

M 81 and M 82 – A Nightmare for the Herschel Family

by Wolfgang Steinicke

M 81 and M 82 of Messier's catalogue is the most popular galaxy pair in the sky. The story of their discovery goes back to the late 18th century. It is strongly related with William Herschel, his sister Caroline and his son John. The whole problem might not be well known. It is an example for the struggle to get correct identifications, in a time knowing only textual descriptions and a few sketches. The visual, thus subjective, observation and measuring of the heavens was, and still is, the main reason for many mistakes.

William Herschel's Observations in Datchet and Slough

In December 1781 William Herschel (fig. 1) got a present from his friend William Watson in Bath, which should strongly influence his sensational career as a deep-sky observer: Messier's „Catalogue des Nébuleuses et des amas d'Etoiles“ [1]. Three objects were already known to him through observations with his 6.2" reflector (with whom he discovered Uranus in 1781) and another 9 inch [2]: the globular cluster M 13 in Hercules (first viewed on Aug. 22, 1779), the Andromeda nebula M 31 (Aug. 6, 1780) and the Orion nebula M 42 (Mar. 4, 1774).



Fig. 1: William Herschel (1738-1832)

With the Messier catalogue he saw the chance to demonstrate the superior power of his telescopes. At that time his largest instrument was the „small 20ft“, a Newtonian with 30 cm aperture and 6 m focal length. The concrete observations started soon after his move to Datchet near Windsor, which happens in late July 1782. His first target was the globular cluster M 5 in Serpens (Aug. 5, 1782).

A year later, on Aug. 6, 1783, he searched for M 81 and M 82 in Ursa Maior (fig. 2), discovered on Dec. 31, 1774 by Johann Elert Bode. The positions (given by Bode and Mechain) were correct and so nothing should go wrong. Herschel notes in his „Journal No. 6“ for M 81: „**81 Neb.** 20 ft 200. Seems to consist of 4 or 5 stars crowded together with many small ones about them; but I am not satisfied that this is really the case.” [3]. In the following entry one reads on M 82: „**82 Neb. M.** I see 5 or 6 stars within the nebula extended in a row, but whether the light that is also extended consists of stars or nebulosity such as in Orion's swordhandle I can not resolve, nor do I see the stars in it distinctly that I do not doubt them. My speculum has not been out long enough to act well.” [4]. In 1793 Herschel listed these observations in his table of Messier objects. Unfortunately he assigned for both nebulae nearly identical coordinates (for 1790). M 82 is put 2' north-east of M 81 (Abb. 3).

