Observing Galaxies

Introduction

The aim of this project was to analytically observe different types of galaxies within the capability of an average amateur telescope, trying to visually acquire the most possible information about the selected targets. The used instrument had also to be appraised.

The visual information directly obtained from the observations at field were later compared to published images of the same targets, in order to find out both coincidences and discrepancies. Each galaxy's actual technical data was also taken into account.

Considerations about the overall achieved estimations were lastly made. In particular, the possible source of inconsistent results were analyzed, suggesting some recommendations in order to improve the potentiality of the amateur galaxy observation, an activity that can certainly be highly rewarding.

The morphological classification of galaxies

Galaxies do look very different in brightness, size and colour, but the most obvious visual difference is their great variety of shown shapes. From the analysis of those different shapes, that is, their morphological structure, many galactic properties can be inferred.

Eight decades ago, the American astronomer *Edwin Hubble* was the first to study the morphology of galaxies, trying to devise some kind of classification scheme that could organize its study. The first overall scheme, his famous "*tuning-fork" diagram*, divided the galaxies into four basic types: *ellipticals*, *spirals*, *barred spirals*, and *irregulars*.

The *elliptical galaxies*, which are about 20% of the total, show an elliptical shape with little or no structure at all. Just by the only criterion of its apparent shape -that is, its eccentricity (e)-, *elliptical galaxies* are subdivided into eight classes (from E0 to E7) according to the following formula:

$$\textit{Elliptical class } N = 10e = 10\left(1 - b/a\right)$$

where a and b are respectively the major and the minor axes of the elliptical shape. Low number classes (that is, elliptical shapes of low eccentricities) are called "*earlier*" classes, and so high numbers become "*later*" classes, as a remnant of early notions when galaxies were supposed to physically evolve along the *Hubble's "tuning-fork" diagram*.

The *spiral galaxies* (both types), which are about 75% of the total, show a disk structure with a bulge and arm patterns; in particular, the *barred spirals* show also a characteristic bar. Both types are subdivided (*classes a*, *b* and *c*) according to two criteria: the bulge strength and the arm characteristics: tightly or loosely wound, smoothness or clumpiness.

The *irregular galaxies* show no regular shape (neither elliptical, nor spiral). Worth mentioning are the *interacting (peculiar) galaxies*, actually two galaxies in the act of colliding each other.

Hubble's "tuning fork" diagram has remained in widespread use as the main classification about galaxy morphological structure. However, many other schemes have been introduced in order to facilitate further analysis.

Two last comments. According to *NASA*'s latter investigations, the "*morphological classification should consist of only two types of galaxies: the spirals and the ellipticals. Barred spirals are a subclass of spiral; irregulars may be either spiral or barred spiral; peculiars are not fundamentally a different type*" [**1**]. Even more, "*it is not yet clear whether bars are a permanent or transient galactic structure*" [**2**].

The used equipment

The telescope used in this project is a *Schmidt-Cassegrain (Meade's 8" LX-90)* of the following basic specifications [**3**]: *Diameter of the objective (D)* (commonly referred to as its *aperture*): 203.2 mm; *Focal length (FL)*: 2,000 mm; *Alignment*: altazimuth.

The performance of the telescope can be calculated from its *light grasp*, *focal ratio*, *limiting magnitude*, *resolving power*, and *magnification* parameters [**4**] [**5**].

The *light grasp (LG)*, that is, how many more times the telescope is capable to collect light compared to an average unaided observer (having a 7-mm-diameter entrance pupil) is

$$(LG) = \left(D \big/ pupil \right)^2 = \left(203.2 \big/ 7 \right)^2 \approx 850 \text{ times}$$

The *focal ratio (FR)*, sometimes called "*speed*" of the telescope, is the ratio of the *focal length* to its *aperture*, that is

$$(FR) = FL \big/ D = 2000 \big/ 203.2 \approx 10$$, and so it is referred to as "f/10"

The main advantage of having a "*fast*" telescope only used for visual observation is that it will deliver a wider *field-of-view*. As an improved *field-of-view* would be of great aid at the moment of the estimation of the galaxy brightness, a "f/6.3 *Focal Reducer/Field Flattener*" was used all through the field observations (also helping to significantly improve the *edge-*

of-field quality definition) [1]. Hence, the so adapted optics make that the used telescope became artificially transformed into a "*faster*" one, of only 1,260 mm of *focal length*.

