Stellar Nursery in the Orion Nebula

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Note: In PDF format most of the images in this web paper can be enlarged for greater detail.

Introduction

The Orion Nebula (M42) is the closest stellar nursery to our solar system. Stellar nurseries are special regions where the vast majority of new stars in the galaxy are born. Interstellar clouds of molecular gas form, produce thousands of new stars and then gradually dissipate. The Orion Nebula is 1,500 light years from Earth and six light years or 35 trillion miles across. It forms the second point of light in the hunter's sword in the Orion constellation.

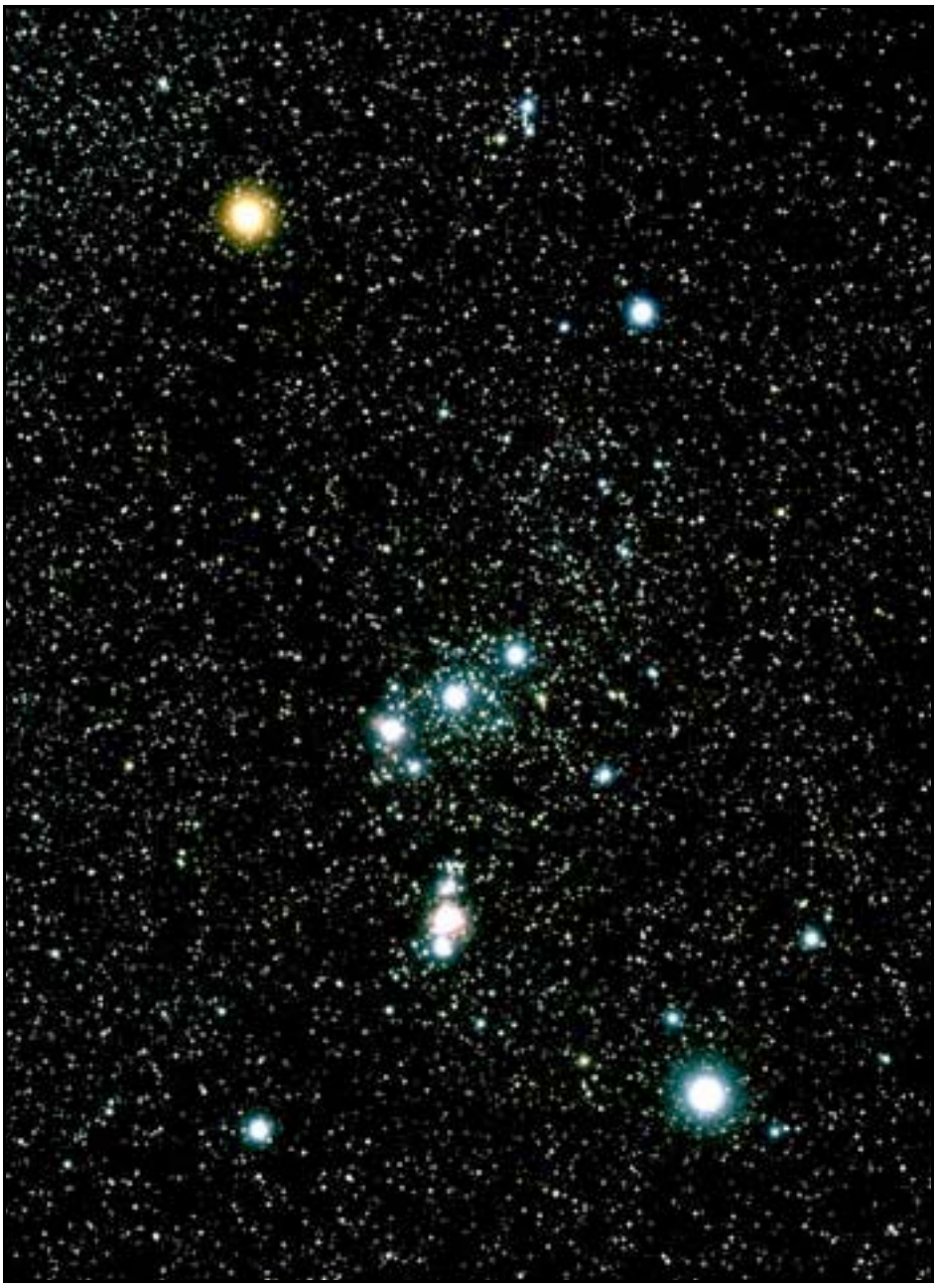
The following images of the Orion constellation show emissions nebulae M42 and M43, and the Running Man reflection nebula NGC 1977, the first point of light in the sword. Emission nebulae radiate a reddish glow that comes from hot ionized gas. Reflection nebulae, as the name implies, reflect starlight rather than giving off their own radiation and have a bluish cast because their interstellar dust grains preferentially reflect blue light. These bright nebulae are actually the brightest parts of a huge cloud of interstellar gas and dust which is several hundred light years across.

The Trapezium Star Cluster at the center of M42 contains more than 1,500 stars. Five massive young stars illuminate the nebula, making it possible to observe many objects that would normally be invisible. The starlight they produce is so intense, in fact, that it ionizes thin layers of the gas in the region, producing a rainbow of colors.

The Orion Nebula is one of the nearest regions of very recent star formation (300,000 years ago). Many of the fainter young stars are surrounded by disks of dust and gas that are slightly more than twice the diameter of our solar system. These are protoplanetary disks that might evolve to form planets.

