

AN ENIGMATIC STRUCTURE IN OUR LOCAL UNIVERSE

by Leo Cavagnaro

A Fascinating Region in the Large Magellanic Cloud to Explore in Detail Through Amateur Telescopes

Part 1

Our neighboring galaxy embraces in its northern portion a region not well known by amateur observers. It is an interesting subject with an enigmatic formation history. The structure I refer to is a large supergiant shell, a kpc-sized ring of HII regions dubbed LMC-4 by J. Meaburn (1980). You will see some names that are not well known when we discuss this region in the article but do not be concerned. Most of the components of LMC-4 are visible in a telescope as small as 8-inch. The region can even be glimpsed using, for example, common 10x50 binoculars.



Uspallata Valley (above) and “La Carrera” (right). Good places in Mendoza to observe the southern starry night skies.

I felt really excited when I saw this region for first time from “Paramillos”, a magnificent observing site in the Los Andes Mountains, just a few kilometers northeast of Uspallata Valley. This site offers very dark skies at about 9,000 feet above sea level.

A lot of papers about the origin of LMC-4 can be found on some specific web sites like www.arxiv.org or “The Astronomical Journal” (www.aj.aas.org). We can get our “amateur-side vision” using just our eyes and optical devices. As an amateur, I can observe one of the most enigmatic regions, unique in the nearby galaxies population. Backyard observers can also see objects that at first glance seem hard to do with small and mid sizes telescopes.

Some years ago I decided to go a step further and observe deep-sky objects other than NGC and Messier objects. For example, the Observing Project on RCW nebulae around the great Eta Carinae Nebula was a great experience. I can now say that although those kinds of objects are usually small and faint, they are sometimes within reach of an

8-inch telescope for example, making it possible to test your instrument...and your patience!

I needed three nights to observe a 1.12 degree field given by my telescope in this region with different magnifications and filters. The last night I observed the galaxy from a new observing site in “La Carrera”, close to a small town named Tupungato, about 70 miles southwest of Mendoza City (latitude $-33^{\circ} 11' 30''$, longitude $69^{\circ} 16' W$).

An Overall View of the Region

So far, I have observed most of the LMC-4 as part of a big observing project on the Large Magellanic Cloud (LMC) I am currently carrying out. The viewed region includes the biggest stellar arc and a single HII region there including also other objects visible in the field. In part 2 of this article I will include my reports about the observation of another stellar arc in LMC-4, the so-called “Sextant”.

This region is situated between the stars θ and δ Doradus (visual magnitudes 4.8 and 4.3) which are clearly visible with the unaided eye from a dark sky site and labeled in any sky chart. Thus, these stars can be used as references to find the area in the galaxy where this zone lies. Also, if you recognize the 30 Doradus complex (Tarantula Nebula), you can find LMC-4 moving your telescope about 2.5 degrees away to the north-northwest.

The region contains several structures noteworthy enough to be given names (read more in the paper “**A Comprehensive Look at LH72 in the Context of Supergiant Shell LMC-4**” by Knut A.G. Olsen *et. al.*). I personally enjoyed observing this part of our satellite galaxy because several structures and tiny open cluster can be found there.

At low magnification (42x in my telescope) the field was very interesting showing stars with a range of brightness. The brightest ones were situated in the northeast part of the 1.12 degrees wide field given by my eyepiece. In the region indicated by the blue ellipse in **Figure 3** (page 13) several fainter stars appear embedded in nebulosity. Moreover, some hazy patches are visible on the edge of the eyepiece field.



NGC 1978. North in the field (see figure above in this page) lies a bright globular cluster in the LMC. NGC 1978 is, for a globular cluster, rather elliptical which had been explained by a merger origin (read more about this object in the paper “**NGC 1978 in the LMC: The Cluster and Surrounding Field**” by D. J. Bomans *et. al.*). Discovered in 1826 by James Dunlop, NGC 1978 is clearly visible at 42x, but round at this power through my telescope and with a small core seemingly a little brighter than the outer parts. It was more beautiful to observe it at 78x, very obvious in the field of view of this eyepiece, also round and rather smooth in appearance (Concentration Class V). At 106x you can see this cluster elongated and rather smooth in brightness with faint outer ends in the direction of its elongation.

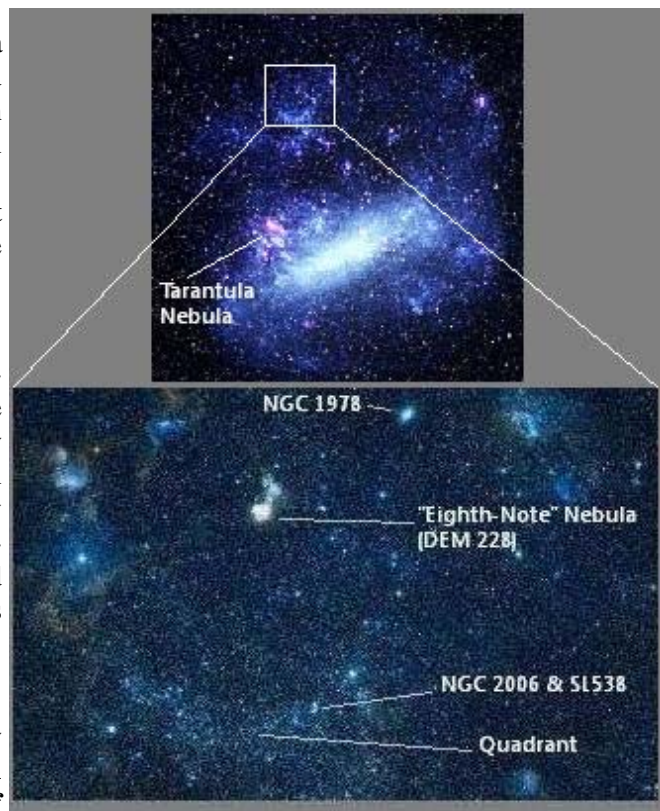
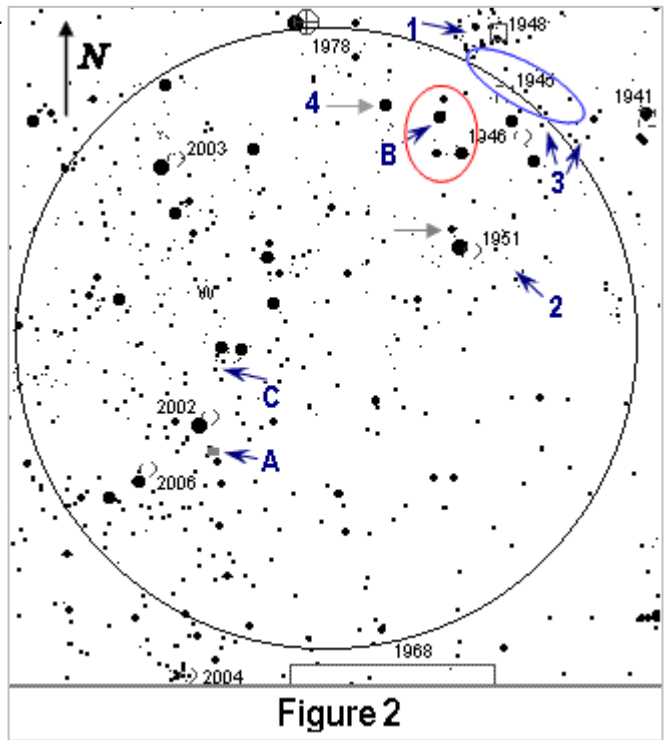



