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THE M51 MYSTERY: LORD ROSSE, ROBINSON, SOUTH AND THE DISCOVERY OF SPIRAL STRUCTURE IN 1845

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Abstract: In April 1845 Lord Rosse discovered the spiral structure of M51 with his 72-inch reflector at Birr Castle. Already in March the new telescope had been pointed at the object in Canes Venatici, later nicknamed the 'Whirlpool Nebula'. Two experienced astronomers were present: Sir James South and the Reverend Thomas Romney Robinson. The problem is that there is no record that they noticed the spiral structure, even though it was immediately seen by Lord Rosse the next month. The solution presented here is based on evidentiary facts, highlighting the nineteenth century astronomical praxis. Focal points are bias, fantasy and a sometimes fatal conspiracy of eye and brain.

Keywords: Spiral structure, nebulae, star clusters, Lord Rosse, Birr Castle, Leviathan of Parsonstown, Whirlpool Nebula, nebular hypothesis, visual observation, drawings.

1 DISCOVERY OF M51 AND JOHN HERSCHEL'S 'RING NEBULA'

M51 (NGC 5194) is a nearby Sbc-galaxy with a visual magnitude 8.4 and a size of 11.2′ × 6.9′. It was discovered on 13 October 1773 by Charles Messier (1730–1817) with a 3.5-inch refractor at Paris. The description, published in his famous catalogue of 1781, reads: "… very faint nebula without stars …" (Messier, 1781: 247).[1] The next to observe the object was Johann Elert Bode (1747–1826), using a 3-inch refractor in Berlin. On 5 January 1774 he saw a "… small faint luminous nebula, possibly of an oblong shape …" (Bode, 1782) and made the first sketch (Figure 1) of this object. The peculiar companion, NGC 5195 (9.6 mag, 5.9′ × 4.6′), was found on 31 March 1781 by Pierre Méchain (1744–1804) with a 3-inch refractor. Then William and John Herschel took over at Slough, directing their large metal-mirror telescopes to the famous double nebula.

Figure 1: Bode's sketch of M51 (after Bode, 1782: Figure 15).

William Herschel (1738–1822) observed M51 four times with three different reflectors (Bennett, 1976): on 17 September 1783 with a 6.2 inch, on 20 September 1783 with a 12 inch (Herschel, 1785), and on 12 May 1787 and 29 April 1788, on both occasions with an 18.7 inch (see Dreyer, 1912: 657). In 1787 he independently found NGC 5195, listing it as I 186 in his first catalogue of nebulae and star clusters (Herschel, 1786). During his 1787 observation he noted: "Very bright, large; surrounded with a beautiful glory of milky nebulosity with here and there small interruptions that seem to throw the glory at a distance." Alas, he never observed M51 with his 48-inch reflector, completed in 1789—it might have shown the spiral structure.

There are also six observations by William Herschel's son John (1792–1871), on 17 & 20 March 1828, 26 & 27 April 1830, 13 May 1830 and 7 March 1831. schel, 1833). On 26 April 1830 the famous drawing was made (and checked the next night), showing the core, surrounded by a divided ring (Figure 2); it appears as Figure 25 in the Slough catalogue. Herschel

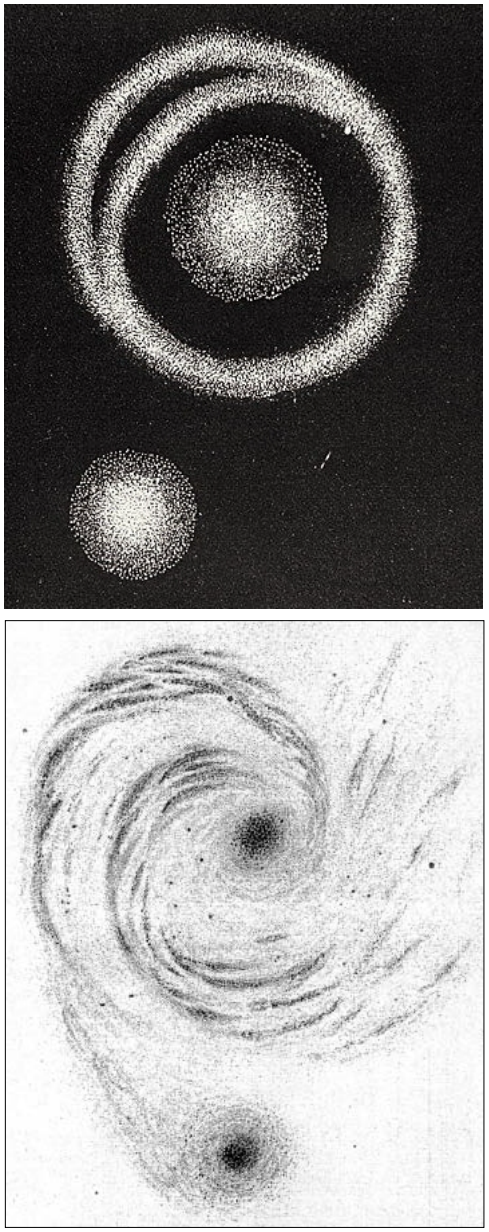

Figure 2: John Herschel's drawing of M51 (top, after Herschel, 1833: Figure 25) compared (bottom) with Lord Rosse's drawing (after Nichol, 1846; rotated, mirror-reversed and inverted).

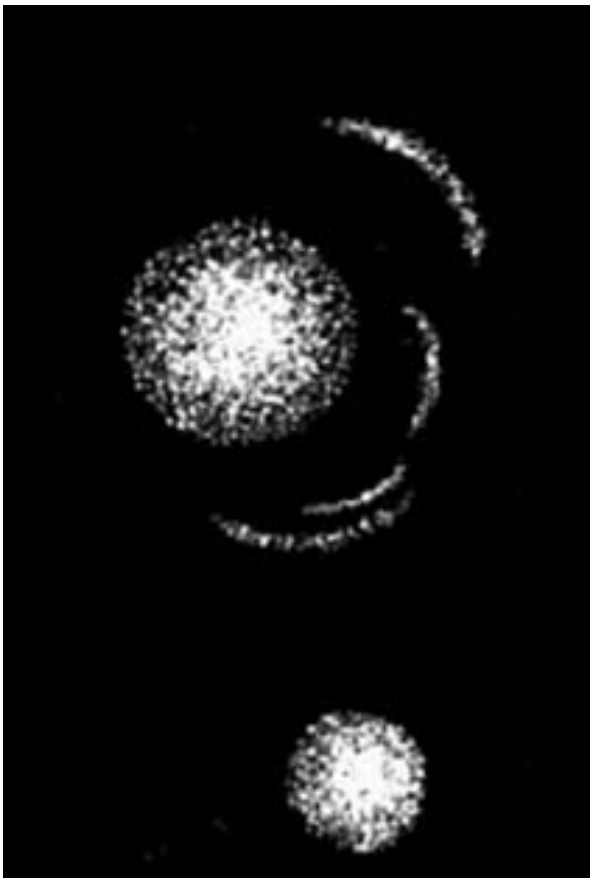

Figure 3: Smyth's sketch of M51 (after Chambers 1891: 74, Figure 55).