Web Reference

http://antwrp.gsfc.nasa.gov/cgi-bin/apod/apod_search?Orion+Nebula

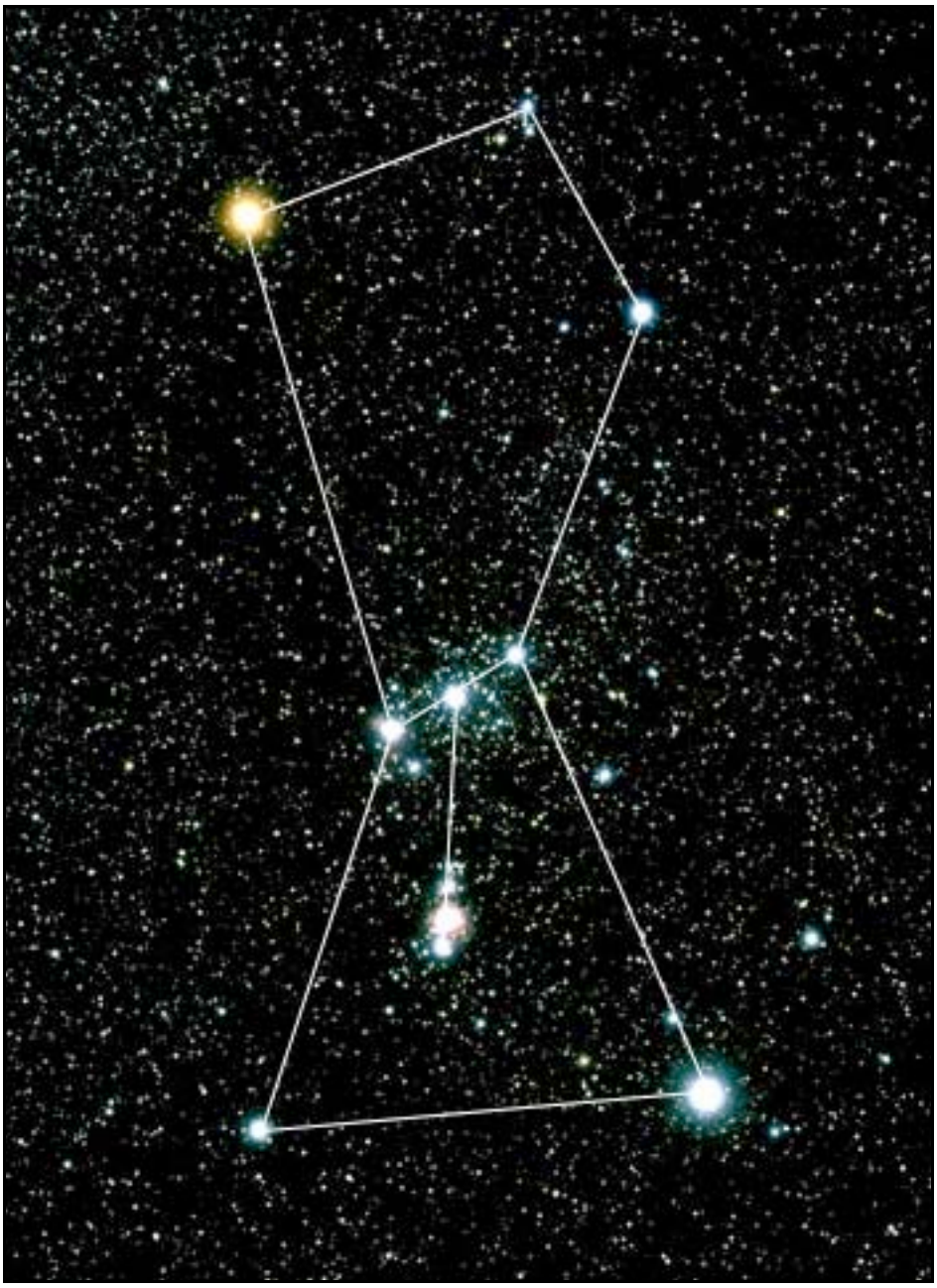


Shown above is the constellation Orion. In North America it is best seen in the evening southern sky during the Winter months. Although the constellation can be clearly seen with the naked eye, this picture is what you would see with a pair of binoculars or small telescope. (Photograph by Akira Fujii)

Web References

http://antwrp.gsfc.nasa.gov/apod/ap040304.html

http://antwrp.gsfc.nasa.gov/apod/ap030207.html

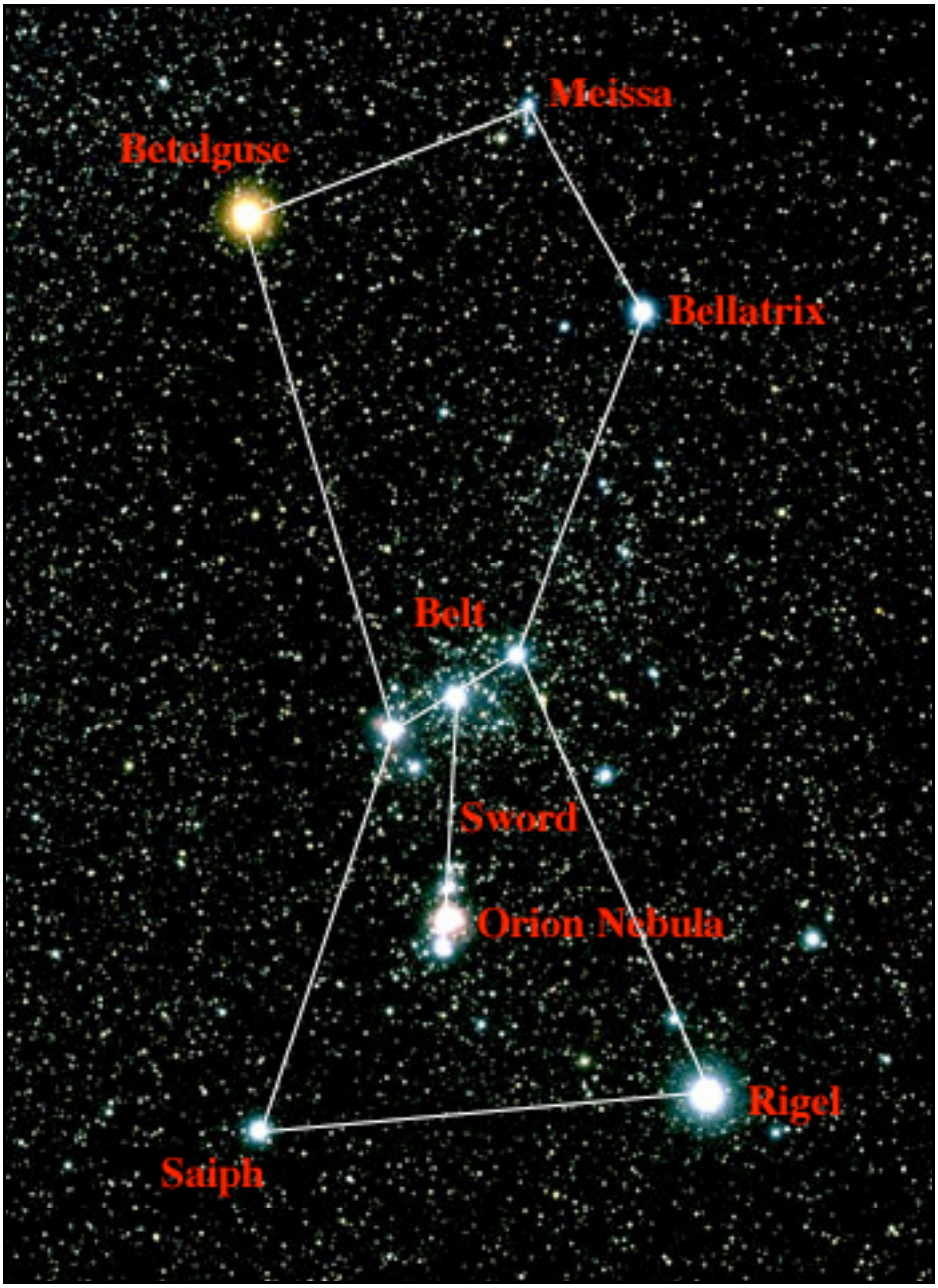


A star map of the constellation Orion showing the five bright stars that form the outline of the constellation with the three bright stars, Alnitak, Alnilam, and Mintaka, in the center that form Orion's belt, and below the belt the bright star region that forms the sword.