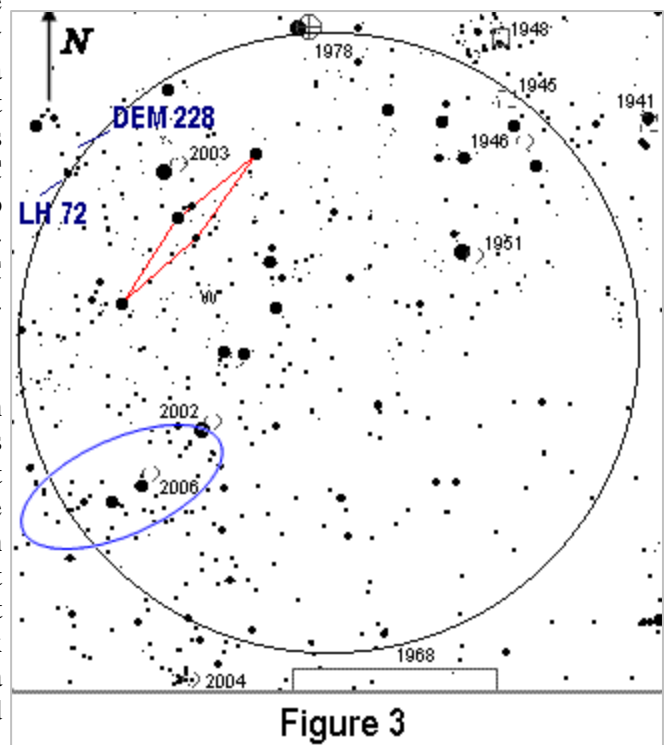
Image from Sky-map.org. I have labeled some of the most interesting objects to observe there. Upper picture by Steve Mandel and John Gleason (north is up)


About 19 arc minutes to the west and situated at the edge of LMC-4 we find a region labeled **1** in **Figure 2**, NGC 1948, a cluster with nebulosity according to [Wolfgang Steinicke's](#) Revised NGC and IC Catalog that looks like an interesting nebula structure easily visible at 42x without a filter appearing round in shape and with a number of stars present there. A careful observation and the use of averted vision made it possible to detect a faint arc-shape nebulosity spreading in the zone enclosed by the blue ellipse in **Figure 2**. Some stars are also visible there, with clearer view of this part at 106x. Also in this figure, the stars within the red ellipse seem to be surrounded by a faint nebulosity. At higher magnification (78x) the stars in NGC 1948 look embedded in nebulosity, round in shape and being the most prominent part of the mentioned wider structure that reaches the asterisms labeled **3** (see **Figure 2**). The nebulosity is fainter in the middle part of the structure. An even fainter nebulosity seems to be situated toward the northwest side of the area (upper right corner in lower panel in Sky-map.org picture). At 106x a small zone of nebulosity which is more conspicuous and bright is visible coincident with the position of NGC 1948 in **Figure 2** on the western edge of the stellar swarm. A UHC filter improved the view of this area.




 **NGC 1951**, an open cluster, looks like a small patch of smooth bright nebulosity (maybe like a small globular, or like a slightly defocused star?). You can see it easily at low magnification. I got the same view at a little higher power (78x).


Close to this stellar cluster using averted vision I could see, for moments, a very faint and irregular nebulosity (**2** in **Figure 2**) that I also observed at 78x while viewing some stars embedded there. I had a similar view at 106x with very faint stars embedded in a very faint nebulosity. The use of a UHC nebular filter did not help to improve the view at least at that last power. Looking at the DSS image, some stars seem to be there. At 78x, on the northeastern edge of NGC 1951, and using averted vision and for certain very hard to see, some faint stars seems to lie (the arrow in **Figure 2** indicates the position). A group of stars lies very close to NGC 1951 (to the west). At 106x, NGC 1951 looks bright and interesting but small (we are observing extragalactic clusters!).

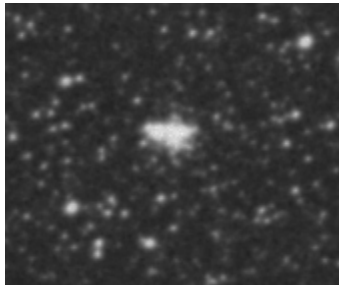


 **NGC 2003**. On the other hand, this 11.3 magnitude open cluster, discovered in 1834 by John Herschel, appears even smaller than NGC 1951 at low magnification, so it was necessary to know its position in advance among the surrounding stars to find it. The pattern of stars marked with red lines in **Figure 3** helped me to recognize the cluster. At 42x it looked like a small star surrounded by nebulosity but bright enough to be seen through an 8-inch telescope. At 78x the cluster was clearly seen looking small and round with a brighter core and a fainter periphery. Observing with averted vision a very small star was visible very close to the cluster.

At 106x this cluster is obvious at a first glance as a small hazy and little elongated spot. The faint star is again visible very close to this cluster.

 **NGC 1941.** This object is labeled as a dark nebula in the old version of Skymap Pro 6.0 (upper right in **Figures 2 and 3**). However, in the interactive charts in Sky-map.org (www.sky-map.org) it appears a bright nebula. Using 78x I saw a small group of stars associated with a faint an irregular nebulosity where this object should be, achieving the best view using averted vision.


 **NGC 1946.** This is a 12.6 magnitude open cluster according to the NGC/IC Project. It is a very challenging object for an 8-inch telescope. It was hard to see at 78x and even at 106x, appearing very small and faint. For very brief moments this object looked sharper and similar to the cluster in **B (Figure 2)** which looked like a small hazy spot at 78x with a brighter core using averted vision when I observed it at 106x. Two asterisms (**3** in **Figure 2**) were useful to identify NGC 1946. The asterism to the right looked beautiful and reminded me of the profile of a drop.



Also in this figure, I have indicated with number **4** a very small and elongated nebulosity appearing in DSS images (left here) similar to a bipolar planetary nebula. I do not know if it appears in a deep-sky object catalogue. I tried to observe it using my telescope. At 78x I just could see a star that I identified using two faint stars situated to the north of this target. Using averted vision there seems to be a pair of faint stars but I could not see the nebula and the shape shown in the image here at all.

Approaching the Stellar Arcs...

After observing some of the clusters and nebulae in the field of view, I aimed the telescope to the south part of the zone reaching the western edge of the biggest arc in LMC-4.

 **NGC 2002.** The identification of this cluster was not easy. Using some stars in the area I could see it looking almost stellar at 42x. Higher power should be useful for a better view and analysis of this LMC object. 106x worked very well to see this open cluster. It is a compact, small and rather bright (10.1 magnitude, 2arcmin in size according to the [Wolfgang Steinicke's Revised NGC and IC Catalog](#)) appearing in my eyepiece like a small defocused star or a star with nebulosity. A small and faint nebulosity is visible with averted vision close to this cluster (letter **A** in **Figure 2**) and also a small hazy object in **C**. It was discovered in 1826 by James Dunlop using a 9-inch telescope and appears in a list of 244 objects compiled by Hartmut Frommert as Dun 214.



James Dunlop Observed the Southern Stars from Australia in the 19th Century.

Stellar Arcs. Shapley's Constellation III

About 53 arc minutes southeast of NGC 1978 and about 1.7 degree southwest from the star δ Doradus lies the biggest stellar arc of clusters and young stars in LMC-4, known as "Quadrant" (Shapley's Constellation III?), receiving this name because it is a quarter segment of a ring. It consists of Lucke & Hodge (1970) associations LH 65, 77 and 84 and is often referred to as LH 77.