The *limiting magnitude (LM)*, that is, the faintest star that it could be seen assuming the best possible conditions (transparent dark-sky and high magnification) becomes

$$(LM) \approx 2.7 + 5 \log (D) = 2.7 + 5 \log (203.2) = 14.2 \text{ magnitudes}$$

The *resolving power (RP)*, that is, the theoretical smallest angular separation in order that two adjacent stars can been observed actually separated (*Dawes's limit*), expressed in arc seconds, is

$$(RP) \approx {}^{116}\!/_{D} = {}^{116}\!/_{203.2} = 0.57 \text{ arcsecs}$$ [2]

The *magnification*, that is, how many times the image at the eyepiece has been magnified, equals the *focal length* divided by the *eyepiece's focal length*. Three eyepieces were used at field, all of them *Meade's Series 4000 Super Plössl* of the following *focal lengths*: 40 mm, 26 mm, and 15 mm. Therefore, the *magnification* obtained from each eyepiece, hereinafter respectively referred to as *low*, *medium* and *high magnification*, were 32X, 48X and 84X.

Previously to the observations, the telescope was collimated in order to assure its best optical performance. Also, the manufacturer's recommended *Drive Training* procedure was completed to guarantee the telescope best pointing accuracy at field.

The field work

All the observational field tasks were carried out from a countryside place ("*Parque del Lago*", *Salto, Uruguay*), completely devoid of any artificial light all around, at more than 25 km from the suburbs of a medium city (*Salto*, 100,000 inhabitants). The latitude of the observational location is 31° 16' south, its longitude is 57° 54' west, while the elevation above the sea level is 40 meters.

Prior to any session, the sky location of the brightest galaxies was studied in order to find out which of them could have been potential candidates. Sky charts corresponding to each selected candidate (covering about 75 x 50 arcminutes and down to 14th magnitude) were print in advance to facilitate both its sky location and drawing at field [**6**].

Three field observational sessions were executed during the autumn of 2003. Here are all the actually observed galaxies, followed by the corresponding altitude at the moment of each observation:

Session # 1: From April 21st, 2003, 22:30 UT, to April 22nd, 2003, 01:15 UT

[1] Other important practical advantage of "*faster*" telescopes is in photographic or CCD applications, as the exposition times become notoriously reduced.
[2] However, atmospheric conditions seldom allows resolving values under 0.5 arcsecs.

Weather conditions: 14.1°C on average, 1019.3 hPa, 63% rel, windless
Sky conditions: totally clear, fair seeing, fair transparency, moonless sky
Observed galaxies: NGC 1365 (25°), LMC (39°), NGC 2903 (36°), NGC 4594 (48°), NGC 5128 (55°) and NGC 5236 (60°)

Session # 2: From May 1st, 2003, 22:30 UT, up to May 2nd, 2003, 04:50 UT
Weather conditions: 9.8°C on average, 1020.0 hPa, 59% rel, windless
Sky conditions: totally clear, fair seeing, good transparency, moonless sky
Observed galaxies: NGC 2903 (37°), NGC 3109 (84°), NGC 3521 (56°), NGC 3623 (44°), NGC 3627 (45°), NGC 4472 (47°), NGC 4486 (44°), NGC 4594 (70°), NGC 4945 (72°), NGC 5128 (78°), NGC 5236 (79°) and NGC 6822 (29°)

Session # 3: From May 24th, 2003, 22:20 UT, up to May 25th, 2003, 01:35 UT
Weather conditions: 9.0°C on average, 1011.6 hPa, 53% rel, tenuous breeze
Sky conditions: totally clear, good seeing, good transparency, moonless sky
Observed galaxies: NGC 3115 (65°), NGC 3109 (75°), NGC 4594 (63°), NGC 4945 (67°), NGC 4472 (50°), NGC 4486 (46°), NGC 4665 (55°), NGC 5128 (76°) and NGC 5236 (87°)

According to each session planning, the corresponding galaxies were observed higher in the sky as possible. Each target was effortlessly found thanks to the precise automatic pointing system ("*go-on*" facility) of the telescope and the galaxy corresponding location chart.

Averted vision[3] was a must in order to try to capture any galactic features, which always appeared faint, subtle, elusive and uncoloured. Particularly, due to their low intrinsic brightness or low currently altitude -which incorporates noticeable atmospheric extinction-, NGC 3109, NGC 1365 at 25° and NGC 6822 at 29° were themselves barely detected, even trying *averted vision*.

Each observed galaxy was roughly sketched at field (an example is shown at the end of this section, also exhibited with the used *"f/6.3 focal reducer"*), taking note of any particular characteristic that actually appeared at each one of the three used eyepieces. The apparent brightness of each galaxy was roughly estimated by means of comparison to nearby stars of similar apparent magnitudes. Later on, the field sketches were made fair copies, having been incorporated the magnitude of those nearby "reference" used stars (to avoid confusion with stars, magnitudes values were expressed to tenths, but omitting the decimal point).