noted in his observing journal: "It is a very bright nebula 1′ in diameter of a resolvable kind of light with a double ring or rather 1½ ring like an armillary sphere." (cited by Hoskin, 1987: 12). He further wrote: "Were it not for the subdivision of the ring, the most obvious analogy would be that of the system of Saturn, and the ideas of Laplace respecting the formation of that system would be powerfully re-called for that object." (Herschel, 1833: 497). Here Herschel refers to the 'nebular hypothesis', which will be discussed later. Because the reflector was used as 'front-view' (the eye-piece pointing directly at the main mirror), the image is reversed. A comparison with Lord Rosse's drawing shows that the division correlates with the most prominent spiral arms. In 1836 William Henry Smyth (1788–1865) observed M51 with his 5.9-inch refractor. His sketch (Figure 3) and description ("… bright centre surrounded with luminosity, resembling the ghost of Saturn …") look like a copy of John Herschel's result (Smyth, 1844: 302).

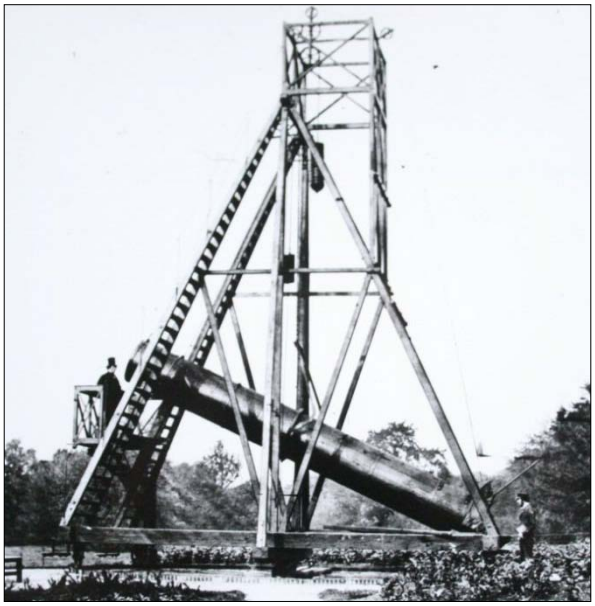

Figure 4: The 36-inch reflector (courtesy: Birr Castle Archive).

2 EARLY OBSERVATIONS OF NEBULAE AT BIRR CASTLE

Birr Castle, located near Birr (formerly Parsonstown) in the centre of Ireland, was actually not a good site for astronomical observation, as too often the weather was bad. But it was the ancestral seat of William Parsons, the 3rd Earl of Rosse, better known as Lord Rosse (1800–1867), and it was there that he had built his giant, metal-mirrored telescopes (Woods, 1844). With the azimuthally mounted 36-inch Newtonian of 1839 (Figure 4) M51 was "… repeatedly observed …" (Parsons, 1850: 510). The first documented observation dates from 18 September 1843. Using a magnification of 320×, Lord Rosse reported: "… a great number of stars clearly visible in it, still Herschel's ring not apparent, at least no such uniformity as he represents in his drawing." (ibid.). About fifty observations of M51 were made until 1878 (Parsons, 1880). On 11 April 1844 Lord Rosse wrote: "… two friends assisting both saw centre clearly resolved." (Parsons, 1850: 510). The two friends were the Director of the Armagh Observatory, the Reverend Thomas Romney Robinson (1792–1867) and the noted English double star observer, Sir James South (1785–1867), both of whom were frequent visitors to Birr Castle. The focus was on 'resolvability', and Robinson in particular was convinced that true nebulosity did not exist and that all nebulae were merely star clusters. However, there were intractable targets, like the Orion Nebula (M42). Thus proof was purely a matter of aperture, and Lord Rosse had built the required instruments.

His largest was the 'Leviathan of Parsonstown' (Figure 5), a 72-inch Newtonian on a meridian mounting (Hoskin, 2002). However, it was not a true transit instrument in that the tube could be shifted horizontally (i.e. in azimuth) around the south direction. The total linear range was about 7.8 feet. By turning a handle near the eye-piece (Newtonian focus) the tube moved along a cross-bar with a cogwheel. So an object could be tracked for a certain time. The azimuthal range—and thereby the maximum observing time—depended on its altitude when crossing the meridian. Objects near the celestial equator were observable for about 45 minutes from the front platform. Towards the zenith, the time increased and reached about 70 minutes at 85°. Now one stood on the highest (fourth) gallery, nearly 60 feet above the ground, as the gallery followed the motion of the telescope tube (see Figure 6).

In September 1844 the great reflector was ready for a test and it showed the globular cluster M2 in Aquarius. However, official 'first light' only was on 11 February 1845, and was witnessed by Robinson and South. On this occasion, Lord Rosse and his guests only saw Sirius and "… some nameless clusters." (Hoskin, 2002: 64) before bad weather terminated all