Through an 8-inch telescope working at 42x it looked like a large arc of stars and nebulosity with some brighter stars situated in the eastern part (left in **Figure 2**). The groups indicated with α in **Figure 4** looked like short

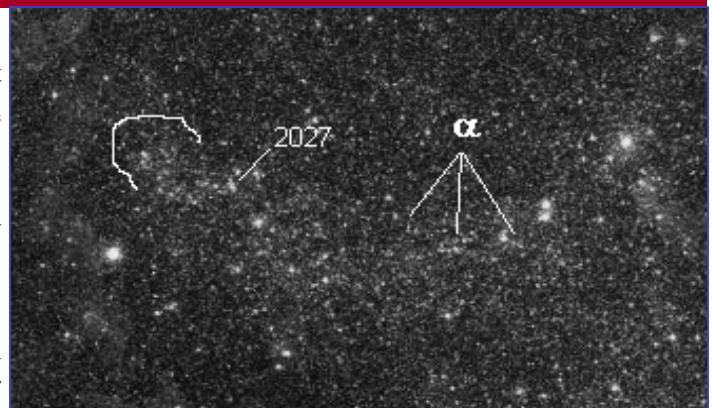


Figure 4

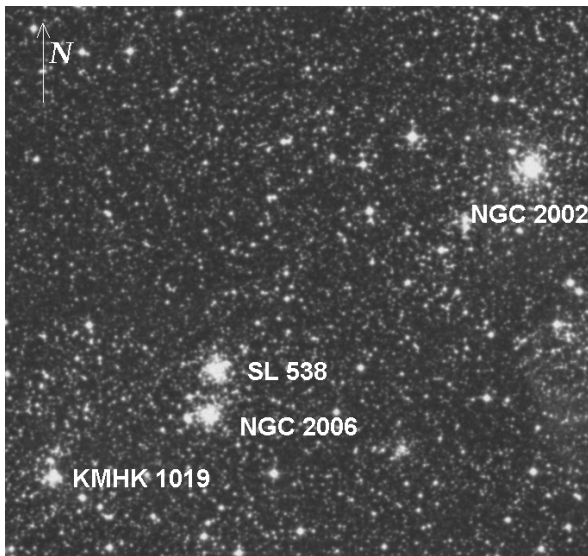
The arc of stars known as Quadrant

chains of very faint stars. The easternmost part of the Quadrant (left in **Figure 4** where North is up) shows faint nebulosity reaching the edge indicated with a white line, where several faint stars are visible in the field. There is an elongated zone which looks brighter just in the region where the objects NGC 2027 and NGC 2034 are situated. Southwest of this arc there is another one, smaller and brighter, known as “Sextant”. I will include my observing reports about it in the second part of this article. The Quadrant and Sextant arcs are indeed unique features; there is nothing similar in the LMC and similar arcs of star clusters have not been reported elsewhere either.

What is wrong with Constellation III?

There are some differences about which part in this region is really Shapley’s Constellation III. The brightest of these arcs was first noted by Westerlund and Mathewson (1966), who wrongly identified as Shapley’s “Constellation III”; nowadays it is known as association LH77 or “Quadrant”. Van den Bergh (1981) called the whole LMC-4 region Constellation III. On the other hand, McKibben Nail & Shapley (1953) designated NGC 1974 as the identifier of Constellation III, including an area of 28’ x 28’ around NGC 1974, a cluster with nebulosity according to the [Wolfgang Steinicke's Revised NGC and IC Catalog](#). According to these researchers, Constellation III is a triple cluster, so they were probably referring to Sextant in which the eastern part of NGC 1974 lies. You can read more about this in **section 2 “Stellar Cluster Arcs”** in the paper **“Triggered Star Formation in the LMC4/Constellation III Region of the Large Magellanic Cloud”** by Yuri & Bruce Elmegreen.

A Binary Open Cluster



DSS image
(http://archive.stsci.edu/cgi-bin/dss_form)

Located Northwest of the OB association LH77 and within the arc “Quadrant”, a pair of open clusters that actually looked globular through my telescope are visible at low magnification (42x) if you observe carefully the area about 7 arc minutes southeast of the cluster NGC 2002. I am talking about NGC 2006 (also SL 537) and SL 538 that have a projected angular separation of about 55 arc seconds. They looked like two very small round formations very close each other. What surprised me is the fact that just one of these clusters has a number in the NGC catalogue, when both of them are clearly visible at low magnification through an 8-inch telescope and look very similar in size and brightness. I checked an image of the pair (figure 1 in the paper **“The Cluster Pair SL 538/NGC 2006 (SL 537)” (1998)** by **Andrea Dieball** and **Eva K. Grebel**). There you can see that the NGC cluster is the southernmost one and “is the fainter member of the pair”. The northernmost cluster (SL 538) looks a little brighter and more compact. The other one (NGC 2006) is a little bigger, fainter and more dispersed. The difference is not so clear in the DSS image here showing

the pair. As far as I know the brighter cluster does not have an NGC number which surprised me as I said. A possible scenario is that the designation NGC 2006 is for both clusters, but the original summary description for NGC 2006, **Cl, eL, vRi, vBvSNM (Cluster, extremely large, Very Rich, Very Bright and Very Small Nucleus in the Middle)** does not mention a double nature of this object. For understanding the “Summary Description” visit <http://www.ngcproject.org/abbrev.htm>

In the paper, the authors state that they saw an enhanced star density between SL 538 and NGC 2006. This may indicate a stellar bridge and thus gravitational interaction between SL 538 and NGC2006. Thus, we can be talking about a real binary open cluster. I think maybe it could be a much smaller, compact and extragalactic version of the “Double Cluster of Perseus”.

At 106x both clusters looked very similar with some difference in brightness. Maybe the best magnification to see this pair was 148x. At this power you can better see the small difference in sizes between the members.

About 4 arc minutes to the east-southeast of the pair and visible in my 8-inch dobsonian is another small cluster, known as KMHK² 1019. It is of similar brightness to the fainter cluster of the pair.

The OB Association LH72 and the “Eighth-Note” Nebula

In the northeastern corner of the field of view (**Figure 3**) and about 1.4 degrees southwest of the star δ Doradus I found perhaps the most interesting structure in the entire region, the OB association¹ LH72 (RA 05 32 12.00 Dec. -66 27 00.0) and its associated nebula DEM 228 (Davies, Elliot & Meaburn, 1976). This nebula, also known with the more friendly name “Eighth-Note” was visible without a filter at 42x. I have indicated with the letter A in **Figure 5** the brighter and most prominent part visible in my telescope, looking round in shape and with a central core even brighter and containing star-like dots. A view with higher magnification was necessary to see these details. These dots maybe star members related to the nebula (LH 72). Using averted vision I could see the nebula more clearly extending to the north-northwest, reaching the 11.6 magnitude star TYC 8891-3384-1, and suggesting to me the characteristic shape you can see in the deeper images of these objects.

At 78x the view was similar with the round prominent zone where some stars possibly belonging to LH72 can be seen within and the extension of the nebulosity following the shape and distribution indicated in **Figure 5**. Through a UHC filter an extremely faint nebulosity seems to reach the bright stars in the upper left corner of

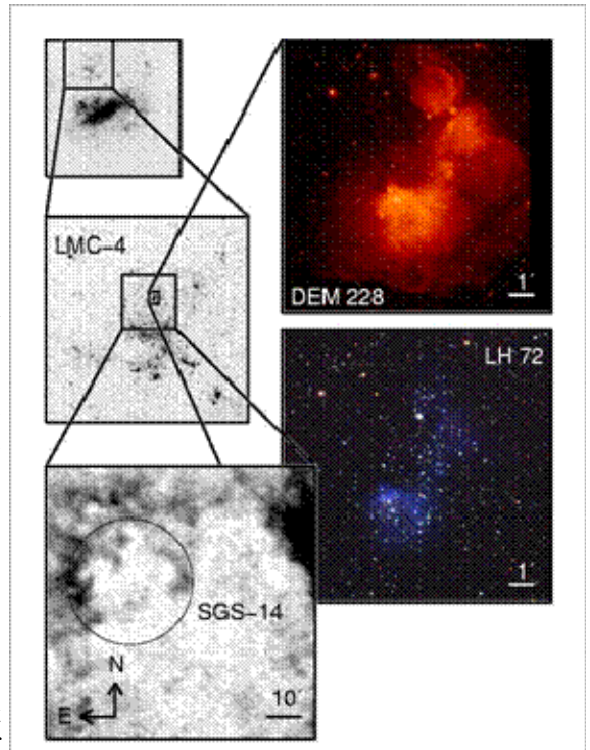


Figure 5, however no nebulosity is visible at all in the DSS image. In C a little brighter patch was visible in my telescope matching well with the photos of this object.