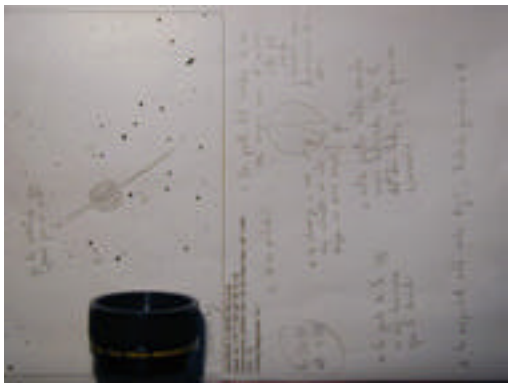
All the sketches have been drawn at the same scale (about 30 x 22 arcminutes), and depict exactly what appeared at the eyepieces (so that all the sketches are *right-side* up, but reversed *left-for-right*). Equatorial coordinates have not been incorporated, as regarding to this project they were considered meaningless.

Along the three sessions, good temperature stabilization of the optics was assured by means of having the telescope installed at least one hour before dusk. Moisture has never affected

[3] *Averted vision* allows the observer to pick up fainter targets than can be seen by looking at them directly; the technique consist in looking just a little away from them, also repeating it from a variety of angles.

the optics (anyway a dew shield was permanently placed at the front end of the telescope, as the photo at the field location shows at the end of this section).

Despite being a countryside public park at the shore of a lake, the selected observational place was truly very solitaire at night, devoid of passing people, let alone passing cars. No person interrupted along any observation. Proper *eye-dark-adaptation* was easily achieved and conserved. The author always worked all alone.



The analysis of the galaxy observations

Considering that the main goal of this project was to observe and analyze different morphological types of galaxies, those eight have been the final selected targets:

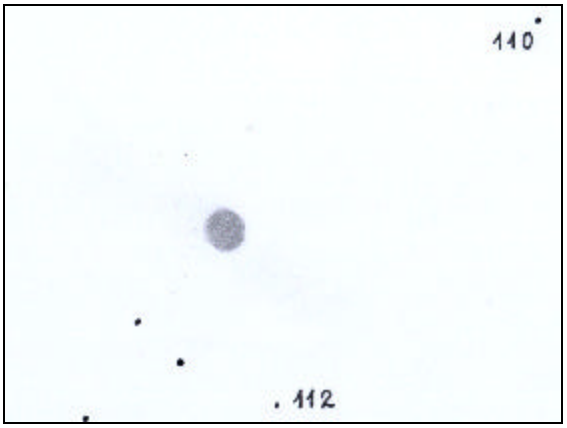
2 elliptical galaxies: NGC 4486 (E1), NGC 3115 (E6)
2 spiral galaxies: NGC 5236 (Sc, *face-on*), NGC 4594 (Sb, *edge-on*)
2 barred spirals galaxies: NGC 4665 (SBa, *face-on*), NGC 4945 (SBc)
1 irregular galaxy: NGC 3109 (Ir)
1 interacting galaxy: NGC 5128 (S0p)

A full page has been assigned to each galaxy target. Each page has the same organization: firstly, the corresponding sketch and a selected photo from Internet, then two paragraphs describing and analyzing those images, followed by the actual technical information, and a final comment about the most peculiar or interesting matters worthwhile mentioning.

The galaxy technical information (extracted from the same source [**7**]) is presented in a table that summarizes its *constellation* location, its *equatorial coordinates* (for equinox 2000.0), its morphological *Hubble type*, its overall *apparent visual magnitude*, its *angular size* (long and short angular dimensions, in arcminutes), its *distance* (in light-years, with an accuracy up to 20%), its *physical extension* (its largest value in light-years, derived from the latter two), and its *position angle*[4] (in degrees).

[4] The *position angle* describes the orientation of the galaxy's long axis, measured counterclockwise on the sky from the celestial north towards the east. It has no sense for a truly circular *face-on spiral* or an E0 *elliptical.*

NGC 4486, an elliptical galaxy class E1



Observed peculiarities at field: The target appeared as a quite well defined shape, almost circular (2.2' x 1.9') and with a featureless uniform distributed brightness: a typical "*early-type" elliptical galaxy.* The overall brightness was estimated to be 11.1 magnitudes, as it seemed to lay just between the two indicated nearby stars. According to the measured relative dimensions, the eccentricity (e) turned out to be 0.14, so that its *Hubble's type* (10 e) became E1.

Deduced characteristics from the adjunct photo: The shape is truly an ellipse of low eccentricity (the major axis is slightly greater than the minor axis), without any other characteristic than its homogeneous brightness and a small blurry zone all around it. Some stars appears in the foreground, and the tiny elongated shown shapes could also be another small galaxies of the *Virgo cluster*.