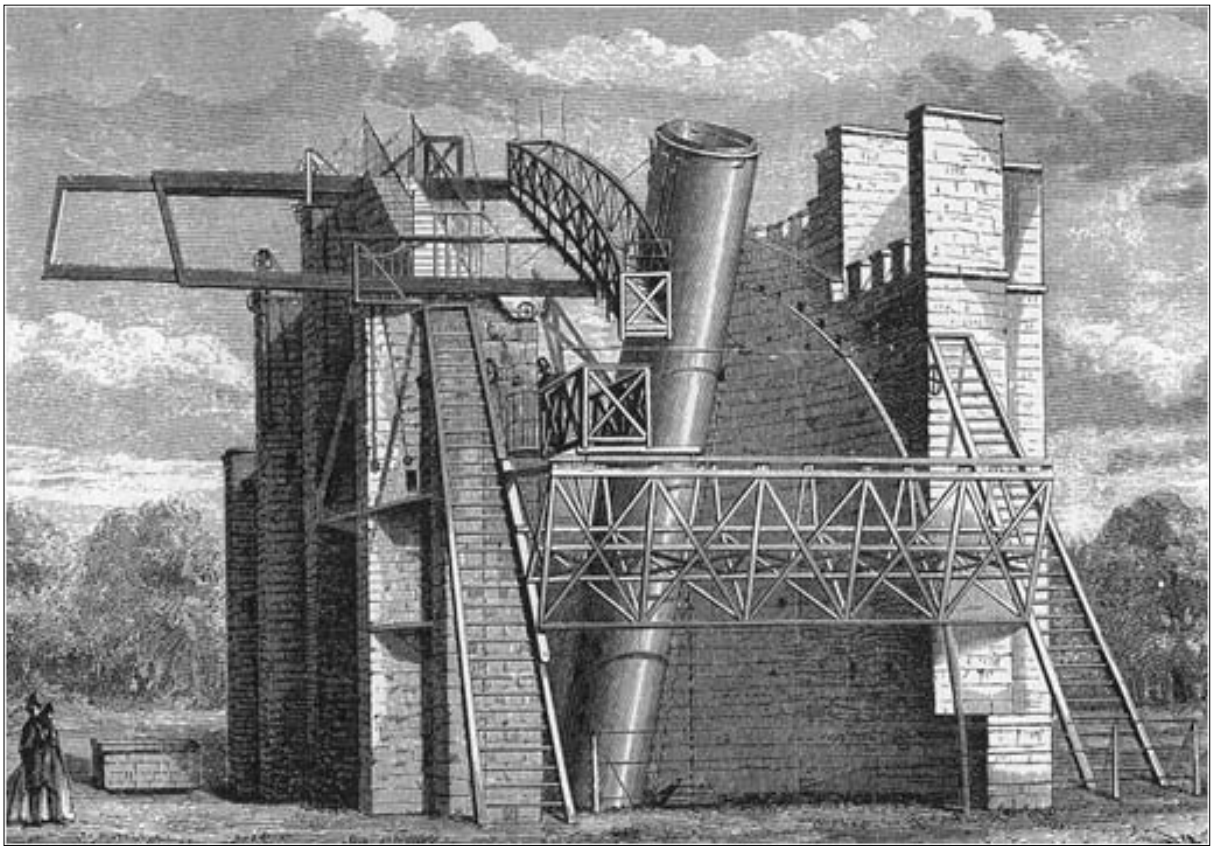

Figure 5: The 'Leviathan of Parsonstown' (courtesy: Birr Castle Archive).

astronomical activity (and did not improve until early March). The three astronomers were disappointed as their key target, the Orion Nebula, was missed and its resolvability was not tested. However, the period from 4 to 13 March 1845 was very clear and stable (New Moon was on the 8th), but at lower than –8° C the nights were unusually cold for Ireland.

There are two independent observational reports by Robinson and South—but there is none by Lord Rosse! On 14 April Robinson gave a talk to the Royal Irish Academy in Dublin, which was printed in their *Proceedings* later that year. There he explained that "… most of the lucid interval from the 4th to the 13th of March was devoted to nebulae." (Robinson, 1845: 125). Moreover, in his observing journal he enthusiastically noted: "… of the 43 nebulae which have been examined *All* have been resolved" (Hoskin, 1990: 339; my italics). South preferred a quicker line of communication: the *London Times*. On 16 April he reported an exceptional event:

> … the night of the 5th [to the 6th] of March was, I think, one of the finest I ever saw in Ireland. Many nebulae were observed by Lord Rosse, Dr. Robinson and myself. Most of them were, for the first time since their creation, seen by us as groups or clusters of stars; whilst some, at least to my eyes, showed no such resolution. (South, 1845).

Concerning the crucial subject of 'resolvability', South sounded more moderate than Robinson. It should also be mentioned that Robinson's statement about "… 43 nebulae …" is a little confusing, because only 39 objects are mentioned in his list (Robinson, 1845: footnote on p. 127). In 1848 he even speaks of "… above fifty nebulae selected from Sir John Herschel's catalogue." (Robinson, 1848: 119).

Figure 6: The 72-inch in a near-zenith position. The cross-bar for the azimuthal motion is at the upper third of the 60-foot (18-m) tube; the highest gallery is on top of the western wall (photograph by the author).

3 M51: DIFFERENT VIEWS IN MARCH AND APRIL 1845

The exceptional night from the 5th to the 6th of March also brought the first observation of Herschel's 'ring nebula', M51, with the new reflector. Could the resolution of the core be confirmed, and would the ring appear now? Robinson's (1845: 128f) record on the observation made about 3 a.m. on 6 March sounds positive:

> … the central nebula is a globe of large stars; as indeed had been previously discovered with the three-feet telescope: but it is also seen with 560 that the exterior stars, instead of being uniformly distributed as in the preceding instances, are condensed into a ring, although many are also spread over its interior. (Robinson, 1845: 128f).

Though there is no lead on the division of the ring, it was now seen as an aggregation of stars. South (1845) gives a similar opinion:

> The most popularly known nebulae observed this night were the ring nebulae in the Canes Venatici, or the 51st of Messier's catalogue, which was resolved into stars with a magnifying power of 548 [560]; and the 94th of Messier, which is in the same constellation, and which was resolved into a large globular cluster of stars, not much unlike the well-known cluster in Hercules, called also 13th Messier.

It is interesting that M94 was seen as a 'ring nebula' too. Actually, the prominent inner spiral arm of the Sa-galaxy is closed. Robinson (1845: 128) described it as "… a vast circular cluster of stars, with ragged filaments, in which, and apparently central, is a globular group of much larger stars." Concerning M51, the essential point is that both observers mention only known features: the resolved centre and the ring. There is absolutely no word about spiral structure!

This discovery was made a month later—by Lord Rosse alone. Unfortunately, the exact date is not recorded. In 1850 Lord Rosse wrote: "The spiral arrangement of Messier 51 was detected in the spring 1845." (Parsons, 1850: 505), and John Louis Emil Dreyer (1852–1926), Robinson's successor at Armagh Observatory and author of the *New General Catalogue* (Steinicke, 2010), is barely more precise. During his appointment at Birr Castle (1874-1878) he edited all of the earlier observing notes for a publication, which appeared in 1880. There one reads:

> 1845, Apr. During this month M. 51 was for the first time examined with the 6 foot and its spiral character immediately noticed, but no record is left of these early observations. (Parsons, 1880: 127).

However, local conditions limit the date (unfortunately, there are no weather reports). From the culmination time of M51 and the phase of the Moon the interval between 1 and 12 April is most likely. On the 1st the nebula crossed the meridian at 1:19 a.m. and the Moon rose at 3:28 a.m. (one day after Last Quarter), while on the 12th the transit was already at 0:35 a.m., and moonset was 2 minutes earlier (two days before First Quarter). Thus the most probable date is 6 April (New Moon), when M51 culminated at 0:58 a.m., 85° above the horizon.

4 THE M51 MYSTERY

The crucial question is: Why was the spiral structure not discovered back in March 1845? In 2005 Mark Bailey, John Butler and John McFarland of Armagh Observatory tried to give an answer (Bailey et al., 2005). However, their conclusion is not really helpful: "It seems likely that Rosse, Robinson and South could have seen the spiral arrangement […] though there is no evidence that they noticed it." The main argument: "With their attention focused on the resolvability of the nebula, it is conceivable that none of the three would have found the spiral arrangement worthy of note."

Another question arises: was Lord Rosse even present when M51 was examined in March? South (1845; my italics) wrote: "Many nebulae were observed by *Lord Rosse*, Dr. Robinson and myself." But this sounds rather vague, and in Robinson's Royal Irish Academy talk he is not even mentioned: "Dr. R[obinson] and his friend Sir James South were invited to enjoy the trial of it [the reflector]." (Robinson, 1845: 119). One further reads that the nebulae "… were examined by Dr. Robinson and also by Sir James South." (Robinson, 1845: 127). Undoubtedly, Lord Rosse wanted to test the power of his new reflector on the clear nights. But he also had many official duties and thus needed his sleep. Robert Ball, Lord Rosse's last assistant, later wrote:

> … it was more the mechanical processes incidental to the making of the telescope which engaged his interest than the actual observations with the telescope when it was completed … [and his] special interest in the great telescope ceased when the last nail had been driven into it. (Ball, 1895: 287).