Images of LH 72 and DEM 228, showing their relationship to SGS-14³ and LMC 4.
 Courtesy of Knut Olsen (NOAO)*
 Reproduced by permission of the AAS

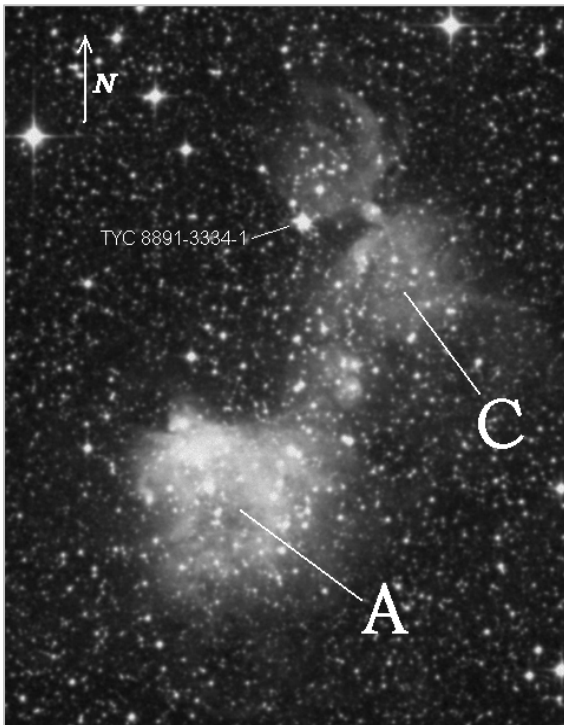


Figure 5

DSS image
http://archive.stsci.edu/cgi-bin/dss_form

Finally, I observed DEM 228 at 106x with the galaxy about 31 degrees of altitude under a good, but not exceptional, dark sky. At this power the nebula was also visible without a filter. Matching with the description at lower magnification, the most prominent nebulosity surrounds the association LH72 and appears a little elongated in the direction NW-SE at this magnification. Using a UHC filter at this magnification, the zone in LH72 looked rather round with an inner part a little brighter.

This HII region does not appear in well known planetarium software and sky charts like Skymap Pro 6, SkyAtlas 2000, Skycharts, and etc. The book “Uranometria 2000.0 Volume 2 by Tirion, Rappaport and Remaklus also does not indicate the nebula but roughly shows the position of LMC-4 in the LMC with the symbol “X” in a detailed map of the galaxy on page 212. I definitely think that DEM 228 or “Eighth-note” nebula (call it as you want) is an LMC object to include in your list when you observe this galaxy.

The descriptions of all these objects were made while observing them with the galaxy at an average altitude of 35 degrees in the sky. The objects could be seen even sharper with the galaxy at its highest (about 53 degrees during the transit) and of course using larger telescopes and always with a well dark-adapted observer.

Whether you are observing at a star party or just alone in a field, remember that when you observe these arcs of stars you are looking at a very unique structure not found elsewhere in our local region of the universe!

Scenarios for LMC-4's Formation

An infalling high-velocity cloud might compress the gas in the LMC disk and so trigger star formation.

In the stochastic self-propagating star formation scenario the stars formed initially trigger further star formation in their vicinity.

Star clusters or γ -ray bursts may trigger star formation to form arc like structures.

The motion of the LMC through the Milky Way halo leads to a bow-shock triggering star formation.

* A special thank to Knut Olsen, the author of a paper about LMC4 and Jill Membrey, the American Astronomical Society Managing Editor, for authorizing me to include a picture from that paper in this article.

Thank you to Rose City Astronomer Jan Keiski for being my grammar checker.

1_ OB Association: The concept of a stellar association was originally introduced in 1949 by V. A. Ambartsumian, who later separated them into OB and T associations (Ambartsumian 1968). Morgan, Sharpless, & Osterbrock (1952) considered as a stellar association any loose group of stars within an area where bright OB stars exist and with evidence of a common origin. A recent definition of a stellar association (Kontizas et al. 1999) refers to it as a single, unbound concentration of early-type luminous stars, embedded in a very young star forming region.

2_ KMHK refers to a list of LMC clusters published in 1990 by M. Kontizas, D.H. Morgan, D. Hatzidimitriou and E. Kontizas (Astronomy and Astrophysics Suppl. Series, Vol. 84, p. 527).

3_ SGS 14 is an HI (neutral hydrogen) Shell

AN ENIGMATIC STRUCTURE IN OUR LOCAL UNIVERSE

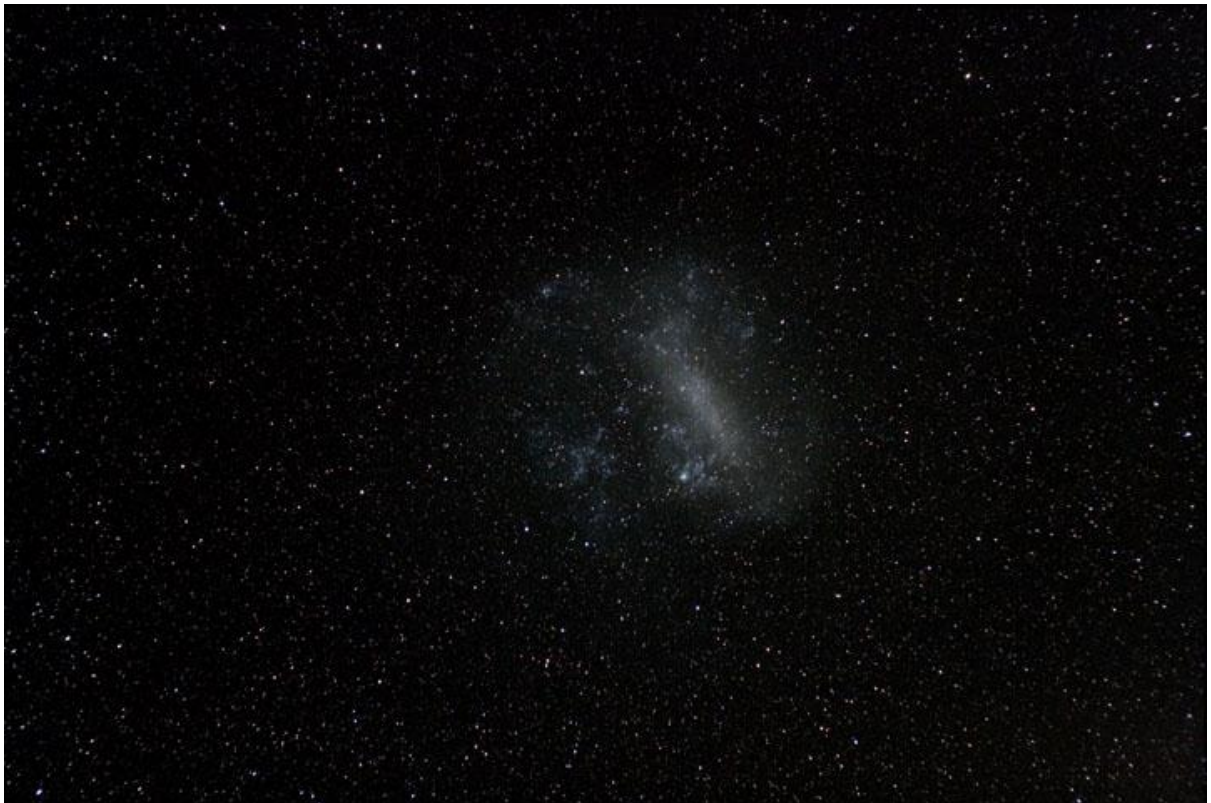
by Leo Cavagnaro

A Fascinating Region in the Large Magellanic Cloud to Explore in Detail Through Amateur Telescopes

Part 2

In Part 1 of the article “**An Enigmatic Structure in Our Local Universe**” I have described a peculiar zone of the Large Magellanic Cloud (LMC) situated to the northwest of the well-known object 30 Doradus (often known as “Tarantula Nebula”), a starburst region. That zone is the Quadrant, a big circular arc of stars in the supergiant shell called LMC-4.

