Unwinding the discovery of spiral nebulae

M E Bailey, C J Butler and J McFarland take a close look at the earliest observations of spiral nebulae, made with the Leviathan of Parsonstown in the 1840s.

ABSTRACT

Evidence for spiral structure in distant galaxies was first noticed by William Parsons, the Third Earl of Rosse, in April 1845 within a few months of the first trial of his great six-foot reflector the "Leviathan of Parsonstown" on 11 February 1845. Despite the significance of this discovery there are puzzling inconsistencies in the story, and the discovery date – sometime in April – is curiously vague. Here we review the chronology of observations of the two principal players in the story: Messier 51 and Messier 99. The former was identified by Lord Rosse as having a spiral arrangement in the spring of 1845, and the latter "the following spring". The Revd Thomas Romney Robinson, the third Director of the Armagh Observatory, was observing with Lord Rosse during February and March 1845, and again in 1848, but he apparently only confirmed Rosse's detection of spirality in both galaxies around 11 March 1848. No-one doubted Lord Rosse's discovery of spirality in M51 (and the following year also in M99), but it was almost three years before the observation was confirmed by another astronomer.

1: M51, the Whirlpool galaxy, in detail in this Hubble Space Telescope image, which shows the spiral arms and dust clouds, which are the birth sites of massive and luminous stars, picked out in red. (NASA and the Hubble Heritage team, StScI/AURA; N Scoville, Caltech and T Rector, NOAO)

Hoskin (1982, 1990, 2002), Dewhirst and Hoskin (1991) and Chapman (1989, 1993) have reviewed the period leading up to the first observations of nebulae with the Earl of Rosse's great six-foot reflector at Birr. Following casting of the mirror in 1842, Dr Thomas Romney Robinson and Sir James South arrived at Birr Castle in February 1845 in order to enjoy the first views through the new instrument.

Robinson's primary concern was whether nebulae could be "resolved" into stars, and by inference whether all such nebulae could be interpreted as immensely distant stellar systems. Another view was that nebulae were simply clouds of luminous gas, or perhaps a combination of stars and gas. At this time the question was central to contemporary discussions of cosmogony (Herschel 1846, Nichol 1846). The principal target was the Orion Nebula; but Robinson had also drawn up a list of some 40 nebulae from Sir John Herschel's catalogue (Herschel 1833) that, according to brightness or other peculiarity, seemed deserving of notice (Robinson 1845).

First observations

First light was on 11 February 1845. However, the sky was hazy and the Orion Nebula (Messier 42) was hidden by clouds whenever it was within range of the great telescope. As Robinson (1845) relates: "Unfortunately, the whole month of February was of the worst astronomical character" and "At length, when all hopes of Orion were lost in the twilight, the mirror was removed from the telescope, and polished on March 3rd."

The newly polished mirror was replaced in the tube the next day and Robinson, Rosse and South then enjoyed more than a week of relatively good weather, from 4–13 March 1845. South (1845) notes: "The night of 5th March was, I think, one of the finest I ever saw in Ireland. Many nebulae were observed by Lord Rosse, Dr Robinson, and myself … 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; and the 94th of Messier."

Thus, within a few weeks of the telescope's first trial, it had been turned towards M51, the famous "Whirlpool" galaxy, and according to Robinson (1845), "most of the lucid interval from the 4th to the 13th of March was devoted to nebulae". South's report that M51 was observed during this interval was confirmed by Robinson (1845), who drew attention to what he called the "second class" of nebula, namely "those that are round, but appear to have one or more nuclei".

The more than a dozen objects in this class includes M51 (=h 1622). Robinson's report, which was delivered orally on 14 April 1845, went on to note: "Here also the central nebula is a globe of large stars; as indeed had previously been 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."

2: Copy of the sketch shown by Lord Rosse at the June 1845 meeting of the British Association. (Taken from Nichol 1846 plate VI)

It is rather surprising that neither Robinson nor South remark upon the spiral arrangement of the stars in M51, despite their detailed series of observations of nebulae during what were evidently several clear (and very cold) nights. Robinson (1845) notes that the period included the lowest temperature, 17 °F, that he remembered in Ireland.