From Robinson's object list it follows that the earliest observation started about 9:45 p.m. (h 536 = NGC 2695 in Hydra) and the latest ended about 5:30 a.m. (h 1929 = NGC 5964 in Serpens); on the latter nebula Robinson (1845: 127) remarked that it was seen "… during twilight." Probably Lord Rosse had left the telescope to his guests, particularly during the second half of the night, and his sporadic attendance may have been the reason that he did not write a report. Regarding the M51 observation at about 3 a.m., it most likely took place without him. This is further supported by Dreyer's note on Lord Rosse's observation in April (mentioned above): "During this month M. 51 was for the first time examined with the 6 foot." The term "… for the first time …" indicates that he had not observed this object previously.

Assuming that Robinson and South actually discovered the spiral structure of M51 on that night back in March why didn't they report it especially since both were egoists and used every opportunity to increase their fame. Of course, such spectacular news would have been communicated immediately! Thus we have two possible explanations: either the structure was not perceived, or there were reasons for keeping the detection secret. As the latter option seems strange at the moment, we concentrate on the former. Then one must answer the question, Why was the structure "… immediately noticed …" by Lord Rosse in April? What were the differences between the two observations?

First, influencing factors like weather and telescope should be investigated. It seems unlikely that the sky was better in early April than during the "… lucid interval …" in March. Concerning the telescope, the most critical element was the speculum mirror which was made from an alloy of copper and tin. Due to chemical processes the reflectivity of the surface steadily decreased (i.e. the mirror tarnished), but on 3

March the mirror had been freshly polished and according to Lord Rosse it was still in good shape in April:

> In the early observations [1845] with the 6-feet telescope we had the advantage of a very fine speculum … there were also at that time several very good nights and many nebulae were resolved. Very soon after, the spiral arrangement was detected. (Parsons, 1861: 703).

The result: in comparison with March, weather and mirror were (at best) of equal quality in April—which only makes matters worse!

Did the eye-pieces play a role? Because the telescope had no finder, the object-search was effected with a three-lens eye-piece of 46 mm focal length, yielding a magnification of 360× and a 13.7′ field of view. For the very observation one changed to the standard eye-piece of 29 mm (power 560×, field 8′). Finally, to inspect details, often a 13 mm single-lens eye-piece was used. At a power of 1280× the tiny field of 3′ only showed the central region of M51 (see Figure 7). No doubt, the same eye-pieces were used in March and April, but perhaps there was a difference in their application, which will be discussed later. After considering all of these external factors, it remains a mystery as to why the spiral structure of M51 was overlooked in March.

After Bailey, Butler and McFarland (2005), the case was next treated by the American astronomer Trevor Weekes (2010). He presents no definite solution, but does offer five possible explanations: (1) "The unusual structure of the nebula M.51 was not noticed in March 1845, because the attention of the [three] observers was concentrated on the question of its resolvability." This matches the main argument of Bailey, Butler and McFarland. (2) "The observing conditions were inferior in March 1845, in which case the spiral structure of M.51 was not so obvious as it was in April." This seems unlikely as explained above. (3) "There were too many observers in March (including nonprofessional visitors) so that it was difficult for one observer to really concentrate on what he was seeing." However, I am convinced that only Robinson and South were present during the crucial observation. (4) "The three astronomers noticed the spiral structure of M.51 in March 1845 and realized its importance, but Robinson and South left it to their host [Lord Rosse] to verify the following month, so that the discovery would be his alone." This does not agree with the personalities of the three people. For instance, Lord Rosse would have authorized his guests to communicate such a discovery, if he was not able to do so himself. (5) "The spiral structure of M.51 only became convincing when its image was systematically examined and committed to paper." This disagrees with Lord Rosse's statement that the "… 6-feet aperture so strikingly brings out the characteristic features of 51 Messier." (Parsons, 1850: 504).

No doubt, there must be a plausible solution to the mystery. In the following section I will present my own hypothesis. It is based on factors which were not taken into account in the two former papers.

5 A LIKELY SOLUTION

I have come to the conclusion that it was a matter of psychology, and my investigation focused on internal factors: ideology and stress. At Birr Castle an ambitious observing program was executed which aimed to disprove the popular 'nebular hypothesis'. Following Pierre-Simone de Laplace (1729–1827), William Herschel and John Pringle Nichol (1804–1859), Director of the Glasgow Observatory, this hypothesis claimed the existence of true nebulosity in space. By gravity such a 'luminous fluid' rotated, and due to friction it lost speed, gradually contracting to form a central star. First this idea described the formation of the Solar System (and particularly of Saturn), but later it was applied to nebulae, stars, clusters and even our own galaxy. A key object was the bright planetary nebula NGC 1514 in Taurus, William Herschel's (1791) "… star with an atmosphere."

Robinson was an uncompromising opponent of the nebular hypothesis. The Reverend, representative of the Church of Ireland, headed the fight against 'materialists' like the Scot Nichol (Bennett, 1990). In his static system of the world, God had created the stars, and there was no room for nebulous matter and evolution. To prove his view, as many nebulae as possible had to be resolved. Robinson—user of a 15-inch

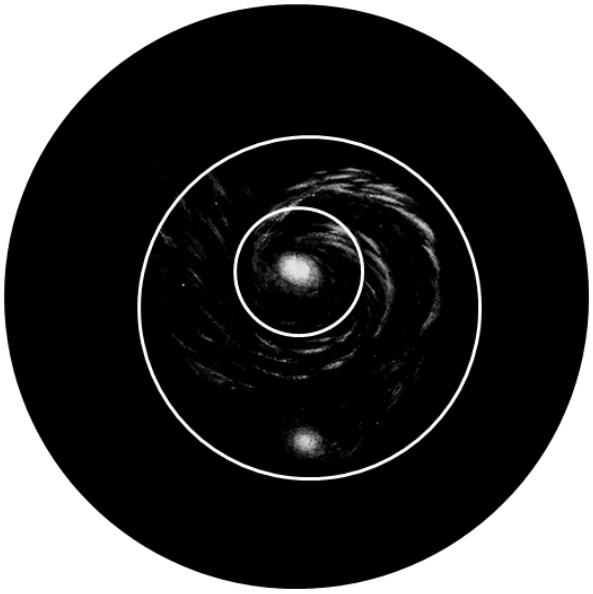

Figure 7: Fields of view of the applied eye-pieces: 13.7′ (finding), 8′ (standard) and 3′ (high-power); (diagram by the author; M51 sketch from Nichol, 1846, rotated).

telescope with metal mirror at Armagh—pushed Lord Rosse to build ever larger instruments. After having applied the 36-inch against the hated idea and its secular advocates, the twice as large 'Leviathan' became his ultimate weapon. He had to accomplish a mission, thus instruments, methods or persons must take a subordinate role. Lord Rosse and South gave him his head and forewent independent observations. Influenced by Robinson, they both confirmed the 'resolvability' of many nebulae, including curious cases like M1 or M97, and even the Orion Nebula (M42) was added in the spring of 1846 (Hoskin, 1990: 339). However, their views were more moderate, and both tried to temper the enthusiasm of the Irish 'chief-ideologist'.