Part 2 is concerned about the other conspicuous structure there, an arc of stars called “Sextant”, also including some clusters and OB associations¹ present in the field of view.



The Large Magellanic Cloud. Photo courtesy of Pat Hanrahan (Rose City Astronomers, Oregon USA)

This Part 2 is focused in a field centered at R.A. 5h 28m 42s Dec. $-67^{\circ} 43' 37''$ (epoch J2000.0), about 45 arc min to the southwest of the biggest stellar arc “Quadrant” and about $1^{\circ} 30'$ to the east-southeast of the 4.8 magnitude star θ Doradus, easily visible to the naked eye under a dark sky. Thus, it can be used as a guide to easily find the field.

A Brief Description of the Field



Canota (Mendoza, Argentina). A view toward the northwest.

I spent two nights (around the first days of March) to observe the 1 degree-field under analysis. The observations were made from Canota, Mendoza Argentina ((latitude $-32^{\circ} 34'$ longitude $68^{\circ} 56' W$). Although a dome of light is present to the south, this nearby observing site about 25 miles to the north of Mendoza city usually offers a 6.1/6.2 limiting magnitude sky. The sky was totally clear both nights, after several days of cloudy and rainy days. However, the seeing was not the best but the sky was steady enough to observe the faint and small details of some of the objects in the zone. The second night had a worse transparency and a higher level of humidity.

At low magnification (42x) the field shows stars with the brighter ones with magnitudes around 8.5 and 9. To the east, some hazy objects containing several stars were visible. To the north you will see maybe the most interesting and conspicuous structure in the whole field, the "Sextant", which harbor an interesting history (read more below) appearing at a first glance as a fine curved formation of nebulosity and stellar aggrupation.

The Stellar Arc "Sextant" (Constellation III?)

To the southwest of the structure known as "Quadrant" described in Part 1 published in the December 2010 issue of the Rosette Gazette (Rose City Astronomers, OR USA), lies a smaller but more noteworthy structure referred to as "Sextant". At a first glance through an 8-inch telescope at low power, this structure looked like a remarkable arc of nebulosity.

The Sextant is a large arc of young stars and clusters shaped like one-sixth part of a ring. A plausible model for the formation of Sextant is that it was triggered by the collapse of a small swept-up shell around a cluster that formed inside a giant expanding HI ring.

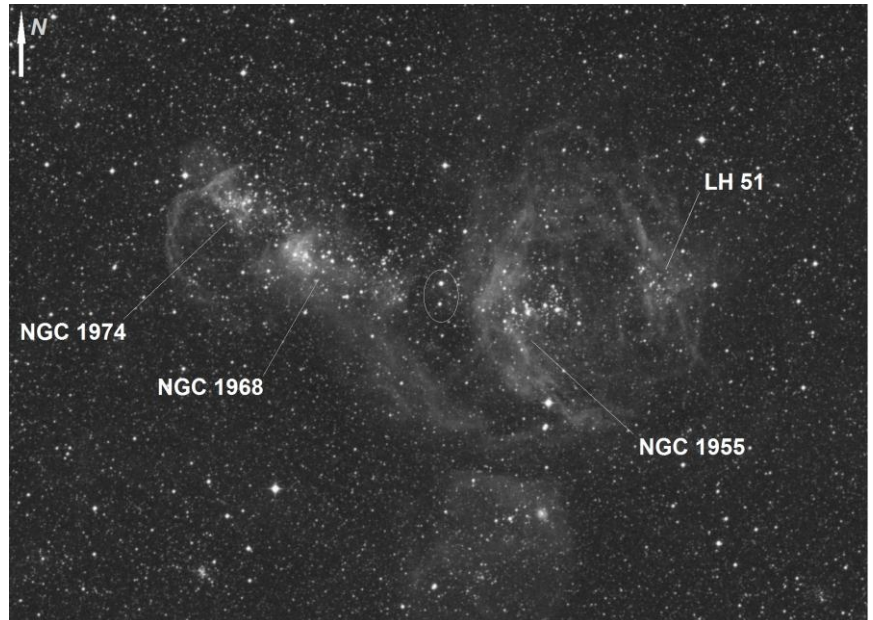


Figure 1. DSS image of the stellar arc known as Sextant. I have plotted the different zones easily discerned through a common amateur telescope.

The question arises again, "Is the Sextant arc the structure called "Shapley's Constellation III"? McKibben Nail & Shapley (1953) designated NGC 1974 (a component of the stellar arc) as the identifier of Constellation III, including an area of $28' \times 28'$ around NGC 1974. They also noted that Constellation III is a triple cluster, so in fact they were probably referring to Sextant (paper "**Triggered Star Formation in the LMC4/Constellation III Region of the Large Magellanic Cloud I have observed**" by Efremov and Elmegreen, May 1998).

The only thing resembling the Quadrant and Sextant stellar arcs is a large region in the Sc galaxy NGC 1620 (also UGC 3103) studied by Vader & Chaboyer (1995), a galaxy situated in constellation Eridanus with a Declination of $-00^{\circ} 09'$, thus being visible from both hemispheres and accessible to most of the amateur observers because of its brightness (mag. 12.4 Surface brightness 13.4). Due to its inclination it is difficult to know if this is a stellar arc or a spiral arm.

At low magnification (42x), four zones were visible there, three of them prominent and one fainter and more elusive. The easternmost one is called NGC 1974, discovered by James Dunlop in 1826, a cluster with nebulosity according with both the NGC/IC Project (<http://www.ngcicproject.org/ngcicdb.asp>) and the [Wolfgang Steinicke's Revised NGC and IC Catalog](#), appearing round in shape and nebular. Observing carefully and using averted vision some very faint stars are visible embedded there.

Immediately to the west of NGC 1974 another nebular patch was visible, NGC 1968. There, an elongated stellar formation composed by stars brighter than those in NGC 1974 was clearly visible. Moving the telescope more to the west, the structure in Sextant is less conspicuous but a continuum of faint nebulosity seems to connect the whole complex. Two faint stars are the most prominent feature there (gray ellipse in **Figure 1**). Moving to the west, the westernmost of the prominent "patches" is very similar to NGC 1968, clearly visible without a filter at this magnification showing a very similar stellar configuration. We are talking about NGC 1955. Harder to see is a patch of nebulosity, LH²51 in **Figure 1**. With averted vision I could see a small area of smooth nebulosity and some stars. The view of the whole Sextant at this magnification but using an UHC filter was marvelous, with NGC 1974, 1968 and 1955 being the most conspicuous patches and with LH51 looking fainter, round and smooth.

The Sextant was also clearly visible at 78x. The nebulosity appeared rather continuous and the stellar configurations in NGC 1968 and 1955 looked similar both in appearance and orientation. However, the configuration of NGC 1955 looked like a rather arced chain of stars. Using averted vision the zones appeared very well detached in the entire structure. LH 51 was also visible, improving the view using this technique.

At the same magnification and using a UHC filter, the Sextant showed four zones of nebulosity, being NGC 1968 and 1955 the most conspicuous ones. At the center of the complex the two stars mentioned above were again visible.