Web References

http://www.astro.wisc.edu/~dolan/constellations/extra/constellations.html

http://antwrp.gsfc.nasa.gov/apod/ap051013.html



The stars that form the Orion constellation are some of the brightest in the night sky. Rigel is the seventh and Betelgeuse the tenth brightest stars observed. The Orion Nebula forms the second bright point in the sword.

Web Reference

http://www.gb.nrao.edu/~rmaddale/Education/OrionTourCenter/optical.html

This magnified image of the central belt and sword of the Orion constellation shows the bright Orion Nebula M42 lower center.

(Photography by Sven Kohle and Till Credner)

The Orion Giant Molecular Cloud (Image by J. C. Casado)

In and surrounding the constellation Orion, approximately centered on the Great Orion Nebula M42 and M43, there drifts a giant cloud of interstellar gas and dust within the Milky Way galaxy. This cloud was formed when a density wave, related to the Galaxy's spiral structure, moved through the medium of the Galactic disk. Some of the stars that form the Orion constellation are part of this giant gas cloud complex that stretches over 100 light years and appears more than 50 times the diameter of the Moon. Components of this cloud include the Horsehead Nebula, the Orion Nebula, the Trapezium open cluster, and small disks containing stellar systems which are just forming. Close inspection of the center of the photograph above shows the three stars which form the Orion's belt (below center).

Web Reference
http://antwrp.gsfc.nasa.gov/apod/ap971201.html

On the following page is the Orion Deep Field by Robert Gendler. Both the Orion Nebula and the dark Horsehead Nebula appear in this stunning composite digital image assembled from over 20 hours of data that includes exposures filtered to record emission from hydrogen atoms. The view reveals extensive nebulosities associated with the giant Orion Molecular Cloud complex, itself hundreds of light-years across. The Orion Nebula (M42), lies at the lower right of the picture. Immediately above it are a cluster of prominent bluish reflection nebulae of the Running Man. The Horsehead nebula appears as a dark cloud, a small silhouette notched against the long red glow at the upper left. Alnitak is the easternmost star in Orion's belt and is seen as the brightest star above the Horsehead. Just left of Alnitak is the Flame Nebula, with clouds of bright emission and dramatic dark dust lanes. Fainter tendrils of glowing hydrogen gas are easily traced throughout the region in this Orion deep field. (In PDF format this image can be enlarged for greater detail.)

(Image courtesy of Robert Gendler
http://www.robgendlerastropics.com/Oriondeepfield.html)

Web Reference
http://antwrp.gsfc.nasa.gov/apod/ap040115.html

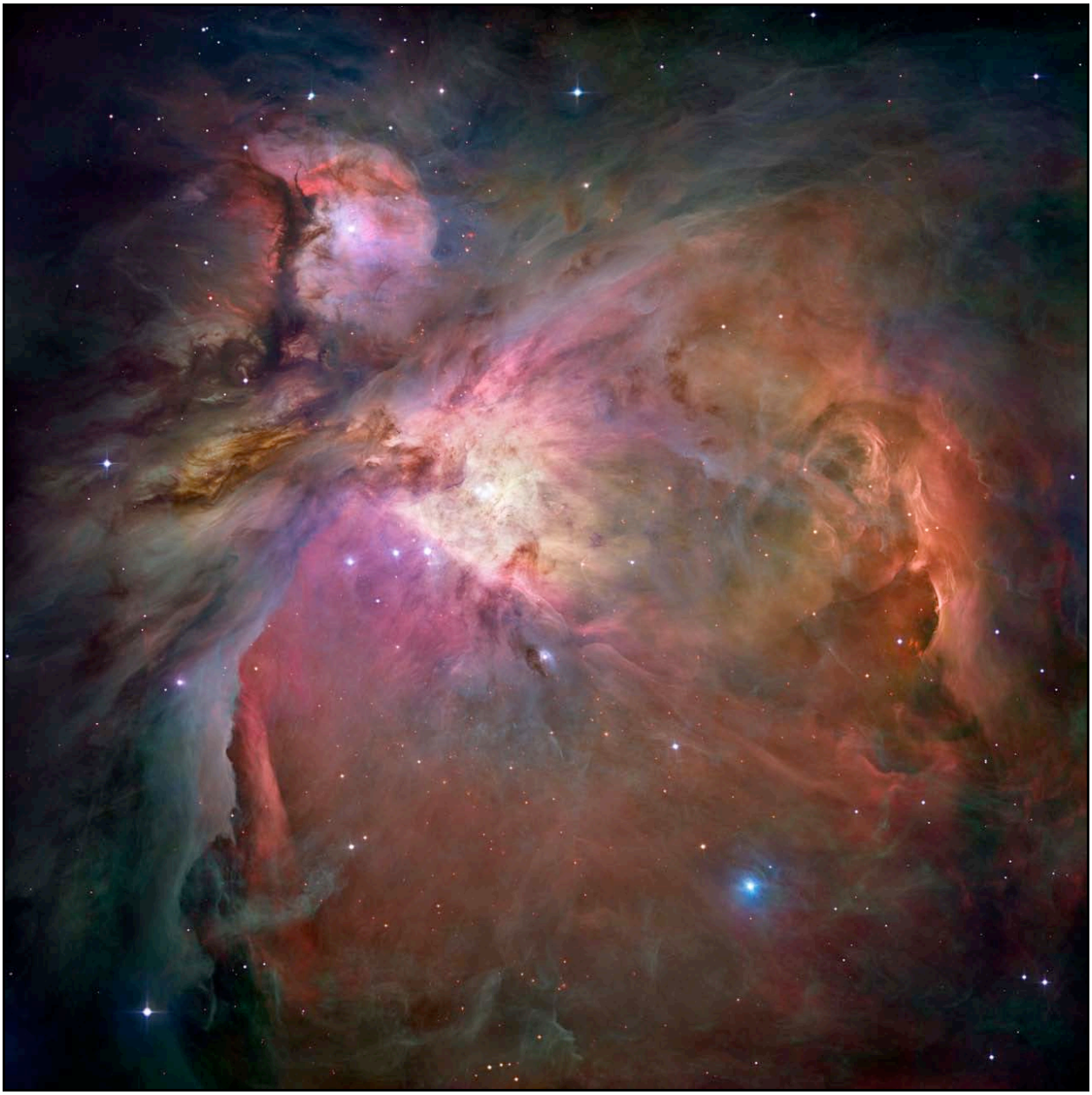
Magnified again the brightest region in Orion's sword resolves into three nebulae, Orion Nebula M42, the large bright area in the lower half, with the much smaller nebula M43 above it to the left, and NGC 1977, the Running Man reflection nebula the bright blue region at the top.