Actual technical information from published sources:

Identification	NGC 4486 – M 87	*Common Name*	*Virgo A radio source*
Coordinates	12^h 30.8^m, +12° 24'	*Constellation*	*Virgo*
Hubble Type	*Elliptical, class E1*	*Angular Size*	7.2' x 6.8'
Magnitude	8.6	*Extension*	90,000 ly
Distance	41 million ly	*Position Angle*	159°

Comments: Due to its *elliptical type*, no particular galactic feature, other that its characteristic shape and uniform brightness, had been expected to see prior to the galaxy actual observation. This guess had full confirmation at field. Nevertheless, at the eyepiece both the galaxy size (2.2' x 1.9') and its overall brightness (11.1 magnitudes) appeared *"quite diminished"* if compared to their respective true values (7.2' x 6.8' and 8.6 magnitudes): roughly three times less in angular size and 2.5 magnitudes lesser. At least the eccentricity, and hence the *Hubble type*, was properly calculated.

NGC 3115, an elliptical galaxy class E6

Observed peculiarities at field: The target appeared as a quite well defined elliptical shape (3.0' x 1.3') of uniform distributed brightness and no other particular detail to mention: a typical "*late-type" elliptical galaxy.* The overall brightness was estimated to be around the 11^{th} magnitude. According to the measured relative dimensions, the galaxy contour showed an eccentricity (e) of 0.57, so that its *Hubble's type* ($10e$) became E6.

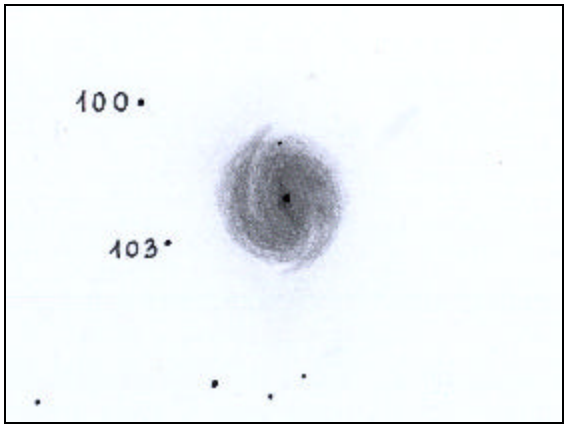
Deduced characteristics from the adjunct photo: The overall shape is an ellipse of high eccentricity (the major axis been notoriously greater than the minor axis). All around the bright featureless elliptical shape appears a tenuous zone, more extended in the direction of the major axis. Many stars appears at the foreground, and towards the bottom left side of the photo, it seems to be another small faint galaxy.

Actual technical information from published sources:

Identification	NGC 3115 – C 53	*Common Name*	*Spindle Galaxy*
Coordinates	10^h 05.2^m, -07° 43'	*Constellation*	*Sextans*
Hubble Type	*Elliptical, class E6*	*Angular Size*	8.3' x 3.2'
Magnitude	8.9	*Extension*	
Distance	21 million ly	*Position Angle*	43°

Comments: As in the previous *elliptical-type* analyzed case, the only observed features of this galaxy were its characteristic shape and uniform brightness. Also, the same conclusions have been achieved: both the galaxy size (3.0' x 1.3') and its overall brightness (11.0 magnitudes) appeared "quite diminished" by roughly the same factors, but the eccentricity, and thus the *Hubble type*, corresponded to the actual values.

NGC 5236, a face-on spiral galaxy class Sc



Observed peculiarities at field: The target appeared as a very large (7.7' x 6.9') round disk with a small *star-like*, albeit notoriously bright, central nucleus: a typical *face-on spiral galaxy*. The contour was not well-defined. Two arms were vaguely detectable at the medium magnification, arising from the bulge in the clockwise direction. A dim star appeared at the edge of the disk. Using the higher magnification and comparing to the magnitude of the nearby indicated stars, the brightness of the bulge was estimated to be 10.2, and the galaxy overall brightness around the 9th magnitude.