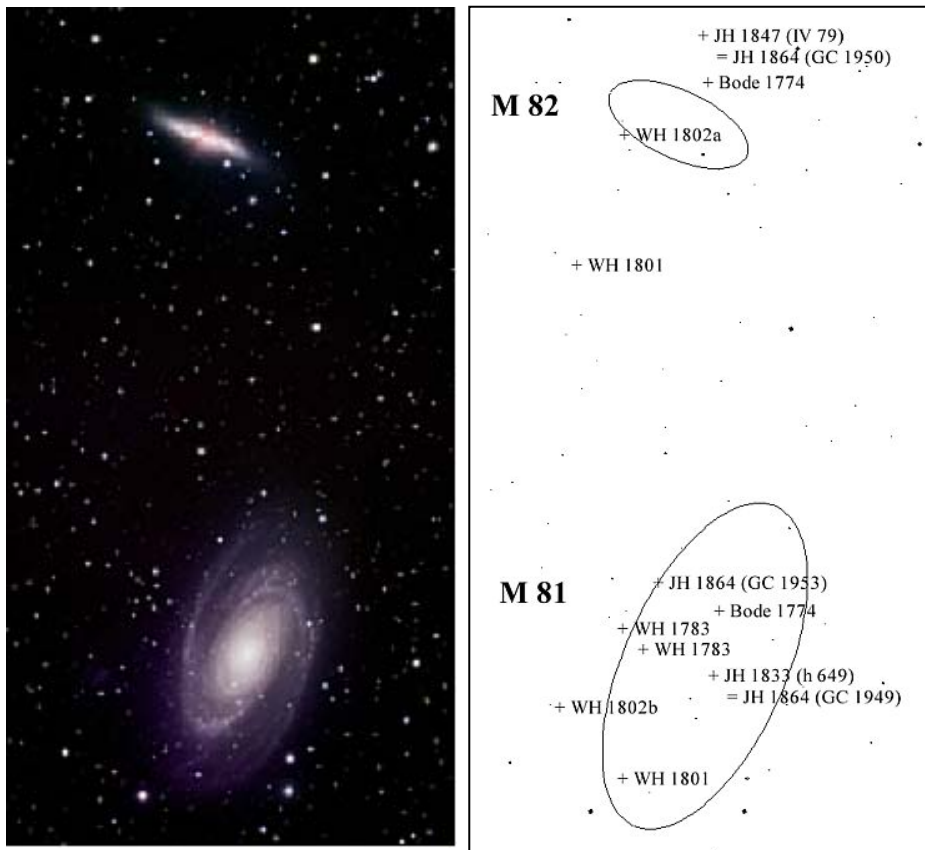


Fig. 2 (left): The galaxy pair M 81 and M 82 in Ursa Major
 Fig. 3 (right): Sketch of observations (see text)

The next observation of the pair was made at Slough (near Windsor likewise) on Nov. 8, 1801. Since October 1783 he used his “workhorse”, the „large 20ft“, a 18.7" Newtonian (aperture 45.7 cm, focal length 6 m, fig. 4). For his “sweeps” he used a magnification of 157 and the field of view was 15'. The notes in his observation log (here Vol. 8) were written by Caroline Herschel. For “No. 81 of the Connoiss. des temps” (sweep 1100) we have: „*eB. the bright part confined to a very small place; the nebulosity is of the milky kind. vmE. from np. to sf. It exceeds the limits of the field.*” And for “No. 82 of the Connoiss. des temps” it is noted: “*eB. mE. from sp. to nf. about 10' long.*” The coordinates given fit fairly well to M 81 and M 82 (the latter lying 10' too far south). The reference star was 24 UMa. Apart from the wrong positions listed in 1793, the world was still ok.

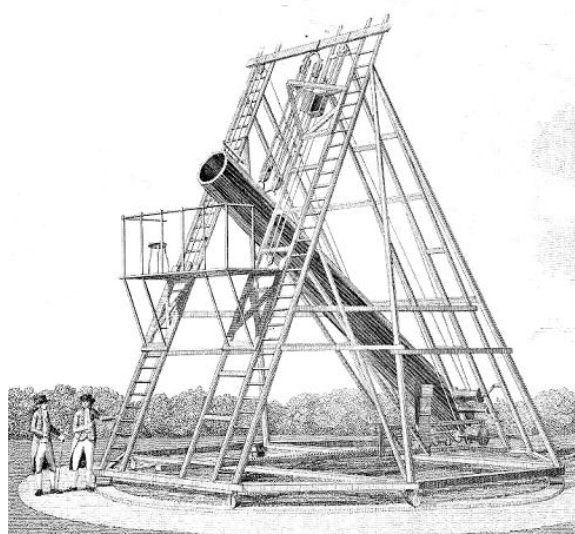


Fig. 4: William Herschel's “large 20ft” telescope

But in „sweep 1112“ made on Nov. 30 1802 things worsened. We have the following entry in Vol. 8 (written again by Caroline): „vB. eL. it very nearly fills all the field; it loses itself imperceptibly. mE, from np. to sf. I can trace it nearly $\frac{1}{2}^{\circ}$ in extent beyond the bright part. 27 Ursae f 15' 0" s 3° 5' RA 9^h 39' 48" PD 19° 57'. No. 82 of the Conoiss.“ [5]. Both, description and position, clearly show, that this is not M 82, but M 81. If the error is due to William or Caroline Herschel, cannot be determined. Let us denote this entry „1802b“ (fig. 5). The object described above (i.e. the preceding entry „1802a“) is amazing: „A very B. beautiful ray of light, brightest in the middle of all the length. About 8' long; 2 or 3' broad. 27 Ursae f 14' 12" s 2° 28' RA 9^h 39' 48" PD 19° 20'. (2507)“. The number „2507“ shows, that Herschel thought this is a new one (he numbered his discoveries continuously). But position and description obviously fit to M 82!

The image shows a handwritten page from an observing log. It contains two entries, each with a vertical margin on the left for corrections. The first entry is numbered '39' and '41' in the margin, with a correction 'for ft. -26'. The second entry is numbered '41' and '12' in the margin, with a correction '-5 = 43' for ft. -27'. The text is written in cursive and includes astronomical coordinates and descriptions of nebulae.

