

# The Universe in my pocket



## The nebular universe



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The Orion nebula.

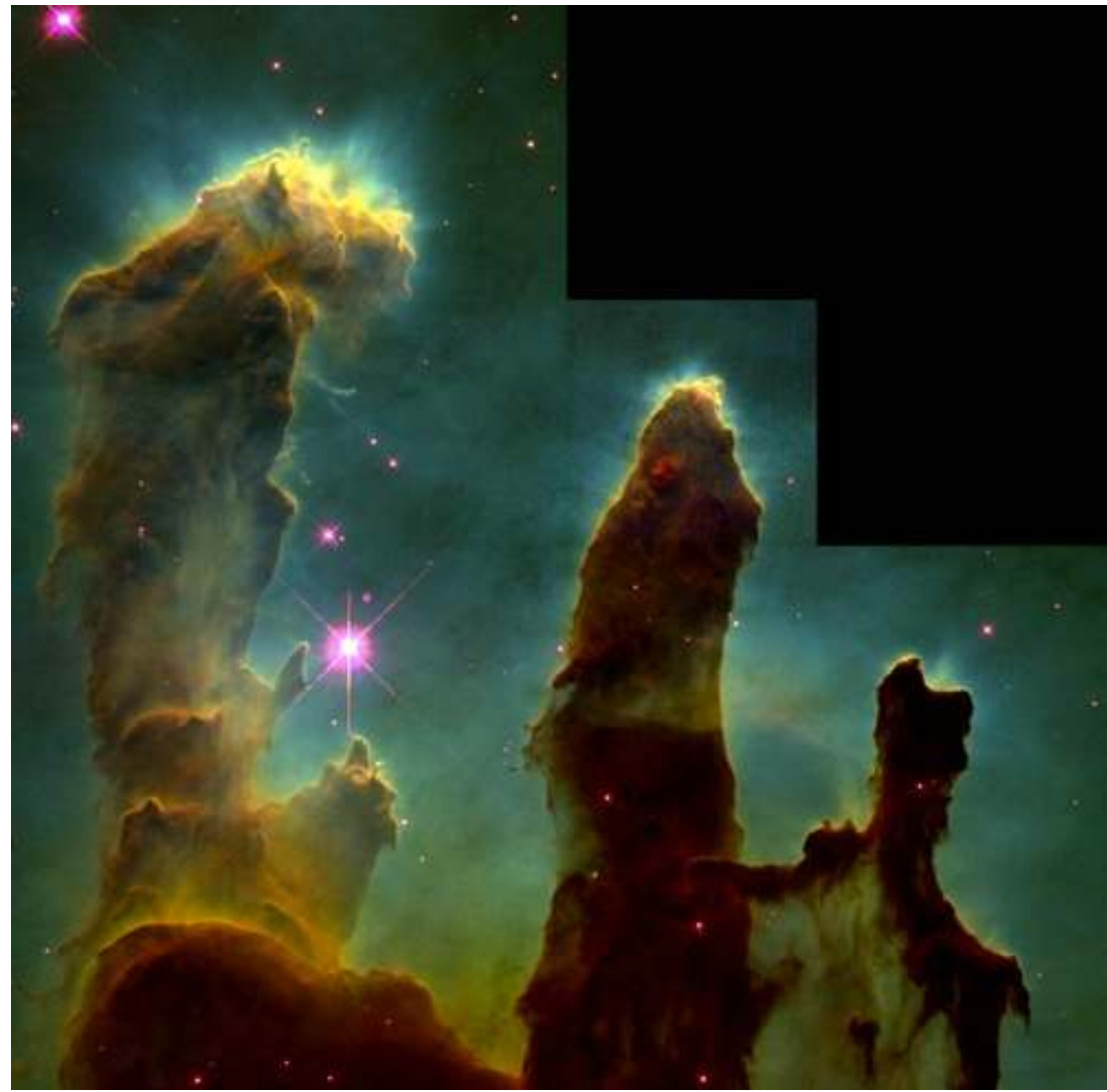
This is the brightest nebula in the sky,  
and it can be seen with the naked eye.