No doubt, Robinson (1845) controlled the observing sessions. He compiled the target list from John Her-

schel's Slough catalogue, arranged the nightly observing program, selected the eye-pieces, and was the primary observer. Especially in the early days after the 'Leviathan' became operational, the Armagh astronomer was under great pressure. Being familiar with the inclement Irish weather, the unusually clear skies experienced in March 1845 made him hurry. Fully programmed for success, he wanted to get the desired results as soon as possible. Thus a maximum number of nebulae had to be resolved with the new reflector.

We now focus on the night from 5th to 6th March, three days before New Moon. Near-zenith objects like M51 were on the agenda. Thus, the highest observing gallery had to be used—a small, mobile and declivious construction, high above the ground (see Figure 6). Considering that Robinson and South had so little experience with the new telescope (it was only their second night using the instrument), this was a rather dangerous task. Robinson (1845: 122) even reported that making observations was "… rather startling to a person who finds himself suspended over a chasm sixty feet deep, without more than a speculative acquaintance with the properties of trussed beams."

To waste no time, the positioning of the telescope was exactly planned. According to South (1845), thanks to the aid of the technical helpers it took no more than eight minutes to get an object into the focus of the 72-inch. First, the long tube was lifted to the right elevation. Then it was shifted in azimuth to the eastern wall to catch the target as early as possible (when there was time enough). To read the relevant scales, there was a pretty bright illumination, which influenced the dark adaptation (Robinson, 1845: 122). After this procedure one expected the object to enter the eye-piece. Robinson (1848: 122) later reported: "In searching for known objects, there is, of course, occasional difficulty in finding them, from the small field of view." Once the object was visible, the tube had to follow it smoothly towards the west. This was not an easy task, as near the zenith a field diameter of 13.7′ was crossed in about 80 seconds (and with the high-power eye-piece the time was even less than 20 seconds). At the same time, the gallery also had to be moved. Moreover, any change of eye-pieces, or the replacement of an observer, used up further precious time.

According to South (1845), there was another target in Canes Venatici. This was M94, which at magnitude 8.2 was the brightest object in Robinson's list. It culminated at about 2:15 a.m. at 79°, and probably followed NGC 4025 (1:22 a.m., 75°) and NGC 4062 (1:28 a.m., 69°), both in Ursa Major, and NGC 4618, located only 1.7° west of M94 (2:05 a.m., 79°). Due to overlapping time slots, the maximum observing time of about one hour could never be used. Probably the complex procedure allowed only 15 minutes for the first observation of an object—which no doubt created a certain degree of stress. Therefore, after each successful 'resolution', the 72-inch was immediately set up for the next target. When eventually M51 was next (culminating about 2:54 a.m. at 85°), the observers had been exposed to the darkness and severe cold for many hours. Somewhat overcome by the exertion, their concentration had faded. The following scenario illustrates how the crucial observation could have happened.

Due to previously-discussed aspects (i.e. optimal weather and the fine condition of the mirror in March, and Lord Rosse's easy success in April), Robinson must have immediately perceived the spiral structure of M51 in the finding eye-piece, but he probably attributed the strange appearance to his weak level of concentration. As if this was not enough, his ideological conditioning forced him to dismiss the unwanted structure from his mind. He was unable to accept it, for as a sign of spinning (true) nebulosity it would confirm the nebular hypothesis. True to the motto "It can't be what shouldn't be", Robinson promptly concentrated on his mission: the resolution of this nebula. He changed to the standard eye-piece (power 560×), ignored any sign of spiral pattern, and instantly perceived Herschel's ring. Now his biased mind forced his eye to see flashing starlets all around. When he eventually applied the maximum power, the core appeared—as requested—like a 'globular cluster'. Lord Rosse later made the following illuminating point: "When certain phenomena can only be seen with great difficulty, the eye may imperceptibly be in some degree influenced by the mind." (Parsons, 1850: 503f).

It may sound harsh, but even a willful deception is thinkable. In this case, Robinson may have kept the truth to himself and prevented South from viewing M51 as a whole—otherwise this experienced British observer immediately would have detected the spiral pattern. The true nature of M51 had to be hidden, because Robinson's authority was at stake! With the argument of advancing time, the maximum magnification was retained and the view kept on the central 'globular cluster'. Obviously South accepted Robinson's procedure and, moreover, the 'resolved' centre met his experience—there was no reason for doubt. Then soon after this the observing session ended. Of course, Lord Rosse was informed the next day (for if he had also been involved that night, it might not have been so easy for Robinson to fool him too).

This also explains the lack of publication, mentioned above: obviously South did not notice anything out of the ordinary, and Robinson would report all but this heretical experience! Instead he proudly heralded to the Royal Irish Academy that Lord Rosse's giant reflector had served its purpose and that the intensive observations in March disproved the nebular hypothesis:

> … no REAL nebula seemed to exist among so many of these objects chosen without bias; all appeared to be clusters of stars, and every additional one which shall be resolved will be an additional argument against the existence of such. (Robinson, 1845: 130).

After the stress-filled days in March, Lord Rosse had gained sufficient experience with the 72-inch. In April the skies cleared up again and, at last, he could act freely and unhurriedly. The guests had left Birr Castle and there were no more ideological constraints. Although he always had little free time, he may have been motivated by the successful observations made by Robinson and South. It was probably on 6 April that Lord Rosse observed M51 "… for the first time." The meridian passage was about 0:52 a.m. at 85°. Obviously, the object was the only one observed that night and Lord Rosse was able to use the maximum observing time of 72 minutes. All decisions were in his hands, and his mind was open to new experiences.