(Image courtesy of Robert Gendler http://www.robgendlerastropics.com/)

This detailed image of the Orion Nebula was constructed using infrared data. The wavelengths of infrared light are longer than visible light and more easily penetrate obscuring dust clouds. Using infrared the star forming regions in the two emissions nebulae M42 (bottom) and M43 (top) can be clearly seen because they are heated by ionizing radiation.

(Image courtesy of the 2MASS Collaboration)

Web Reference http://antwrp.gsfc.nasa.gov/apod/ap020420.html



This detailed image of the Orion Nebula released by NASA January 2006 is the sharpest ever, constructed using data from the Hubble Space Telescope's Advanced Camera for Surveys and the European Southern Observatory's La Silla 2.2 meter telescope. The mosaic contains a billion pixels at full resolution and reveals about 3,000 stars. (In PDF format this image can be enlarged for greater detail.)

(Image courtesy of NASA and ESA)

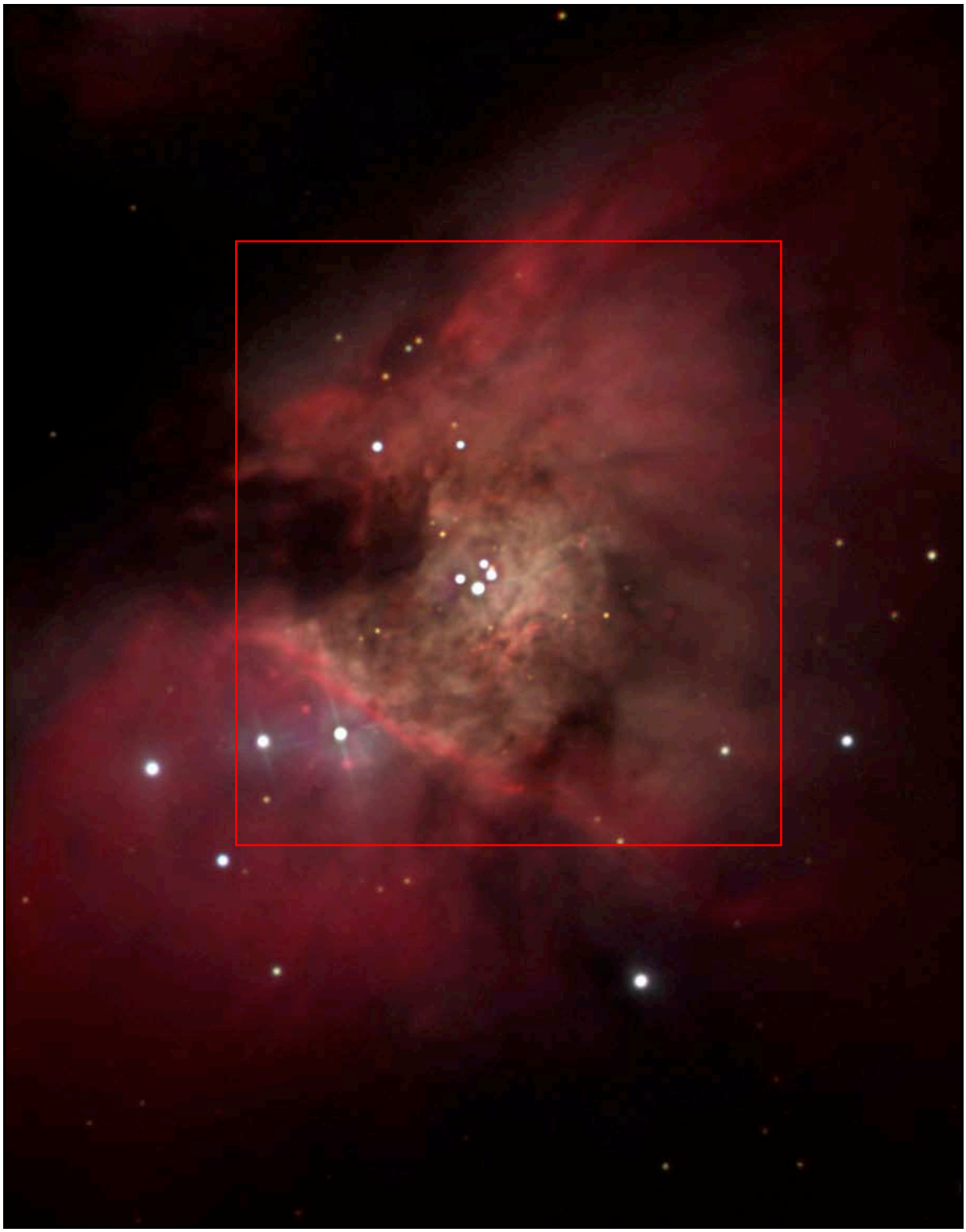
Web Reference

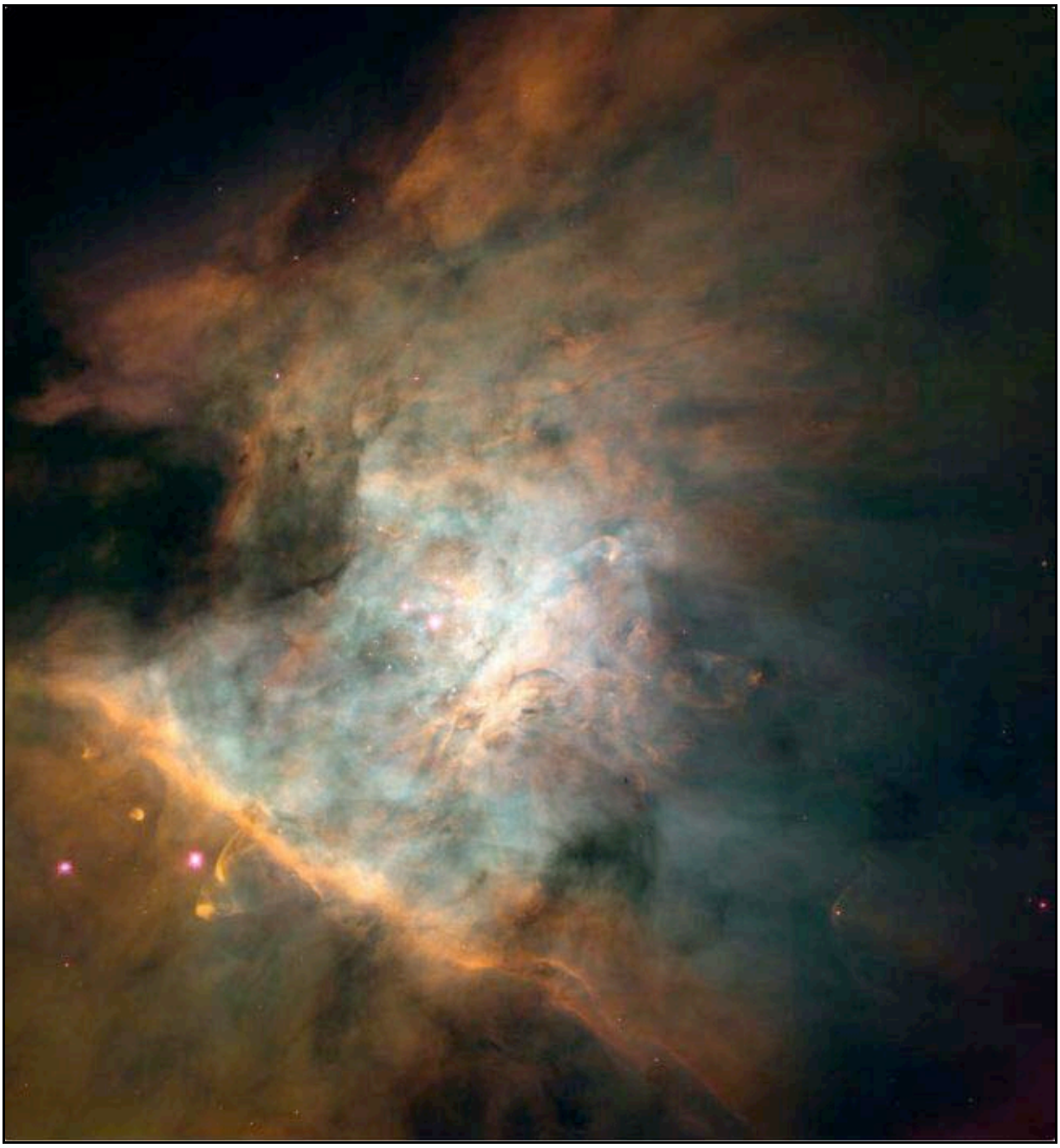
http://hubblesite.org/newscenter/newsdesk/archive/releases/2006/01/

In this image only nebulae M42 and M43 are shown. The intense area in the center of the image is the Trapezium, the most active star forming region in the M42 nebula. What follows is a set of images that progressively magnify the Trapezium to show greater details of this stellar nursery. In each image the area to be magnified is outlined in red.

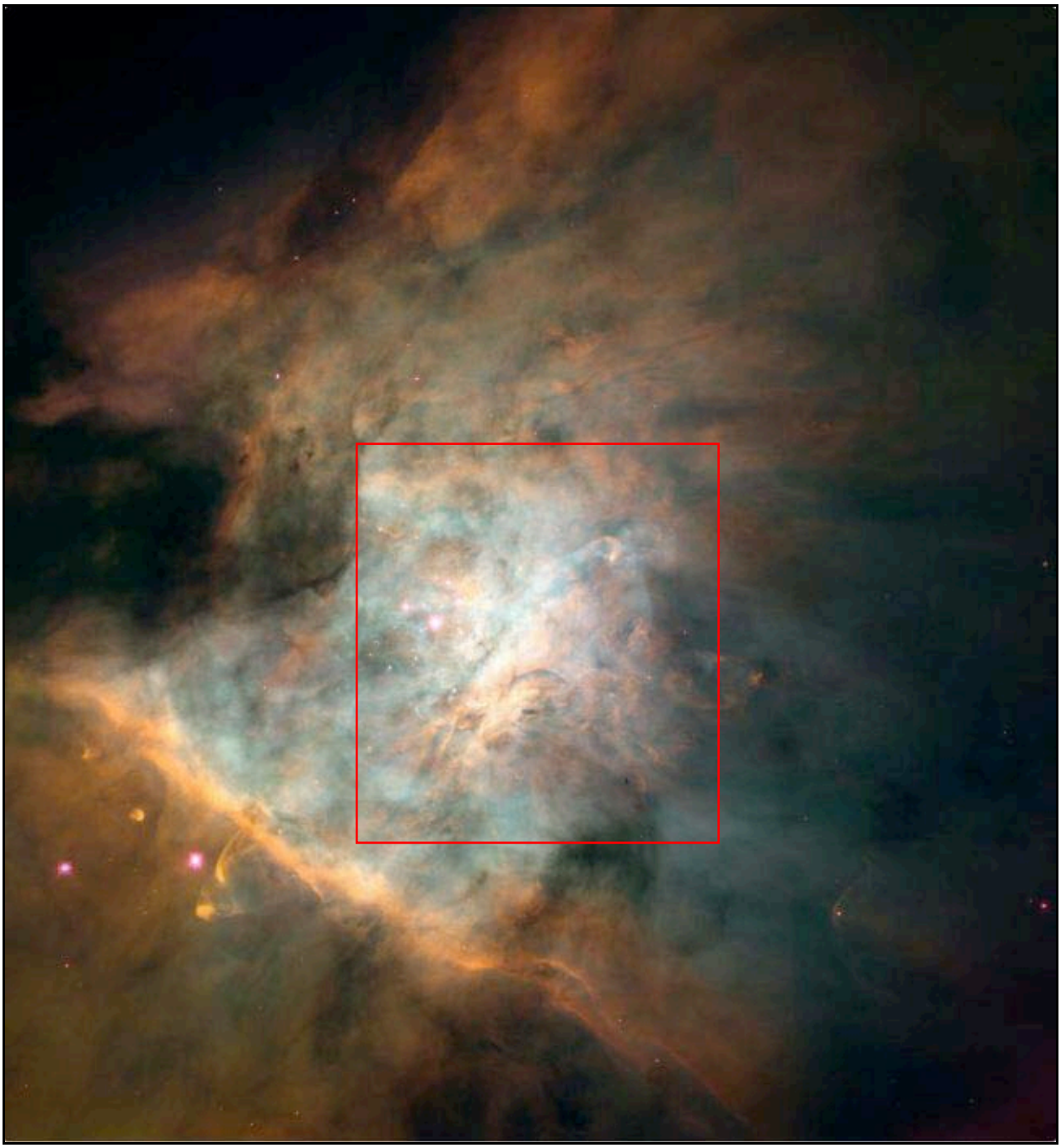
(Image courtesy of Robert Gendler http://www.robgendlerastropics.com/)

(Image courtesy of Robert Gendler http://www.robgendlerastropics.com/)