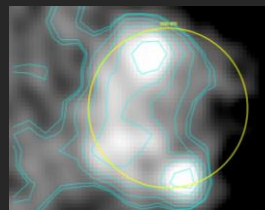
At 104x the Sextant was visible across the field filling it and offering a wonderful view of the entire structure. NGC 1974 looked like a swarm of faint stars of similar brightness in a round configuration and embedded in faint nebulosity. NGC 1968 looked more obvious containing brighter stars in an elongated configuration in the direction NE-SW and, like NGC 1974, embedded in faint nebulosity. Immediately to the west, the "central" zone showed no

Supernova Remnants in the LMC

The MCSNR (Magellanic Cloud Supernova Remnant Database) lists the confirmed and suspected supernova remnants in both the Large and the Small Magellanic Clouds, our nearby neighbors.

Two supernova remnants, namely the SNR 0532-675 and the SNR HP99 498 are situated in the field of view under study in this article. There is not an optical counterpart for HP99 498, a curious case in the nearby galaxy.

SNR 0532-675 (R.A. 05h 32m 20s Dec. $67^{\circ}31'40''$) is an optically confirmed remnant



Radio image of the SNR 0532-675 (Copyright by Rosa Williams and The MCSNR Team)

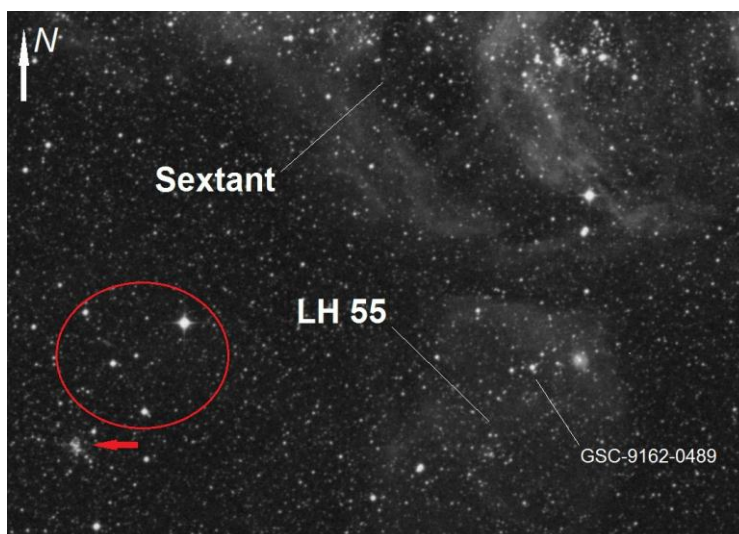


Figure 2 (DSS image)

nebosity with a "dark" zone dividing the two patches from those situated to the west. The two stars mentioned have visual magnitudes 11.2 and 12.8.

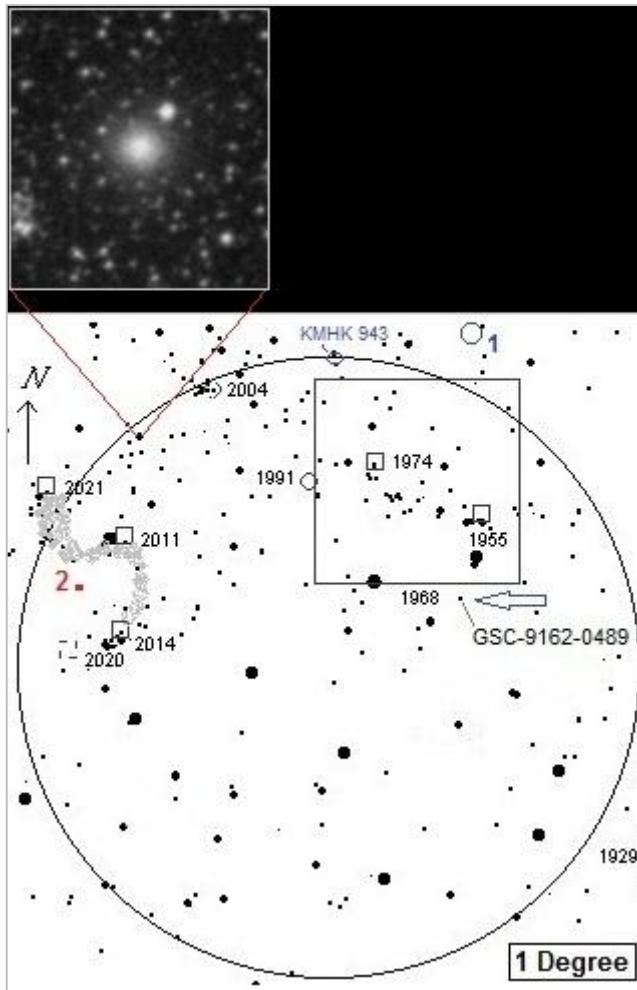


Figure 3

this power and with this filter the nebosity seems to have a triangular shape narrowing northward. A final observation at 104x showed this not very well detached nebula very barely visible with averted vision.

Indicated by an arrow in **Figure 3** there is a small nebula that was hard to observe at low magnification (42x). Using averted vision, a small smooth nebosity seems to be situated very close to the star GSC-9162-0489. The small nebula (0.7 x 0.7 arcmin in apparent dimension) has the not colorful denomination LHA 120-N51B. It is the small and round nebosity visible to the west (to the right) of the star GSC-9162-0489 in **Figure 2**. Very close to this nebula lies the OB association LH 55.

At higher magnification (78x), the small nebula is still barely visible. For moments, using averted vision, a very small nebosity was visible and an extended faint nebosity became visible surrounding it, and reaching and engulfing the star GSC-9162-0489. The extended nebosity (actually an HII region) is known as LHA 120-N 51E and it is associated with the OB association LH 55.

104x was an appropriate magnification to observe this region with LH120-51B appearing like a small nebosity with a bright central spot. A more detailed inspection of the small object LH120-N51B at 213x made it possible to see the faint small nebula with a bright stellar-like core.

Displaying a rather symmetric configuration, NGC 1955 and LH 51 are seen very similar to NGC 1968 and 1974 respectively (see **Figure 1**). NGC 1955 showed stars similar in brightness to that in NGC 1968. Finally, LH 51 was seen similar to NGC 1974 but a little fainter and showing less number of stars. Its appearance, similar in shape, looks more nebular. Through a UHC filter the sextant looked very impressive. A wider nebosity was visible in NGC 1955 in the direction N-S (visible in **Figure 1**). LH 51 appeared bigger than NGC 1974 and 1968 through this filter but fainter and smoother.

To the east of the Sextant appears an object labeled in the chart as NGC 1991 (see **Figure 3**). However, I could not see anything there. According to the NGC/IC Project, NGC 1991 is another denomination for NGC 1974 so surely there is a mistake in the original eyepiece field chart.

A little bigger and round nebosity was detected in the zone **1** in **Figure 3** (left) being barely visible at 42x using a nebula filter (UHC). Observing it at 78x without a filter and using averted vision, it appeared like a faint and rather round nebosity not very well detached from the background sky. Through a UHC filter it looked bigger in size comparing with earlier observations and round in shape. On the other hand, an extremely faint nebosity seems to cover the zone between the Sextant and the zone **1**. At

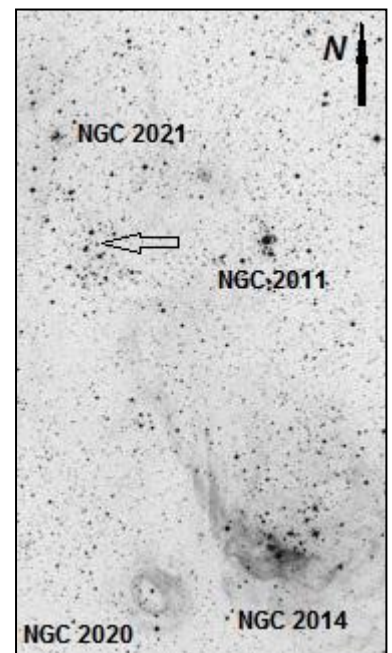


Figure 4 (DSS image)

with a bright stellar-like core.