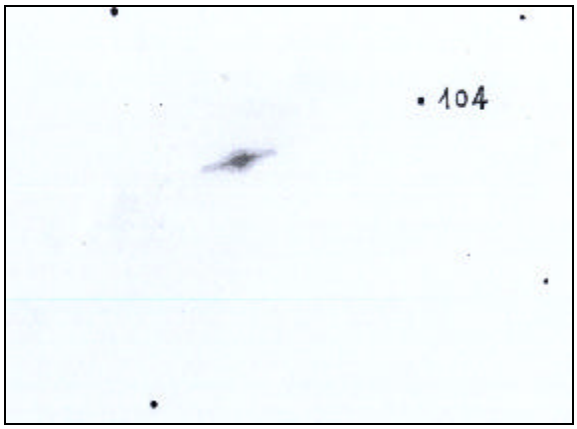
Deduced characteristics from the adjunct photo: The imaged galaxy denotes a *multiple arm spiral*, although quite close to the *grand design* structure, as besides the two main long, narrow and well-defined arms (which provides a basically symmetric structure), many other unsymmetrical minor arms appear. The showed prominent small bright bulge and narrow, loosely wound arms are typical of Hubble's *class c* spiral galaxies. The overall galaxy shape is not well-defined, as the brightness gradually decays towards the farther parts of the disk. Inside the spiral arms, the obvious predominant blue colour indicates the presence of a lot of young, hot, luminous, massive stars (O and B *stellar types*), while the reddish knots are due to H II regions.

Actual technical information from published sources:

Identification	NGC 5236 – M 83	*Common Name*	*Southern Pinwheel*
Coordinates	13^h 37.0^m, -29° 52'	*Constellation*	*Hydra*
Hubble Type	*Spiral, class Sc*	*Angular Size*	11.2' x 10.2'
Magnitude	7.6	*Extension*	40,000 ly
Distance	8.5 million ly	*Position Angle*	44°

Comments: The observation (admiration) of this galaxy was a very rewarding experience. Due to its large size and brightness it also was an easy task, as its structure could be seen within reasonable definition. Both the angular size and brightness appeared *"undersized"*, although the angular dimensions were not so diminished as in the *ellipticals* cases.

NGC 4486, an edge-on spiral galaxy class Sb



Observed peculiarities at field: The target appeared as an overall elongated shape (4.1' x 1.2') with a well-defined big and bright central area, whose brightness gradually decreased towards both sides: a typical *edge-on spiral galaxy.* Increasing the magnification decreased the definition of the shape, and no other feature was observed. The bulge seemed to shine about the same as the indicated star (10.4 magnitude), and the overall galaxy brightness was roughly estimated one full magnitude lesser.

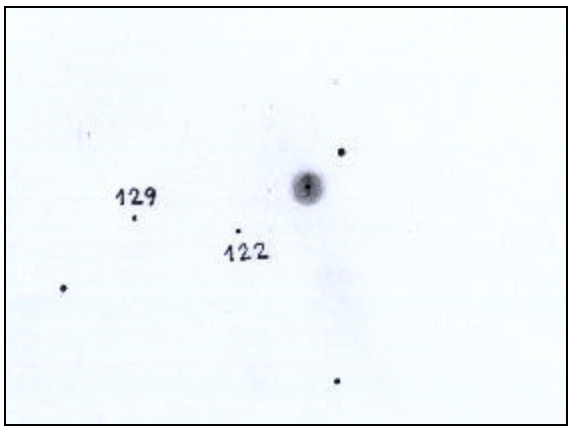
Deduced characteristics from the adjunct photo: The imaged galaxy shows an almost *edge-on spiral galaxy*, with a notorious dark lane due to the great concentration of dust at the disk. The "middle-size" bulge with respect to the disk size is typical of Hubble's *class b* spiral galaxies. Due to its particular orientation, the arms cannot be distinguished, but on the other hand the thin relative dimension of the disk becomes quite obvious.

Actual technical information from published sources:

Identification	NGC 4594 – M 104	*Common Name*	*Sombrero Galaxy*
Coordinates	12^h 40.0^m, -11° 37'	*Constellation*	*Virgo*
Hubble Type	*Spiral, class Sb*	*Angular Size*	8.9' x 4.4'
Magnitude	8.3	*Extension*	100,000 ly
Distance	41 million ly	*Position Angle*	89°

Comments: The large but thin dust lane, characteristic feature of this galaxy, was not seen at all. Maybe it was needed high magnification or a more transparent sky. The relationship of the galaxy dimensions -length to width- of the observed target (4.1/1.2 = 3.4) was quite different to that obtained from the "true" technical data (8.9/4.4 = 2.0); however, the same relationship directly measured over the photograph gives almost the same value (3.5). This fact would indicate that this technical *angular size* data does include information arose from sources largely beyond the capabilities of amateur telescopes.

NGC 4665, a face-on barred spiral galaxy class SBa



Observed peculiarities at field: The target appeared as a *not-so-large* (1.6' x 1.5') and a *not-so-bright* round disk, almost circular, with a visible central bright bulge and -at higher magnifications- a bar that practically divided the disk into two sides: a typical almost *face-on barred spiral galaxy.* No arms were detected. The brightness of the bulge was intermediate between the referenced nearby stars, thus estimated to be 12.5, and the overall galaxy brightness half one magnitude lesser, that is, around the 12th magnitude.