We have all watched stars at night. They look so isolated in the darkness of the sky!

But this is just an illusion. There is no emptiness between the stars, but rather, a multitude of particles, atoms and molecules. Millions, even billions in one cubic meter. Those particles assemble into interstellar clouds - or nebulae .

These clouds are very faint, and only a few can be seen with the naked eye.

But with the help of large telescopes on Earth and in space, astronomers are able to see the richness of the nebular universe and share their discoveries by publishing beautiful photographs of these nebulae. 3



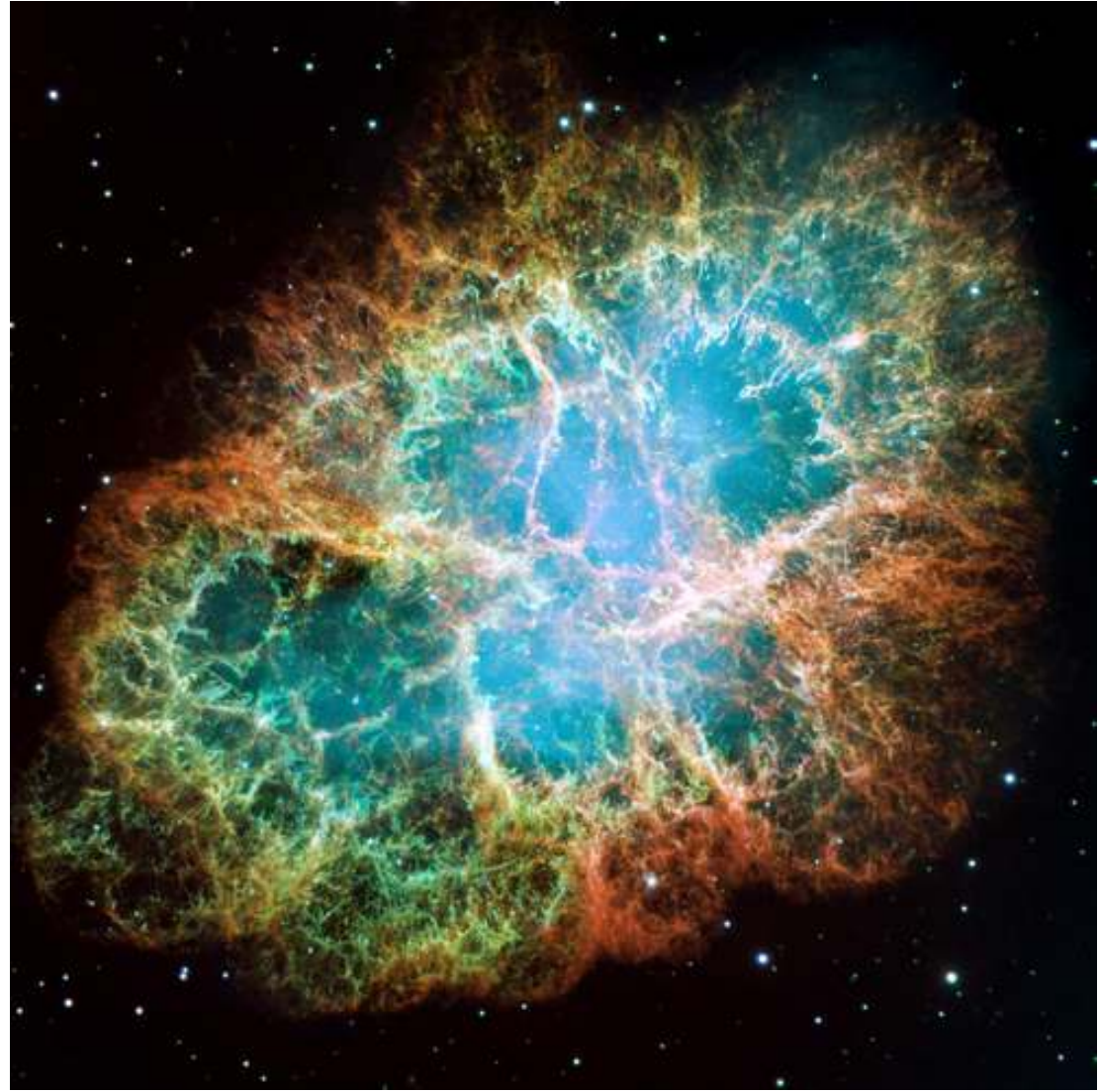
Part of the nebula M16, called « The Pillars of Creation ».  
It is in clouds of interstellar gas and dust like these, that new stars are formed.