The DSS image (**Figure 2**) shows a very small stellar cluster situated to the east of the region LH 55, indicated by a red arrow. I used the asterism indicated with a red circle to try to find it but at 78x and 104x it was not visible clearly.

Moving the telescope to the northeast of the Sextant, at the north edge of the eyepiece field, a sort of small nebula with smooth appearance was visible at 78x. Observing carefully with averted vision there seems to be a group of faint stars. This object is the cluster KMHK³ 943 situated in an HII region named DEM L212 (see **Figure 3**). KMHK 943 appeared like a small and little elongated hazy patch with a few stars embedded there when I observed it at 104x. Always averted vision improved the details.



NGC 2004 was a noticeable 9.6 magnitude open cluster through my 8-inch telescope at 42x, situated in a region rich in faint stars. A bright and condensed core was visible surrounded by fainter stars.

Even without a nebula filter some zones of nebulosity were visible there (toward the northwest and the southeast from this cluster). A faint lane of nebulosity seems to connect NGC 2004 with the Sextant situated to the southwest. At the same magnification but using an UHC filter, the cluster was visible also very detached suggesting the existence of nebulosity there. At 78x, this cluster appeared interesting with a small and bright core which presented a "grainy" appearance when I saw it using averted vision. The outer parts of the cluster showed faint stars, some of them discerned and visible. The core of NGC 2004 seems to be a little offset.

At even higher power (104x), this cluster showed a "bright granular core", where I could start to discern some stars observing carefully with averted vision. The outer zones, much fainter, appeared with faint stars, some of them being identified at this magnification.

NGC 2004 is mentioned together with NGC 2100, another LMC cluster, in the paper "**A Hypervelocity Star from the Large Magellanic Cloud**" (Alessia Gualandris and Simon P. Zwart, 2008) as possible parent clusters of HE 0437-5439, an 8M_☉ hypervelocity star with a possible origin in our satellite galaxy and now located at a distance of 61 kpc from the Sun.

Also, a round object (an HII region?) was not visible, in a region populated by a group of faint stars (see upper panel in **Figure 3**). At 78x, the identification of this object was unfruitful. The stars immediately surrounding this object were barely visible that night through the 8-inch telescope making more difficult the accurate identification of the zone. Seemingly a faint star seems to be there but even higher magnification and perhaps a nebula filter would be more useful to try to see this challenging object.



NGC 2011, according with B. Kumar, R. Sagar and J. Melnick in their paper "**CCD Photometric and Mass Function Study of 9 Young Large Magellanic Cloud Star Clusters**" (February 2008) is located in the OB association region LH 75 with its photographic image indicating that it is elongated, fairly condensed and partly resolved cluster. Clearly visible through an 8-inch telescope like a single stellar swarm, this open cluster is actually a double cluster with its fainter component being not visible (read more in the paper "**HST WFPC2 Observations of the Peculiar Main Sequence of the Double Star Cluster NGC 2011 in the Large Magellanic Cloud**", by D. A. Gouliermis *et. al.*). At low magnification (42x) it looked bright but much smaller than NGC 2004. The view at this magnification reminded me that of a small and bright planetary nebula. Near this cluster, faint stars and nebulosity suggest to me the S-Shape type distribution I have indicated with gray color in **Figure 3**, with the end part, near NGC 2021, appearing like an oval-shaped group of faint stars (indicated by the arrow in **Figure 4**). The S-shape I saw actually does not match very well with the DSS image of that zone.

A higher magnification (78x) made possible to show NGC 2011 like a defocused star immersed in the way of the S-shaped structure of stars and nebulosity present there. The oval aggrupation showed several stars of rather similar brightness. Through an UHC filter, NGC 2011 appeared like a star surrounded by small nebulosity. At 104x, NGC 2011 was bright looking like a star with a very small surrounding nebulosity. On the other hand, the zone near NGC 2021, a small 12.1 magnitude open cluster according with the NGC/IC Project, is a notable zone of stars and nebulosity, a structure that seems to be present in other regions of the Large Magellanic Cloud with the S-shape nebulosity being visible too.



NGC 2014 (LH 76; Lucke & Hodge 1970) is an OB association that lies at the southern edge of LMC-4, embedded in the H II region DEM 229. At 42x it was a beautiful stellar aggrupation easily visible. In its southern edge the brightest star of the swarm was detected (about 9.8 visual magnitude). The cluster looked elongated very closely east to west. Using a nebula filter (UHC), the view showed better the nebulosity present there and the stars looked dimmer, but they were visible. At 78x with a UHC filter some stars are visible in a hazy environment.

High magnification (104x) shows a stellar swarm with its members easily discerned and some of nebulosity engulfing the region.



NGC 2020, discovered by John Frederick William Herschel in 1836, was barely visible at low magnification (42x), needing averted vision for brief moments of better detection. It looked round in shape and with smooth brightness. Catalogued as a diffuse nebula, some sources like the [Wolfgang Steinicke's Revised NGC and IC Catalog](#) suggest that this nebula is maybe a supernova remnant.

The UHC filter improved very well the view of this object, looking again round in shape and smooth in appearance but much more detached from the background sky.



DSS image of NGC 2020

At 78x it looked round and mostly smooth in appearance. Averted vision was necessary for a better view of this object. At least two stars are superimposed. Using a nebula filter (UHC) I got a good view, being easily detected and also appearing almost round in shape and smooth in brightness, seemingly showing an inner dark feature when it was visible in detail using averted vision, suggesting the inner "hole" visible in the DSS image here.

At 104x I get the same view. The inner part appeared like a dark lane or "bar" across the object with averted vision and a UHC filter.

Number **2** in **Figure 3** (page 4) indicates a very small cluster with nebulosity that was visible through my 8-inch scope.

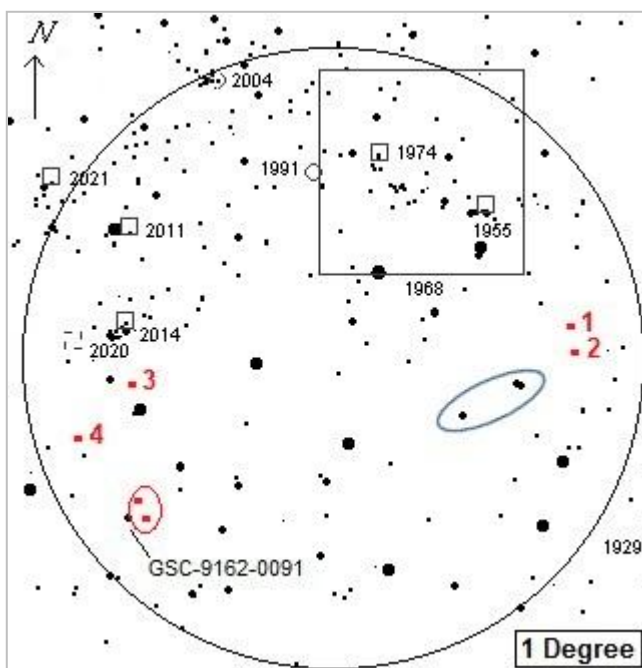


Figure 5

Obscure Stellar Clusters

Before beginning with the visual observation of the field I was studying the DSS image. This made possible the identification of some faint and small stellar aggruppations (open or globular clusters?) that you will not find in common amateur sky charts and planetarium software. Most of these clusters are located in the lower half of the eyepiece field. In **Figure 5** I have plotted the clusters with red dots and numbers. The goal was to try to see these objects visually through my 8-inch telescope under the usual dark skies we have in Canota.