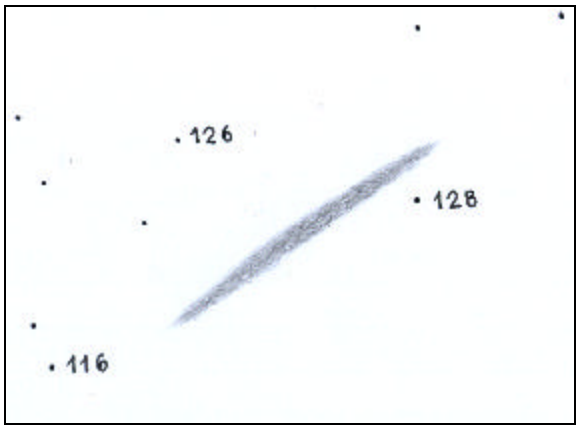
Deduced characteristics from the adjunct photo: The imaged galaxy denotes a *flocculent* structure, as the arms of the *barred spiral* appears clumpy and fragmented. The showed prominent bulge and tighter wound arms, with a smooth distribution of stars, are typical features of any Hubble's *class a* spiral galaxies (whether barred or not).

Actual technical information from published sources:

Identification	NGC 4665	*Common Name*	
Coordinates	12^h 45.1^m, +03° 03'	*Constellation*	*Virgo*
Hubble Type	*Barred spiral, class SBa*	*Angular Size*	4.3' x 3.6'
Magnitude	10.5	*Extension*	
Distance	30 million ly	*Position Angle*	5°

Comments: Despite this galaxy is almost *face-on*, and apart from its bright bulge and its tenuous bar, no other morphological detail was observed. Considering its low brightness and medium size, but mostly because of the "vague" definition of its arm structure (typical of any *class a* spiral galaxy), the few observed features were certainly among the expectations. In order to see more details it should be needed a larger aperture and/or higher magnifications, on very good dark skies.

NGC 4945, a barred spiral galaxy class SBc



Observed peculiarities at field: The target appeared as a tenuous smudge of very large and elongated (17.0' x 1.4') shape, with only two issues worthwhile mentioning: 1) its contour was not well-defined, and 2) despite the absence of details or high brilliant zones, the overall brightness was not uniformly distributed. Those subtle features rule out the *elliptical* structure hypothesis and enlighten about its *spiral* condition. At the higher magnification, the galaxy occupied almost all the *field-of-view*. Its brightness was difficult to estimate, but it was roughly considered to be around the 12th magnitude.

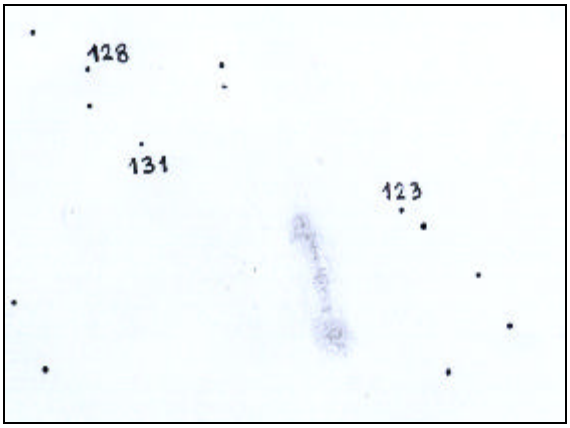
Deduced characteristics from the adjunct photo: The imaged galaxy shows a great tilted (almost *edge-on*) *spiral*, basically confirmed by the diversity of the shown features (i.e., the bulge, the dark rifts). Particularly, the large dark rifts that appears in its "under-left" side, denotes that this is the near side of the galaxy. The bulge is relatively small (it does not jut out over the disk, like in the NGC 4594 case), and the arms are not tightly wound (it can be seen many curved dark rifts at both sides of the galaxy, besides the "front" ones), so that this undoubtedly is a Hubble's *class c* spiral galaxy. However, the bar remains quite hide.

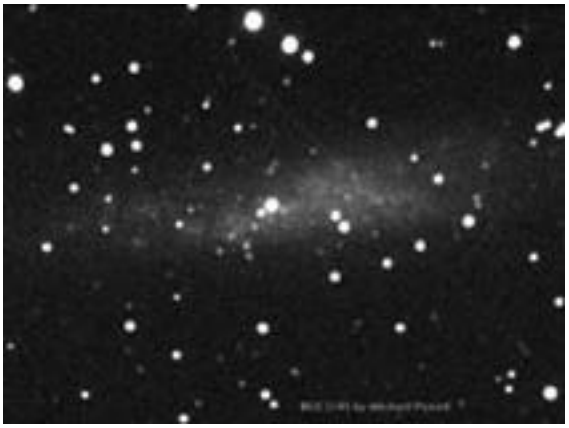
Actual technical information from published sources:

Identification	NGC 4945 – C 83	*Common Name*	
Coordinates	13^h 05.4^m, -49° 28'	*Constellation*	*Centaurus*
Hubble Type	*Barred spiral, class SBc*	*Angular Size*	20.0' x 4.4'
Magnitude	8.8	*Extension*	
Distance	16 million ly	*Position Angle*	43°

Comments: There was a big difference between the galaxy shape observed at field (ratio large to width of 12.1) and its shape at the photo (with a ratio of 5). One possible reason for such difference, supported by the observed fact of the "not well-defined contour", could be that the "front" dark rifts actually were hiding a great portion of the near side of the disk. This possibility can be "tested" improving the *contrast* of the observed image at the eyepiece (i.e. observing at higher magnitudes, preferentially through bigger *apertures*).

NGC 3109, an irregular galaxy





Observed peculiarities at field: The target appeared large (6.9' x 1.9') but quite dim and diffuse, consisting of several very tenuous scattered smudges of different sizes, instead of just one unique smudge. Apart from its very elongated form, no particular shape was defined. At the medium magnification the smudges appeared even more diluted, and at the higher magnification, almost completely vanished. The galaxy overall distributed brightness was something in between the magnitude of the three referenced nearby stars, thus estimated to be around magnitude 12.7.

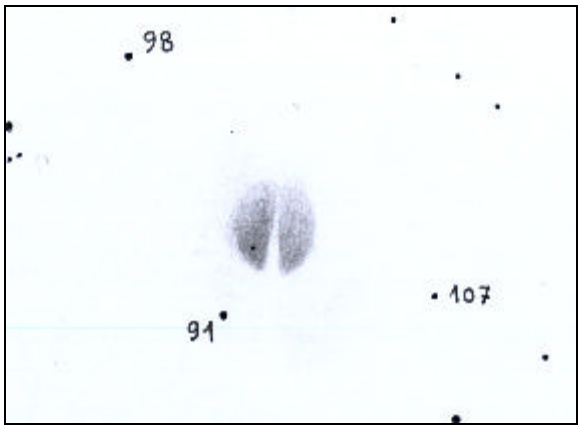
Deduced characteristics from the adjunct photo: The imaged galaxy shows an amorphous galaxy, as no detail can be deduced (there is no central part, no disk, no symmetry, no bright zones) other than its several *almost-separated* parts. It can not be any doubt about its classification as an *irregular* galaxy. All the stars that appear are at the foreground.

Actual technical information from published sources:

Identification	NGC 3109	*Common Name*	
Coordinates	10^h 03.1^m, -26° 10'	*Constellation*	*Hydra*
Hubble Type	*Irregular, class Ir+*	*Angular Size*	14.5' x 3.5'
Magnitude	9.8	*Extension*	
Distance	6 million ly	*Position Angle*	93°

Comments: By far, this was the faintest observed galaxy of all the eight selected targets. Moreover, it also appeared as something almost "magical": nothing at all was actually observed by directly looking at it, and only when it was indirectly observed (*averted vision*) it became hardly noticed, just to disappear again when the glance tried to return and focused where the faint smudges seemed to be located. Almost three full lesser magnitudes, and half angular dimensions, were the estimated values compared to the technical ones.

NGC 5128, an interacting galaxy



Observed peculiarities at field: The target appeared quite bright and with a very unusual form, basically round (4.7' x 4.4') with two well-separated hemispheres, and no specific bright zones inside them. Higher magnifications were worthwhile in order to capture more details. Both hemispheres were more brilliant and more well-defined at the same side of the round shape (bottom side of the sketch), while the one al the left was more luminous than the other. At the upper side of the sketch, both hemispheres seemed to gradually vanish. The very dark rift that separated both hemispheres (practically, the sky itself) was wider at the bottom side, and also diluted itself towards the opposite side. A very faint star appeared in the foreground of the brighter hemisphere. The galaxy overall brightness, a hard task due its large and brilliant surface, was roughly estimated in 9.7 magnitudes.

Deduced characteristics from the adjunct photo: The imaged galaxy shows a more detailed composition of the basic structure already described. The notorious blue colour denotes two large concentrations of newborn massive hot stars, separated by a wide dust lane, where appears to be some reddish areas of old stars. Not one, but many foreground stars can be seen in front of the galaxy. Undoubtedly, this galaxy is not elliptical, nor spiral.