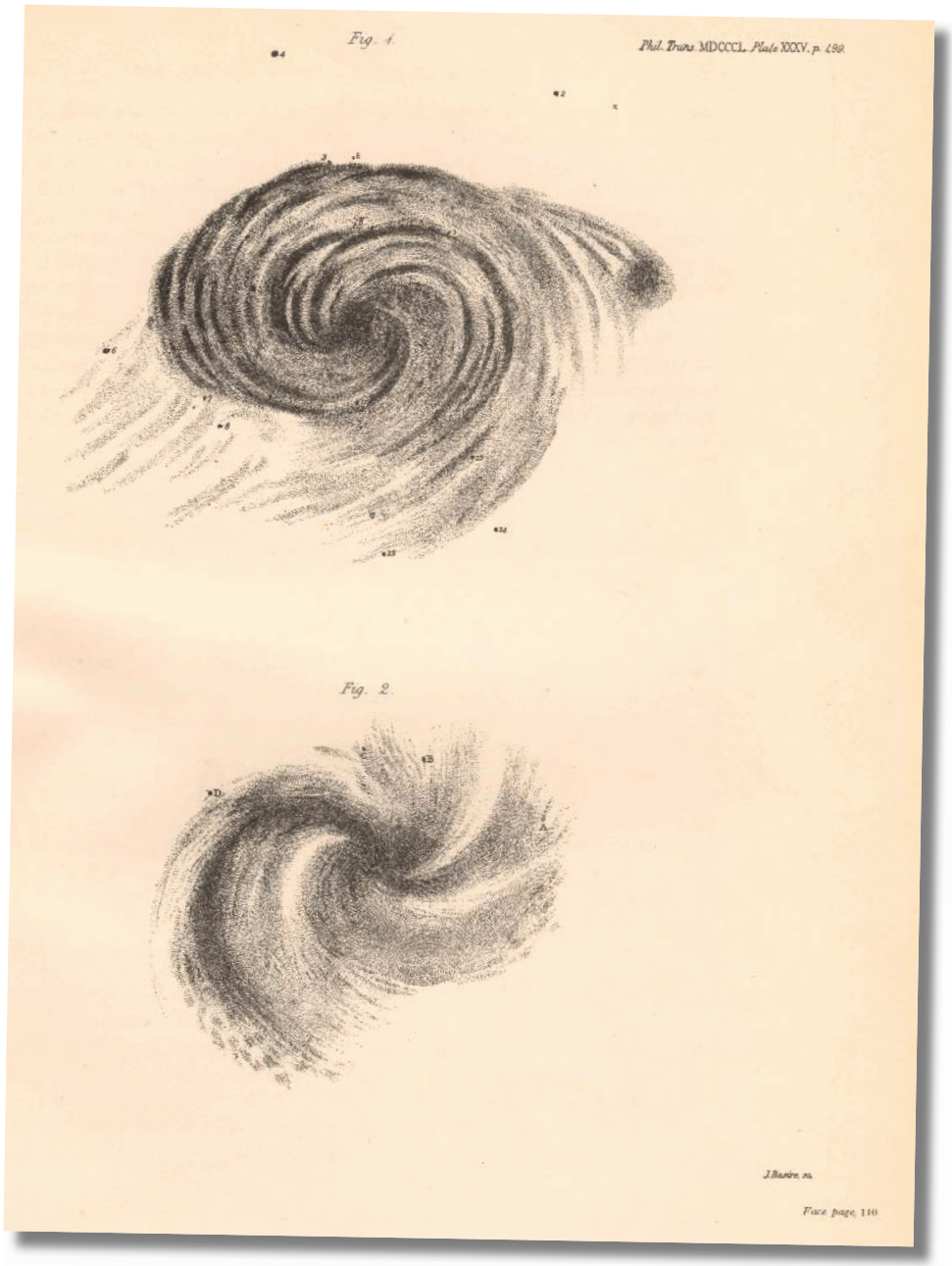
The situation is further clouded by the report of the Fourth Earl (Rosse 1880), that: "1845, Apr. During this month M. 51 was for the first time examined with the 6 foot and its spiral character immediately noticed, but no record is left of these early observations."

Discussion

The remark that M51 was observed only for the first time in April 1845 is inconsistent with the reports of South and Robinson. Both indicate that the first observation of M51 was probably as early as 5 March 1845.

There are two possibilities. Either the spiral character of M51 was indeed noticed as soon as the galaxy was first examined with the 6-foot reflector (Rosse 1880), or it was not. In support of the first view is the statement by Rosse (1850) that: "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."

This suggests that both Robinson and South may have seen spirality in M51, together with Rosse, possibly as early as 5 March 1845. However, 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.



3: Copy of early drawings of M51 and M99 by Rosse (1850 plate XXXV). (Taken from Parsons 1926 figures 1 and 2 facing p110)

It is also possible that they did not recognize the spiral structure simply because they were not *looking* for it. As Chapman (pers. comm.) has pointed out, "when the observers saw stars in M51 … they saw exactly what they were looking for". And "it was only after the object had acquired a degree of familiarity, a month later, that other details became apparent – such as spiral structure".

The approach of astronomers to the problem of the nebulae changed dramatically, however, in June 1845. It was then that the Third Earl's drawing of M51, made in April that year, was circulated at the Cambridge meeting of the British Association for the Advancement of Science, evidently to much acclaim (Herschel 1846). Following this meeting, the primary focus of attention shifted away from the question of whether nebulae could be "resolved" to a discussion of their *form*. As Rosse (1861) later remarks: "In the early observations with the 6-feet telescope we had the advantage of a very fine speculum … and many nebulae were resolved. Very soon after, the spiral form of arrangement was detected; and our attention was then directed to the form of nebulae, the question of resolvability being a secondary object."

Conclusion

It seems likely that Rosse, Robinson and South could have seen the spiral arrangement of M51 when it was first observed, probably on 5 March 1845, though there is no evidence that they *noticed* it. Be this as it may, spirality had certainly been detected by the end of April 1845 (Hoskin 1982, Rosse 1880), the month in which Rosse drew the spiral arrangement of M51.

The drawing shown by Lord Rosse at the June 1845 meeting of the British Association is reproduced by Hoskin (1982). For comparison, figure 2 shows the copy of Rosse's original sketch which was commissioned and published as a double-plate by Nichol (1846). The latter writes: "I am glad to state, that – aided by willing and ingenious artists – my rather venturous attempt to represent these masses of stars in the light in which they appear – viz: *white* on a *dark ground*, has been considered by his Lordship to be successful." The following spring (i.e. 1846), Lord Rosse also identified spiral structure in M99 (figure 3; Rosse 1850).

No-one doubted the reality of the reported spiral structure of these nebulae, but it seems not to have been until around 11 March 1848 (i.e. another three years) that Robinson (1848) became the first person independently to confirm Rosse's earlier observations. It would be interesting to examine the surviving correspondence of Rosse, Robinson, Nichol and others from around March 1845, and perhaps other sources, to determine whether further light can be shed on the first observation of spiral structure. ●

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