars can **ionize** or knock loose electrons in the gas atoms of the nebula. When the electrons recombine with the naked atomic nuclei, light is emitted that we see as the glow coming from these nebulae. Many emission nebulae are found in conjunction with molecular clouds where young protostars are forming. If a massive or **giant star** forms inside the molecular cloud, the intense ultraviolet radiation from this star is enough to ionize the surrounding gas to create an emission nebula.