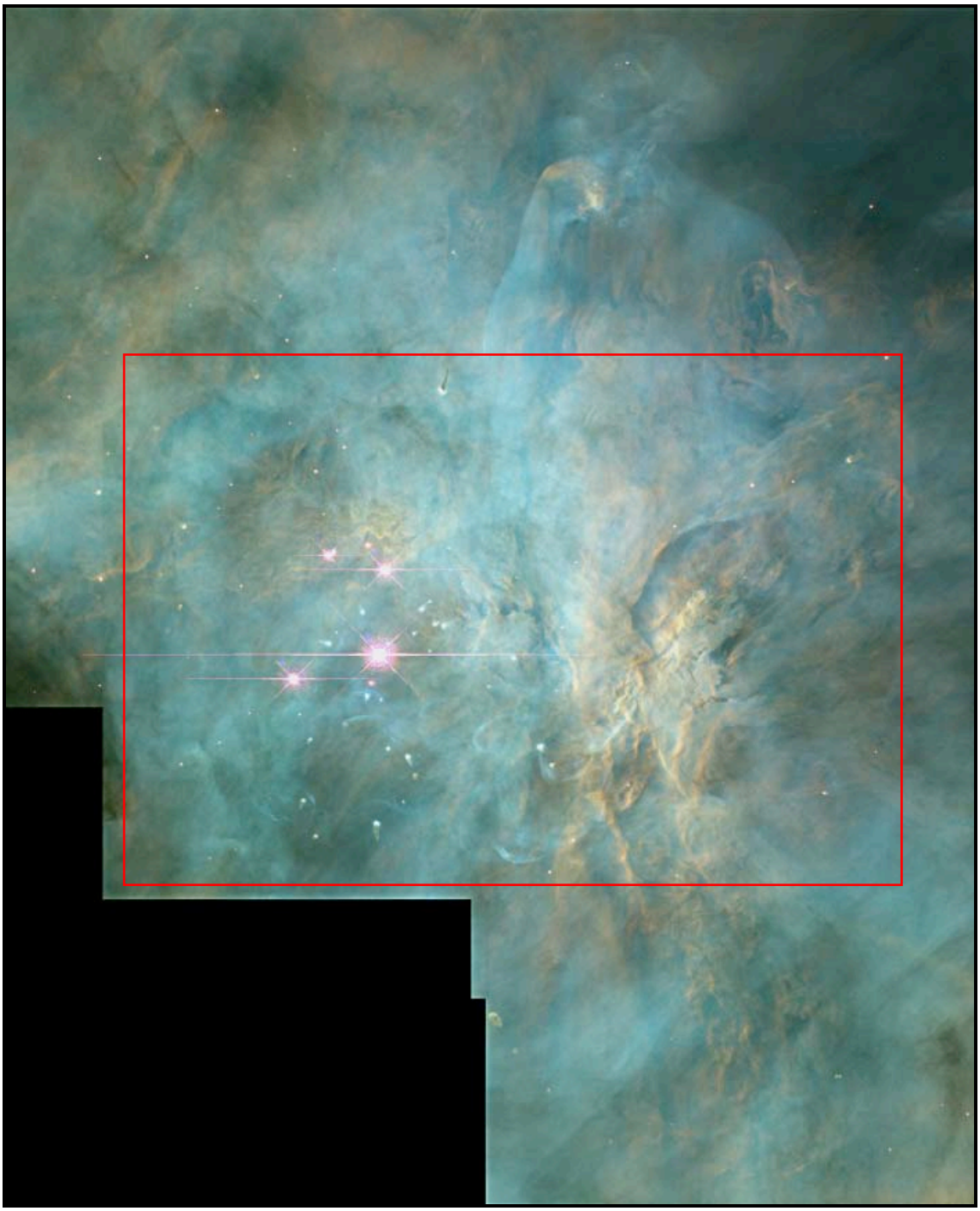




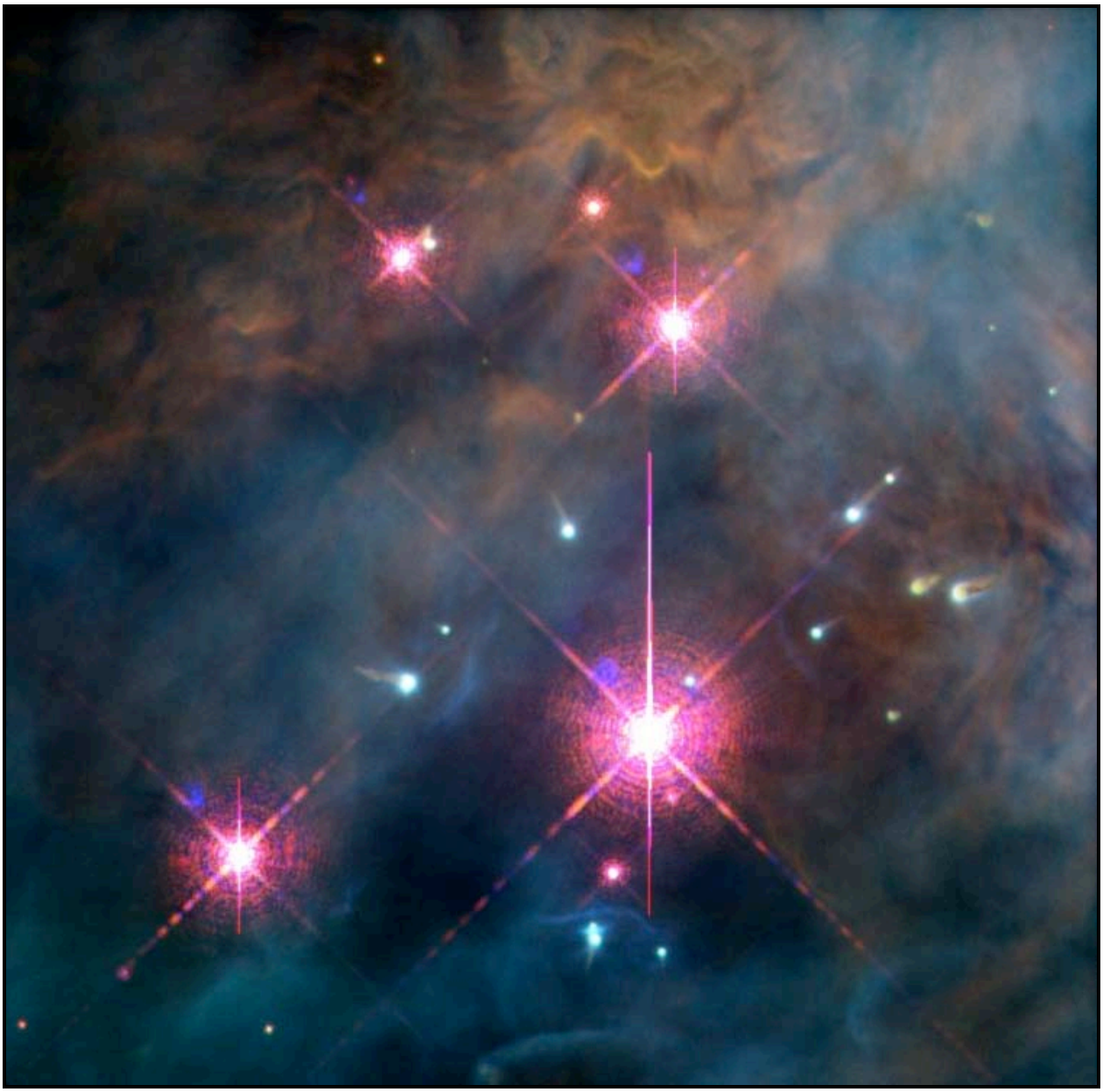
(Image courtesy of the Hubble Space Telescope/NASA)