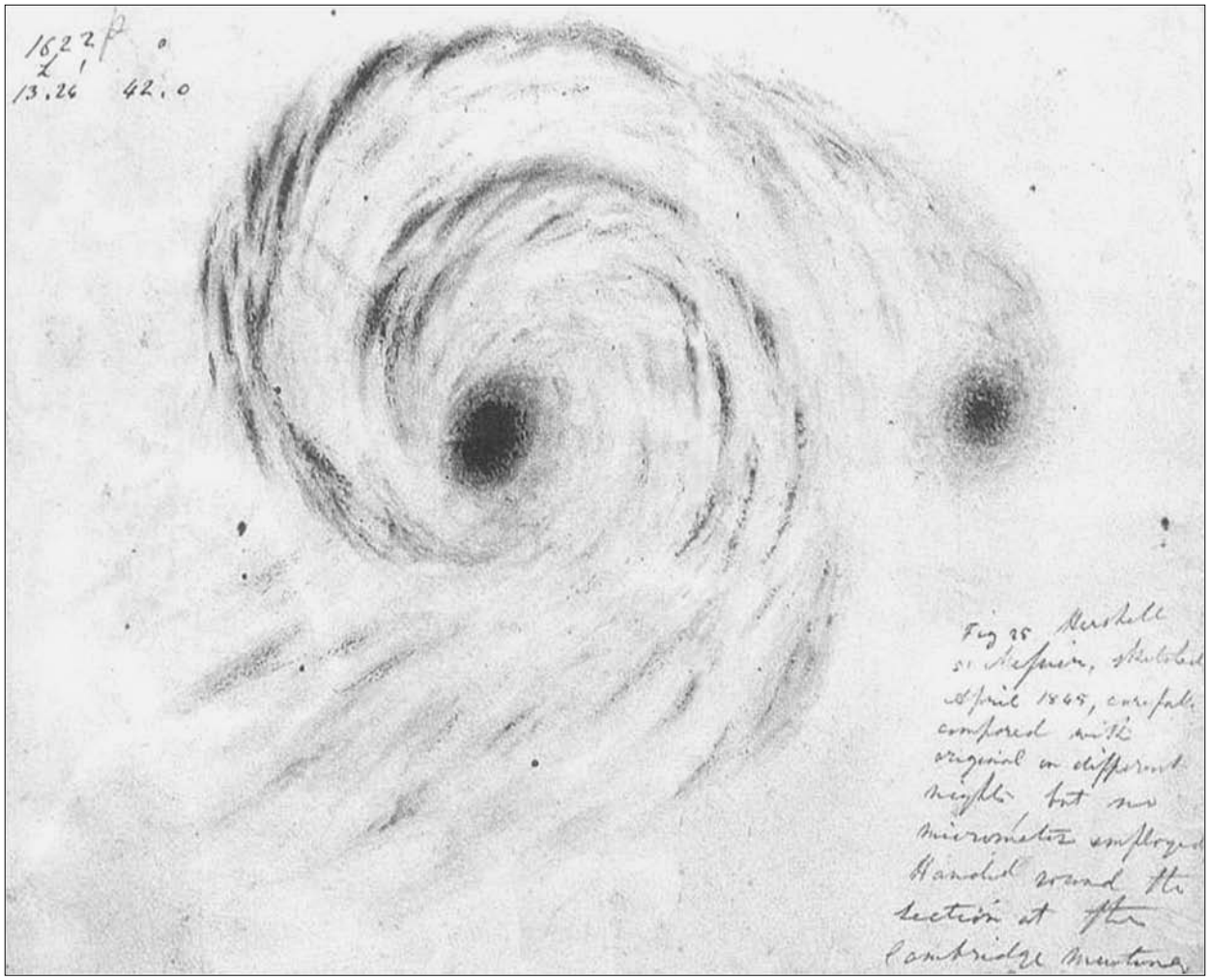

Figure 8: Lord Rosse's first drawing of M51, made in April 1845 (after Hoskin, 1982).

In this context success was inevitable and Lord Rosse immediately saw the spiral structure when he looked through the finding eye-piece! Afterwards he used higher powers to study the new pattern in detail. He also may have been astonished that Robinson, the primary observer in March, had not recognized it. Perhaps here was some doubt about his sincerity. Lord Rosse was a scientist to the core. His moral character did not allow repressing the perceived structure or even hiding it. Ideological blinkers and willful blindness were alien to him. Obviously, South and Robinson were not informed directly (a willful act?), as both filed their reports in the middle of April.

6 LORD ROSSE'S FIRST DRAWING OF M51 AND THE SEARCH FOR SPIRAL NEBULAE

Of course, the important discovery had to be depicted, and so a drawing was developed (Figure 8) in the nights between 6 and 12 April 1845. Lord Rosse presented it on 19 June during his talk "On the nebula 25 Herschel, or 61 of Messier's catalogue", given at the 15th Annual Meeting of the British Association for the Advancement of Science in Cambridge (Hoskin, 1982). The term "25 Herschel" refers to Figure 25 from the Slough catalogue, while "61" is a typo (it should be "51"). The text on the drawing reads:

> Fig 25 Herschell [Herschel] 51 Messier, sketched April 1845, carefully compared with original on different nights, but no micrometer employed. Handed round the section at the Cambridge meeting.

Figure 9: Rambaut's M51 drawing of March 1848 (courtesy: Armagh Observatory; photograph by the author).

At the upper left corner we have "1622" (h 1622) and "13 . 26 42 . 0" (i.e. the right ascension is 13h 26m and the North Pole Distance 42° 0′). Ironically it was Robinson's nemesis, Nichol, who was the first to publish the drawing, in his book *Thoughts on Some Important Points Relating to the System of the World* (1846).

According to Lord Rosse, many visitors to Birr Castle benefited from this illustration: "… this nebula has been seen by a great many visitors, and its general resemblance to the sketch at once recognised even by unpractised eyes." (Parsons, 1850: 504). Moreover, he encouraged other astronomers:

> A 6-feet aperture so strikingly brings out the characteristic features of 51 Messier, that I think considerably less power would suffice, on a very fine night, to bring out the principal convolutions.

Indeed, the spiral pattern was later confirmed with much smaller apertures.

In March 1848 two further drawings of M51 were made at Birr Castle. We owe the earlier one to William Rambaut (1822–1911), Lord Rosse's first scientific assistant (Figure 9). The other one, Lord Rosse's second drawing, was published in 1850 and became the standard image of a spiral nebula (Figure 10; see Parsons, 1850: Fig. 1). Another drawing was finished on 6 May 1864 by Lord Rosse's last assistant, Samuel Hunter (Parsons, 1880: Plate IV, Fig. 1). It is interesting that the companion NGC 5195 is shown here as a 'spiral' (Figure 11). Altogether five drawings of M51 were made at Birr Castle, and these were complemented by many sketches that are in the observing journals.

The discovery of the spiral structure of M51 changed the research at Birr Castle:

> … after the spiral form of arrangement was detected … our attention was then directed to the form of the nebulae, the question of resolvability being a secondary object. (Parsons, 1861: 703).

That is, the focus was no longer on the nebular hypothesis. Gradually, doubts appeared that all nebulae were disguised star clusters. However, Lord Rosse did not generally question his own observations (e.g. the 'resolution' of M42), but he was open to new ideas if they looked physically reasonable.

The systematic search for spiral nebulae started at Birr Castle in 1848, soon after the disastrous Irish potato famine ended (during which the 72-inch was mainly idle). By 1861 no fewer than 76 cases had been documented, 67 of which were true spiral galaxies—an amazingly large fraction (Parsons, 1861). Strangely, among them were eleven objects which had been observed by Robinson and South. Two striking cases were NGC 2903 (h 604; Figure 12) and M65 (h 854) in Leo, and their spiral structures were detected by Lord Rosse on 24 March 1846 and 31 March 1848, respectively (Parsons, 1850: 511f and Figs. 3 and 7). Like M51, these should have been recognized as spiral galaxies in March 1845—raising the likelihood of two further 'Robinson cases'.