## Where stars form

Stars are not eternal: similar to human beings, they come into the world, evolve throughout their lives and finally die.

They form in large interstellar clouds, by a process that is not yet fully understood. This process involves gravitational contraction, allowing the matter to reach the high densities of stellar interiors.

Some of these recently born stars are so hot that they can remove the electrons from the atoms in the surrounding cloud, creating ionized nebulae such as the Orion nebula.



The Crab nebula.  
This is the remnant of a supernova  
whose explosion was recorded by  
Chinese astronomers in 1054 .

# Supernova remnants

A star with a large mass ends its life in a huge explosion.

Astronomers called this phenomenon a « supernova », because they thought they were witnessing the appearance of a new star at a place in the sky where no star was seen before.

We now know that a supernova is, on the contrary, a dying star, throwing into interstellar space the elements that it manufactured during its lifetime.

A supernova remnant is the nebular matter that remains after the explosion.



The Helix planetary nebula.

This is one of the closest planetary nebulae known. The light it emits takes 700 years to reach the Earth (while light from the Sun takes only 8 minutes).



# Planetary nebulae

Stars with masses similar to that of the Sun end their lives in a much calmer way.

They swell up in size, losing their external layers, which are then illuminated by the remnant of the parent star, producing the so-called planetary nebulae.

The term planetary nebulae was coined by William Herschel in 1785 to describe these nebulae because with his telescope they looked like planets. He later regretted not having called them 'stellar nebulae'.



The spiral galaxy M101.

This is a galaxy similar to the Milky Way. In its spiral arms, new generations of stars are being formed.

In the catalogue of the French astronomer Charles Messier published in 1781, it is described as a 'Nebula without star, very obscure & pretty large'.

# Galaxies

Galaxies are stellar associations that can contain hundreds of billions of stars.

Some of them, those with a spiral or irregular shape, also contain large amounts of gas. Such galaxies are still forming stars, and contain many « young » stars that are only a few million years old.

Other galaxies, those with a rugby ball shape, do not form stars any more. All of their stars are old - some of them older than ten thousand million years.

Earlier, galaxies were called `nebulae' because it was not known that they were made of stars.



The Horsehead nebula.  
It is made of dust grains mixed with gas.

# Interstellar dust clouds

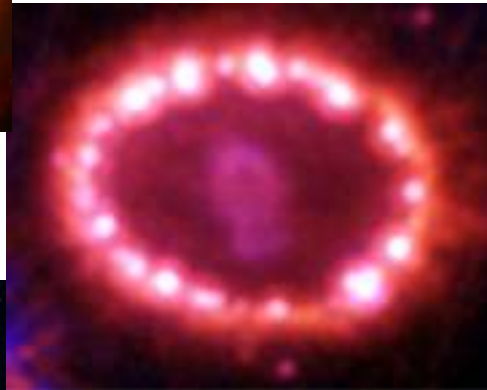
In photos of nebulae and galaxies, dark zones can sometimes be seen. They are produced by concentrations of interstellar dust grains.

These grains, which are microscopic solid particles of carbon or silicon, absorb energy from the visible light of nearby stars.

As they cool, they emit a light invisible to the human eye but detectable with infrared telescopes.