(Image courtesy of the Hubble Space Telescope/NASA)

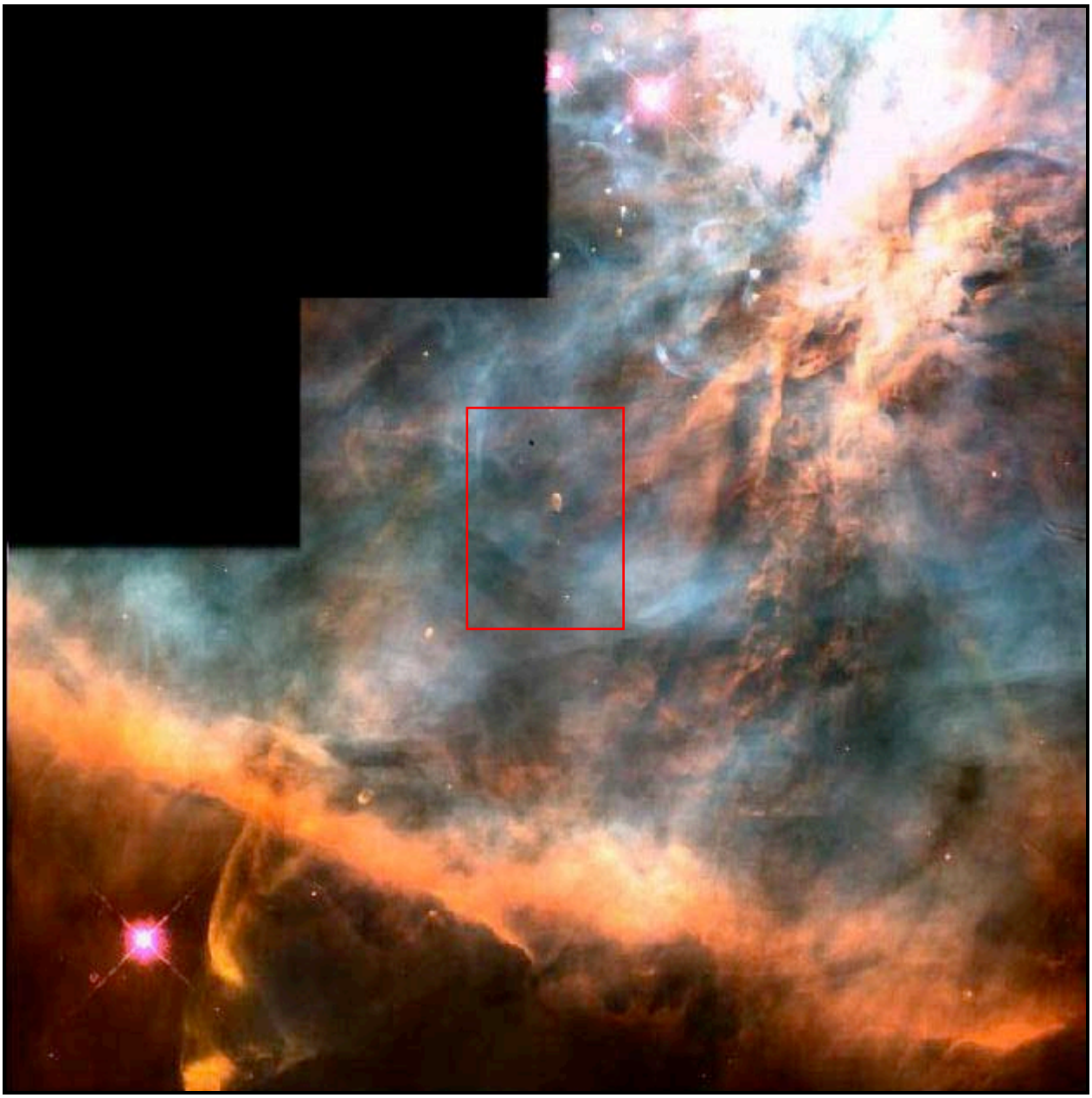


In this enlarged image the Trapezium Cluster's massive central stars are left of center. Note the swarm of teardrop shaped protoplanetary disks or "proplyds" surrounding the massive center stars.



The five main young and massive Trapezium stars are responsible for the illumination of the entire Orion Nebula (the top left massive star is really two -- a binary star system). These stars were born with masses 15 to 30 times larger than the mass of our sun.

(Image courtesy of the Hubble Space Telescope/NASA)