Numbers **1** and **2** in **Figure 5** indicate the positions where two small stellar clusters lie. In the case of the cluster **2** I used the stars marked with the blue ellipse as a guide because it is situated about the same distance that exists between those stars in the same imaginary line that connect them. At low

magnification (42x) and with higher power (78x) they were not visible at all needing even higher magnification to know if they are visible in a small telescope. However, even at 104x the clusters were out of reach of my 8-inch telescope.

Crossing the field and reaching the eastern edge four more small objects lie there. In **3** the DSS image shows a small hazy object and a small stellar cluster in **4**. Both were not visible at low magnification (42x). I observed this zone again using 78x and 104x but both were not visible.

A "Hidden" Pair of Very Faint Clusters. A Case for Applying High Magnification.

I had a very interesting experience trying to find out if two small clusters in the field, indicated with a red ellipse in **Figure 5**, were catalogued or not and in which catalogue they would appear. Two extremely faint stellar clusters are located in the southeast part of the field and they were in the threshold of visibility in my 8-inch telescope under a dark sky and with our neighbor galaxy about 38 degrees high in the southwest late summer sky.

I could not find these clusters labeled in planetarium software or sky charts because they are very small, faint and unknown objects. I included them in the observing list after analyzing the DSS image of the field proportioned by http://archive.stsci.edu/cgi-bin/dss_form. I did not have the equatorial coordinates (epoch J2000.0), so I made a first approximation of their positions working with that image and obtaining the coordinates proportioned by this web page. After achieving a first approximation (within 1 arc minute in accuracy) I checked the list of the "Catalogue of extended objects in Magellanic Clouds (Bica+, 2008)" available at CDS "The Strasbourg astronomical Data Center" <http://vizier.u-strasbg.fr/viz-bin/VizieR?-source=J/MNRAS/389/678>. There I selected the Open Clusters and Associations table options with 3740 and 3326 rows (objects) respectively (you can get it at <http://vizier.u-strasbg.fr/viz-bin/VizieR?-source=J/MNRAS/389/678>, I found them!!! The clusters are catalogued and they are named KMHK 1027 (also BRHT38a) and KMHK 1032 (BRHT38b). **Figure 6** shows both clusters in a RGB composition image (upper right) obtained using the Aladin⁴ previewer at the SIMBAD query results page [http://simbad.u-strasbg.fr/simbad/sim-id?Ident=\[SL63\]%20551](http://simbad.u-strasbg.fr/simbad/sim-id?Ident=[SL63]%20551).

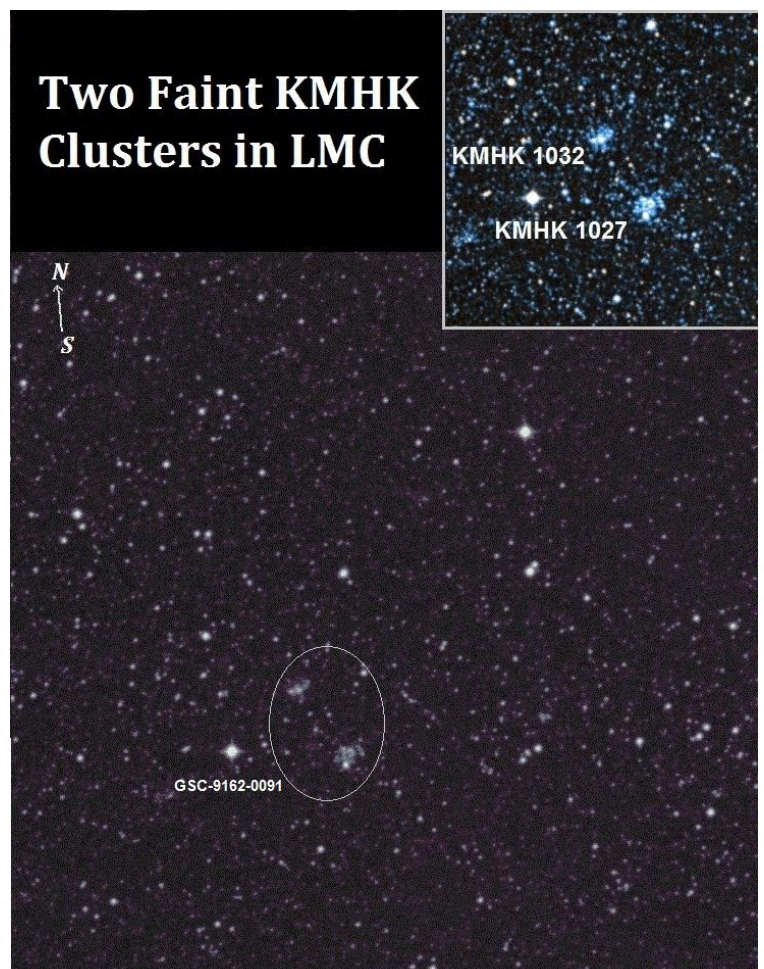


Figure 6. A composite image of ordinary clusters in LMC, with a close up RGB image of the clusters (upper panel).

At 42x, the small stellar clusters close to the 11 magnitude star GSC-9162-0091 (indicated with the gray ellipse in **Figure 6**) were not detected.

At 78x the clusters were hardly viewed. With averted vision two very small hazy spots were visible for moments. Using an eyepiece that gave me 104x the two clusters were detected like small and faint spots, needing averted vision for a brief improved view.

At 213x I got the best view of the cluster pair. With averted vision they looked like very small hazy patches. KMHK 1027, the southernmost one (lower in **Figure 6**), with an apparent dimension of 1 x 0.9 arc min., is a little bigger and brighter than KMHK 1032 (0.7 x 0.7 arc min.) and it was more easy to see for me. The very

faint star on the south edge of KMHK1027 could be glimpsed too. Definitely they are good target to test your visual acuity!!!

The Large Magellanic Cloud hosts a zoo of deep-sky objects to test your telescope, visual capability and to know how far you can go in visual observation.

Thank you to Rose City Astronomer Jan Keiski for checking grammar.

1_ OB Association: The concept of a stellar association was originally introduced in 1949 by V. A. Ambartsumian, who later separated them into OB and T associations (Ambartsumian 1968). Morgan, Sharpless, & Osterbrock (1952) considered as a stellar association any loose group of stars within an area where bright OB stars exist and with evidence of a common origin.

A recent definition of a stellar association (Kontizas et al. 1999) refers to it as a single, unbound concentration of early-type luminous stars, embedded in a very young star forming region.

2_ LH Luke, P. B. and Hodge, P. W. “A Catalogue of Stellar Associations in the Large Magellanic Cloud”. *Astronomical Journal* 75, 2 (1970): 171 – 175.

3_ KMHK refers to a list of LMC clusters published in 1990 by M. Kontizas, D.H. Morgan, D. Hatzidimitriou and E. Kontizas (*Astronomy and Astrophysics Suppl. Series*, Vol. 84, p. 527).

4_ Aladin is an interactive software sky atlas allowing the user to visualize digitized astronomical images, superimpose entries from astronomical catalogues or databases, and interactively access related data and information from the *Simbad database*, the *VizieR service* and other archives for all known sources in the field ([see available data](#)). Created in 1999, Aladin has become a widely-used *VO tool* capable of addressing challenges such as locating data of interest, accessing and exploring distributed datasets, visualizing multi-wavelength data. Compliance with existing or emerging VO standards, interconnection with other visualisation or analysis tools, ability to easily compare heterogeneous data are key topics allowing Aladin to be a powerful data exploration and integration tool as well as a science enabler. Copyright © UDS/CNRS - distributed under GPL v3 licence