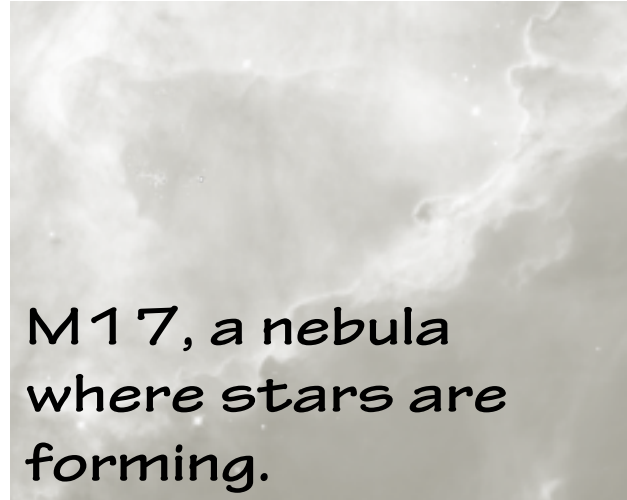
Do you  
recognize  
these types of  
nebulae?

# Quiz

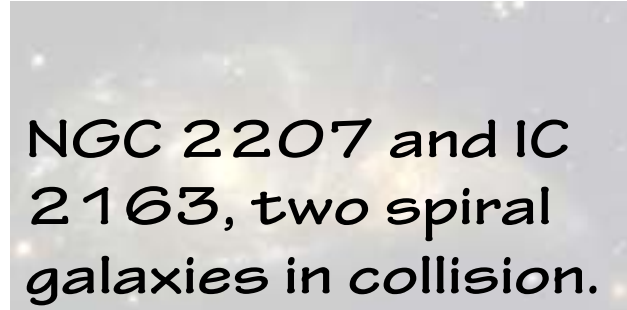


Solutions on  
overleaf



A grayscale image of the M17 nebula, showing a complex, filamentary structure of gas and dust with bright, wispy regions and darker, more dense areas.


M17, a nebula  
where stars are  
forming.

A grayscale image showing two spiral galaxies, NGC 2207 and IC 2163, in the process of colliding. The galaxies are distorted and their spiral arms are interacting.

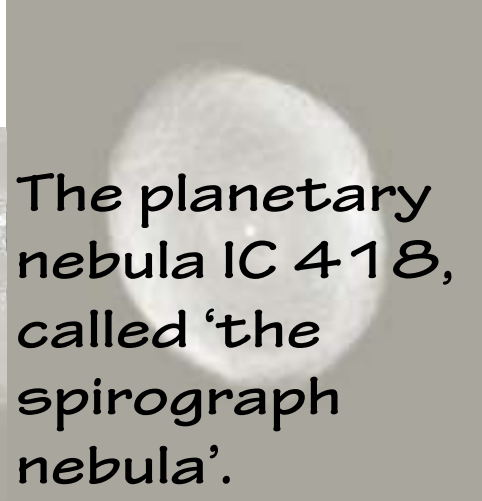
NGC 2207 and IC  
2163, two spiral  
galaxies in collision.

A grayscale image of the supernova SN 1987A, showing a bright, circular ring of light with a dark center, surrounded by a faint, diffuse glow.

The supernova  
SN 1987A.

A grayscale image of the Unicorn nebula, a part of the Trifid nebula. It shows a bright, irregularly shaped nebula with a prominent, dark, filamentary structure that obscures parts of the nebula.

The Unicorn: a  
part of the Trifid  
nebula obscured  
by interstellar  
dust.

A grayscale image of the planetary nebula IC 418, also known as 'the spirograph nebula'. It features a bright, circular ring of light with a dark center, surrounded by a faint, diffuse glow.

The planetary  
nebula IC 418,  
called 'the  
spirograph  
nebula'.

# The Universe in my pocket No. 1

This booklet was written in 2013 by Grażyna Stasińska from Paris Observatory (France) and revised by Stan Kurtz from the UNAM Radio Astronomy Institute in Morelia (Mexico).

It is dedicated to the school children of Choroní (Venezuela) and their families.

The front cover shows the Cat's Eye planetary nebula. The photos from this booklet were obtained with the ESO large telescopes and with the Hubble Space Telescope. They are provided by NASA, the STScI and by ESA.



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