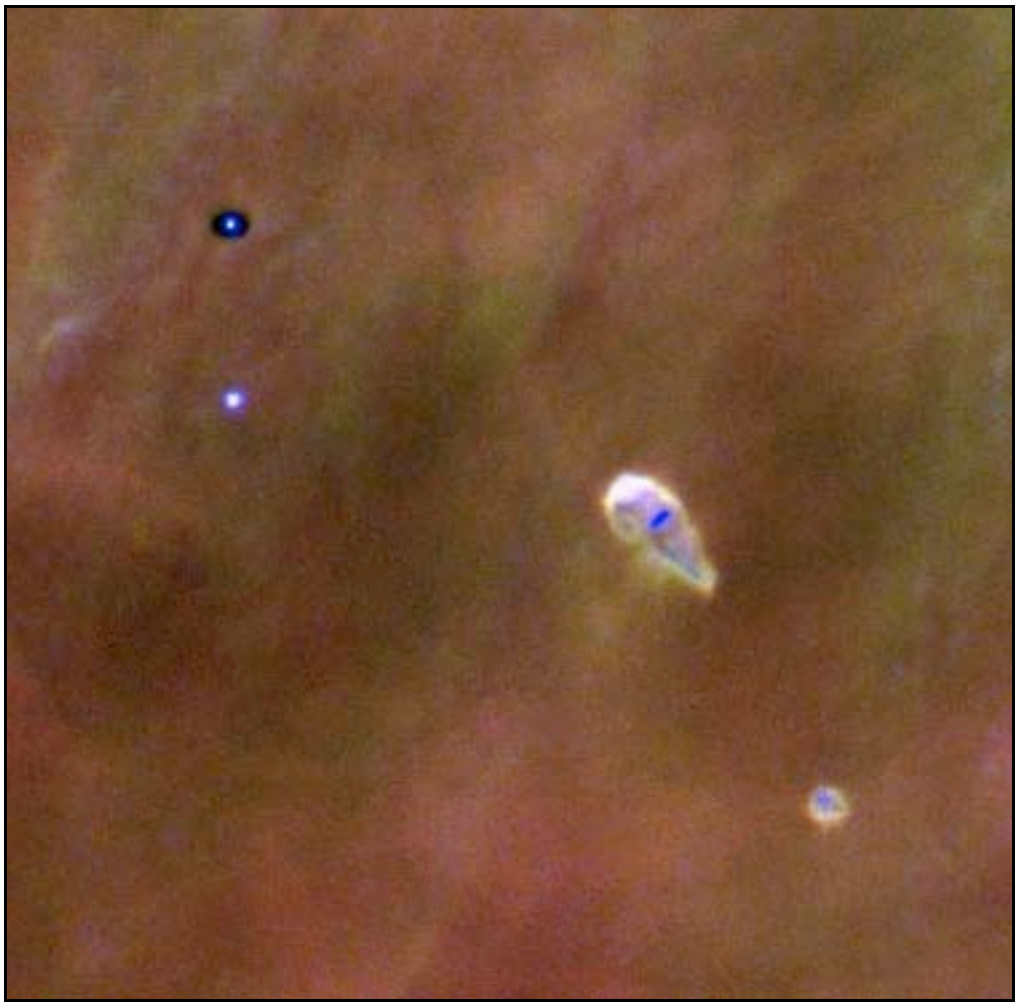


Protoplanetary Disks below the Trapezium Cluster

(Image courtesy of the Hubble Space Telescope/NASA)

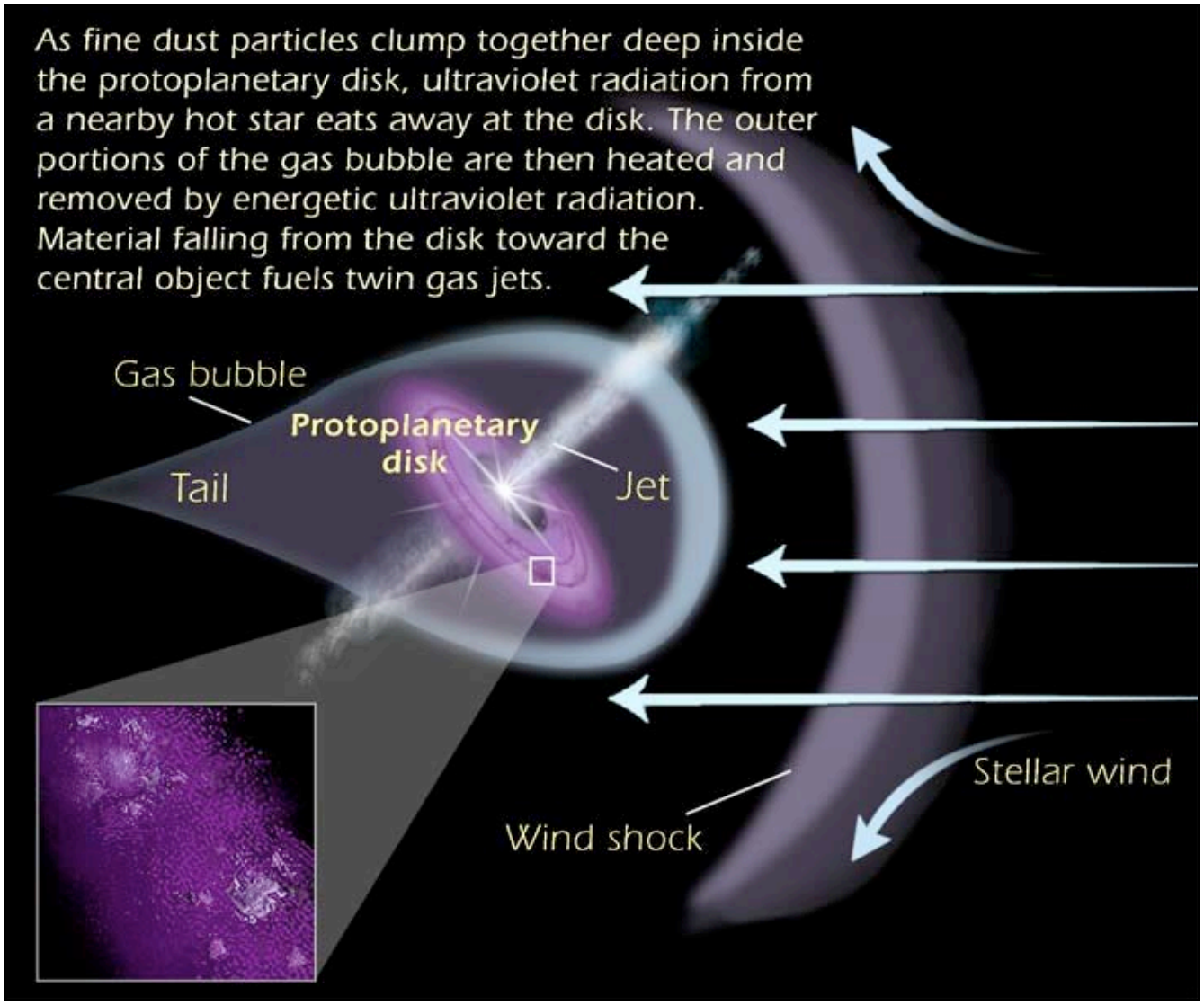
Web Reference
http://hubblesite.org/newscenter/archive/1994/24/

From top to bottom there are five protoplanetary disks or proplyds in this enlarged image.



This Hubble image shows the top four proplyds from the last image in greater detail. The proplyds which are closest to the hottest stars of the parent star cluster are seen as bright objects, while the objects farthest from the hottest stars are seen as a dark objects.

This is a computer simulation of a protoplanetary disk which shows the disk with two jets shooting both directions at right angles from the disk itself. The disk and jets are enclosed in a teardrop shaped “bubble” of gas formed by the intense radiation from the nearby massive stars.



(Drawing courtesy of NASA)

Disks around young stars (also known as circumstellar disks) are thought to be made up of 99% gas and 1% dust. Even that small amount of dust is enough to make the disks opaque and dark at visible wavelengths. The dark disk is seen in this image because it is silhouetted against the bright backdrop of the hot gas of the Orion nebula.

(Image courtesy of European Space Agency)

For further information on related topics go to:

Cosmological Evolution
http://fire.biol.wwu.edu/trent/alles/Cosmic_Evolution_index.html

Alles Introductory Biology Lecture: *Cosmological Evolution*
http://fire.biol.wwu.edu/trent/alles/101Lectures_Index.html

David L. Alles Biology Home Page
http://fire.biol.wwu.edu/trent/alles/index.html