The nine non-spiral objects belonged to five (modern) classes: the planetary nebulae NGC 1514, NGC 6781, NGC 6905 and NGC 7662; the elliptical galaxies NGC 205 and NGC 5557; the irregular galaxy NGC 4485; the reflection nebula M78; and the globular cluster M12. For instance, NGC 1514 (h 311) in Taurus—William Herschel's key object—was described by R.J. Mitchell as a "… new spiral of an annular form." (Figure 13; Parsons, 1861: 714 and Plate 25, Figure 7).

Later Wilhelm Tempel (1821–1889), Director of the Arcetri Observatory in Florence, suggested that the Birr Castle observers showed a certain "… spiral addiction". He judged the spiral pattern to be an illusion:

> … one cannot fend off the thought that these forms and shapes are only figments of the imagination, even that their description and drawing can be recognised as an endeavour to assign this form to all nebulae. (Steinicke, 2010: Section 11.3.4).

This statement caused an open conflict with Dreyer in 1878, which Tempel eventually lost. Curiously, his own drawing shows indications of spiral arms (Figure 14).

7 THE EFFECT ON THE NEBULAR HYPOTHESIS AND THE SUBJECTIVITY OF VISUAL OBSERVING

The discovery of spiral nebulae lent credence to the nebular hypothesis. Nichol felt vindicated, as expressed in his books, *Thoughts on Some Important Points Relating to the System of the World* (1846) and *Architecture of the Heavens* (1851). These objects were testimonies of star formation from nebulous matter.

Of course, Robinson could not turn a blind eye to reality. Already on 11 March 1848—at the first M51 observation after Lord Rosse's—he confirmed the spiral structure with the 72-inch (although a check observation with the 36-inch was negative). This may sound odd when we have already suggested that Robinson actually detected spiral structure himself back in March 1845, but we must consider the authority of Lord Rosse which Robinson never questioned. Robinson could hardly question Lord Rosse and ignore (or even deny) the clear evidence of spiral structure yet again. Interestingly, Robinson did not change his ideology, thanks to a rather clever reinterpretation of the observational results. He postulated a rotating ensemble of cosmic "… bodies floating on a whirlpool …" (Robinson, 1848: 128) composed of stars! To him, the reality of nebulous matter was still denied.

From the modern point of view, we must confess that there are true elements in both ideas. The spiral arms host stars as well as 'nebulous matter' (gas and dust). But, according to the present density wave theory, the arms themselves are not truly rotating. Furthermore, matter does not end up gravitating to the centre (like in a whirlpool), where, according to the nebular hypothesis, a star should be born.

Today M51 is often called the 'Whirlpool Nebula'. As Tobin (2008) has shown, the term 'whirlpool' already appeared in the literature in 1833, in connection with the nebular hypothesis. Until 1847 it was only used to characterize a phenomenon rather than a real object. The first to call M51 the 'Whirlpool Nebula' was the American astronomer Ormsby Mitchel (1810?–1862). In 1847 he published a paper titled "Lord Rosse's Whirlpool Nebula" which included a copy of Lord Rosse's drawing that Nichol had published one year earlier (Mitchel, 1847). Nowadays it seems rather curious that gaseous nebulae like M42 or galaxies like M51 should be 'resolvable'.

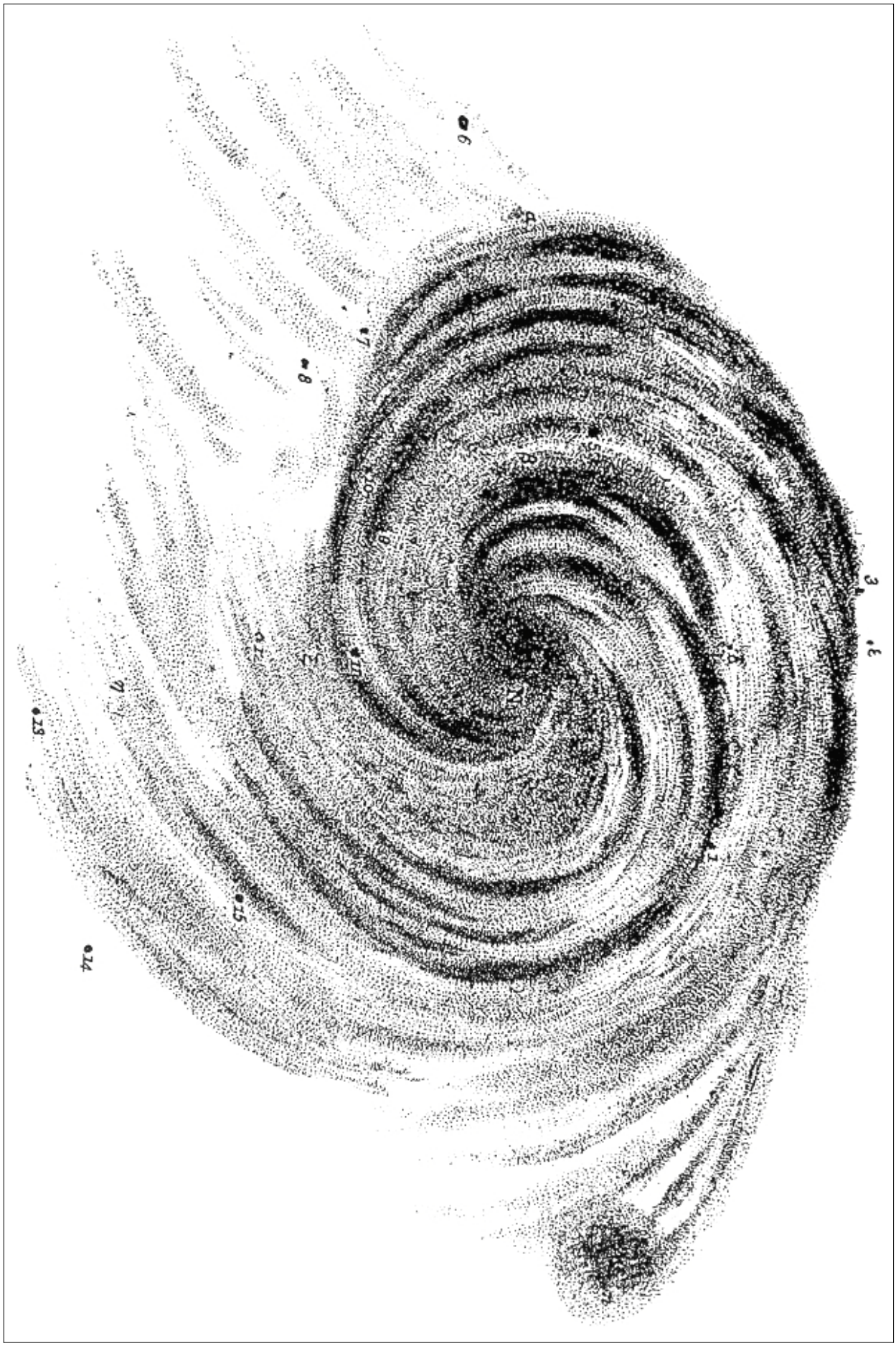

Figure 10: Lord Rosse's second drawing of M51, finished on 31 March 1848 (after Parsons, 1850: Figure 1).