Note: *This galaxy is one of the strongest radio sources. From this fact and its unusual structure, is thought to be an elliptical galaxy that is colliding against a spiral galaxy, thus its special classification as an "interacting" galaxy.*

Actual technical information from published sources:

Identification	NGC 5128 – C 77	*Common Name*	*Centaurus A*
Coordinates	13^h 25.5^m, -43° 01'	*Constellation*	*Centaurus*
Hubble Type	*Peculiar, class S0p*	*Angular Size*	27' x 20'
Magnitude	6.7	*Extension*	
Distance	14 million ly	*Position Angle*	35°

Comments: Both its large angular size and high brightness allowed to directly obtain interesting and valuable information, at the same time that it was really a noteworthy target.

The overall analysis

The galaxy photos show many more stars that actually appeared at the field observations, indicating that the brightness of those faint stars are under the *limiting magnitude* of the used telescope, that is, under the 14th magnitude.

The following table presents an overall comparison between the observed physical size and magnitude of each galaxy and its corresponding same values obtained from published data. The "Δ ***size***" column corresponds to the raw percentage of the observed angular extension to its actual angular extension, and the "Δ ***mag***" column corresponds to the difference between the estimated visual magnitude and its actual visual magnitude.

Galaxy	***Class***	***Observed size and mag***		***Actual size and mag***		Δ ***size***	Δ ***mag***
NGC 4486	*E1*	2.2' x 1.9'	11.1	7.2'x6.8'	8.6	31%	2.5
NGC 3115	*E6*	3.0' x 1.3'	11.0	8.3'x3.2'	8.9	37%	2.1
NGC 5236	*Sc, face-on*	7.7' x 6.9'	9.0	11.2'x10.2'	7.6	69%	1.4
NGC 4594	*Sb, edge-on*	4.1' x 1.2'	9.4	8.9'x4.4'	8.3	46%	1.1
NGC 4665	*SBa, face-on*	1.6' x 1.5'	12.0	4.3'x3.6'	10.5	37%	1.5
NGC 4945	*SBc*	17.0' x 1.4'	12.0	20.0'x4.4'	8.8	85%	3.2
NGC 3109	*Irregular*	6.9' x 1.9'	12.7	14.5'x3.5'	9.8	48%	2.9
NGC 5128	*Interacting*	4.7' x 4.4'	9.7	27'x20'	6.7	17%	3.0

The first obvious corroboration is that all the observed and measured angular extensions, and all the estimated apparent magnitudes, have achieved results that are under the corresponding actual galaxy values.

The lowest underestimation in angular extension was for the *interacting galaxy* (17%), possibly due to the fact that the outer regions of this particular colliding galaxy, although actually extended up to very large dimensions, have very low brightness.

The two *ellipticals* were both underestimated in extension for about two thirds, while the four *spirals* achieved higher but more spread results (from 37% up to 85%). This could be originated in the fact that the variation of the surface brightness of *elliptical galaxies* relative to the "radius" (measured by their *effective radius*), generically decays more abruptly compared to same variation of *spiral galaxies* (measured by their *scale length*)[5].

The overall surface brightness of the eight galaxies were underestimated between 1.1 and 3.2 magnitudes. Three *spirals* achieved almost the same lowest differences (slightly over one full magnitude), the two *ellipticals* reached similar and intermediate results (around 2.5 lesser magnitudes), and the worst cases were the *irregular*, the *interacting*, and the *spiral* NGC 4945 (all around three full magnitudes).

[5] An *effective radius* can also be calculated for *spirals*: it comes out to about 1.7 times the *scale length*.

While both the *irregular* and the *interacting* differences can be explained due to their particular conditions (highly extended regions of very low brightness that actually resulted "invisible", but obviously really account for the overall galaxy brightness), the *spiral* NGC 4945 was a rather weird case, as this galaxy achieved at the same time the "best" measured value in extension and the "worst" estimation in brightness. But the cause is almost still the same, with the only difference that in this case a large faint portion was actually observed.

In order to improve the "quality" of the potential results, it is necessary to acquire more "information". To use telescopes of higher *aperture* is the straightforward way to obtain it, as their higher *light-collecting* capability increases both the *limiting magnitude* and the *resolving power*, while the *contrast* is also substantially bettered. Also, higher *apertures* allow to take advantage of higher *magnifications*, which intrinsically have the benefit of darkening the background sky.

Conclusion

The observation of galaxies by means of amateur telescopes can be a highly worthwhile activity. Not only the majestic beauty of those faint targets are well reachable to the average amateur, on condition that a fair instrument under dark skies is used, but also plenty of interesting information can be inferred.

Even though galaxies appear faint, subtle and uncoloured at the eyepiece (far different from the usual bright, full-coloured, breathtaking photos seen on any astronomy magazine), the perception of such an intimate and genuine connection with those remote worlds is a highly recommended experience that any sensitive person should try at least once.

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