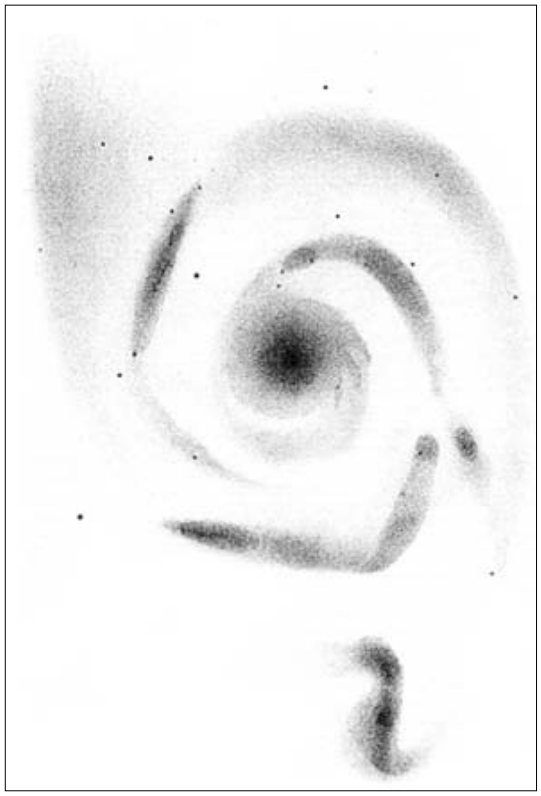

Figure 11: Hunter's drawing of M51, finished on 6 May 1864 (after Parsons, 1880: Plate IV).

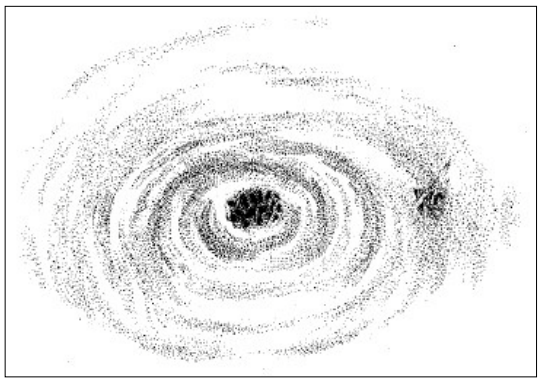

Figure 12: The spiral galaxy NGC 2903 in Leo, drawn by Lord Rosse on 5 March 1848 (after Parsons, 1850: Figure 3). The knot in the spiral arm is the conspicuous HII region NGC 2905, discovered by William Herschel in 1784.

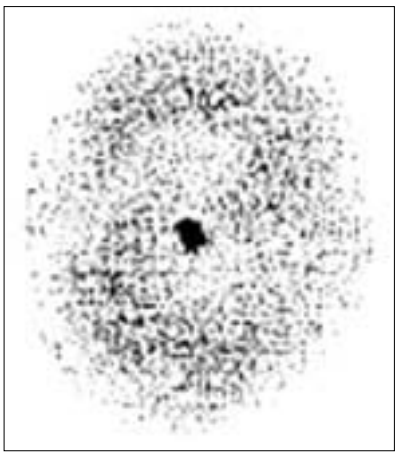

Figure 13: The 'annular spiral nebula' NGC 1514 in Taurus, sketched by R.J. Mitchell on 9 January 1858 (after Parsons, 1861: Plate 25, Figure 7).

No doubt, the nineteenth century observers entertained an illusion. Actually, all objects investigated by Robinson and South were extragalactic, but even the 'Leviathan' was unable to resolve these remote stellar systems into single stars! It is possible that the mirror caused the phenomenon. Its metal surface, polished by a machine and less homogeneous than a modern aluminium-coated glass, pyrex or ceramic mirror, could generate a mottled structure when extended nebulous objects are imaged. Moreover, it is strange that some galactic objects—such as planetary nebula—were seen as 'spirals'.

Any explanation of such illusions should consider the subjectivity of visual observing. In the early nineteenth century there were no objective images and the physical nature of the nebulae was still unknown. When an object was observed unbiased (e.g. for the first time), a description or drawing could strongly deviate from reality. False images easily appeared, especially when the observer was gazing at a faint nebula for a long time with high magnification and a small field of view. On the other hand, known structures were perceived much more easily than unknown ones. But sometimes this led to a curious effect, where one 'saw' the wanted structures, even though they actually were out of reach (i.e. beyond the telescope's power). Facing the often-strange conspiracy of eye and brain, a large portion of self-criticism was needed. Robinson's observation of 1845 should be a warning to others!

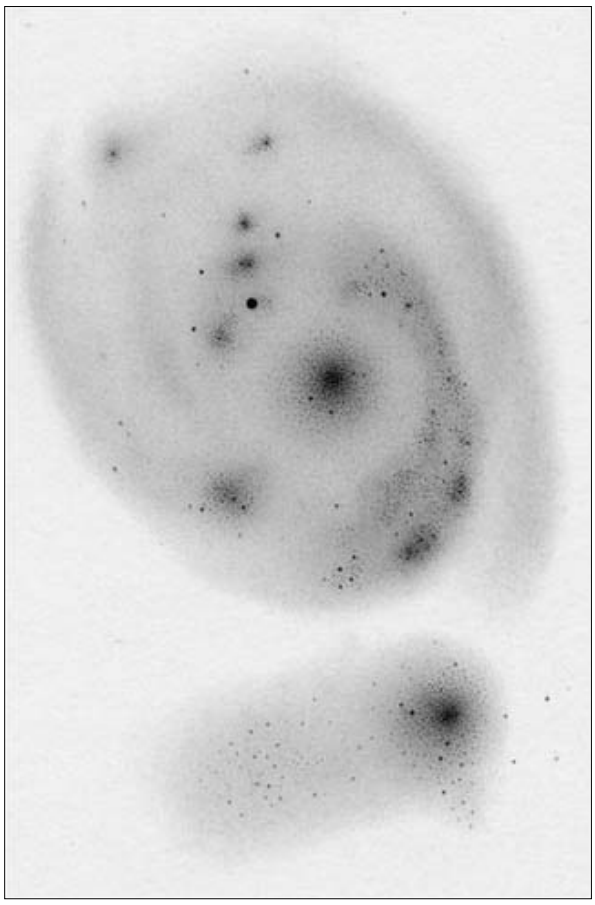

Figure 14: Tempel's drawing of M51, made about 1877 with an 11-inch refractor (courtesy: Arcetri Observatory).

8 NOTES

1. All English translations in this paper from French and German sources are by the author.

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