39	41	19 46	A very B. beautiful ray of light, brightest in the middle of all the length. About 8' long; 2 or 3' broad. 27 Ursae f 14' 12" s 2° 28' RA 9 ^h 39' 48" PD 19° 20'. (2507)
		for ft. -26	
41	12	20 24	vB. eL. it very nearly fills all the field; it loses itself imperceptibly. mE, from np. to sf. I can trace it nearly $\frac{1}{2}$ in extent beyond the bright part. 27 Ursae f 15' 0" s 3° 5' RA 9 ^h 39' 48" PD 19° 57'. No. 82 of the Conoiss. &c.
		-5 = 43	

Fig. 5: Part of William Herschel’s observing log for Nov. 30, 1802 (written by Caroline Herschel)

The reason for the confusion can be traced, reading his final note on this observing session: „The bubble did not stand right; I therefore by the great motion set the bubble right, and found that the great ropes had shortend so as to raise the telescope 18'. And when the bubble was right as at the beginning the PD clock shewed 17° 9', so that the PD string has shortened 39'.“ Herschel thought the southern nebulae (described in “1802b”) to be M 82 – which is in fact M 81. Therefore he must assign the other a new one, as there was no preveously known object north of M 82! The declination difference is 37', which is roughly the error calculated from the wrong alignement of the mounting. It is interesting, that the positions given in his description were already changed by 26' and 27' respectively, ie. both nebulae were firstly put half a degree more south. Herschel’s “corrections”, made in this unhappy night, had a fatal consequence: suddenly there were three bright, large nebulae in the field!

There was another, last, observation of M 81/82, made on Nov. 26, 1810 with the large 10ft reflector (also known as “X-feet”). The telescope, build in 1799, had 60 cm aperture and 3 m focal length (fig. 6). In Herschels report (review No. 8) one reads: “81 Con I viewed this Nebula with the large 10feet. It has a bright resolvable Nucleus, certainly consisting of 3 or 4 stars or something resembling them. It is about 15 or 16 minutes long. I used the 1st and 2nd powers; but the object was already too low for being seen in advantage.” [6]. On M 82 he noted: “82 Con I viewed this Nebula also. It is mottled in its length as containing 5 or 6 very small stars affected with Nebulosity. With No. 1 about 1/5 of the Field or less = about 6 or 7' in length. The breadth is about 1½ or 1¾. The object is too low.” Both descriptions match the objects, but there are no coordinates. A third nebula is not mentioned.

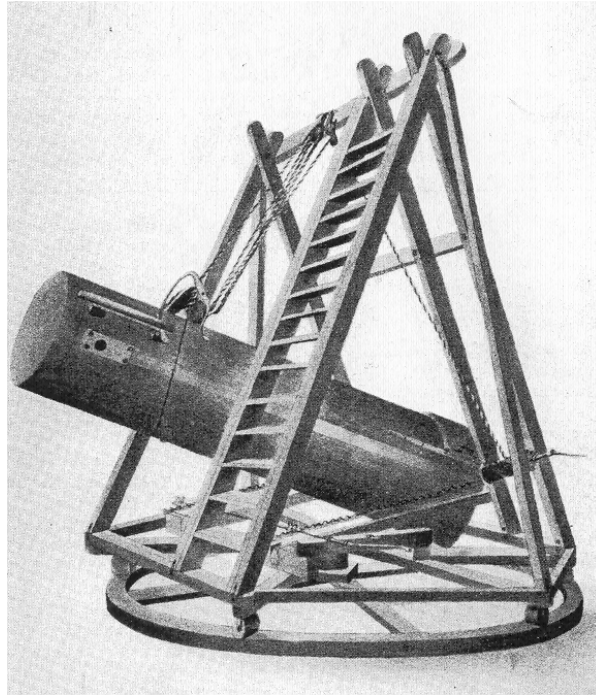


Fig. 6: William Herschel's "X-foot" telescope

M 81 and M 82 in John Herschel's Catalogues

What has Herschel's son John (fig. 7) done with all these reports? Could he resolve the puzzle? Quite the contrary: he has raised the confusion to even higher power! Let's start with his 1833 catalogue, collecting his Slough observations, made with the „large 20ft“ [7]. There is an entry „h 649“, which is identified with M 82. The observation on Oct. 28, 1831 is described as: „*eB; eL; E, pos = 156°.0; g b and then s v m b M, with faint rays of light nearly to extremities of field (15'). The most condensed part is 4'.1 l and 3' br.*“ [8]. The position (for 1830) is 9 41 17 +69 52 11. This clearly is M 81! The „true M 82“ was not observed.



Abb. 7: John Herschel (1792-1871)

The next level is John Herschel's Cape catalogue of 1847. There we find an appendix „Places and Descriptions of Eight Nebulae discovered by the late Sir William Herschel, and not published in his Catalogues“ [9]. The list contains 8 objects, found on Nov. 30, 1802. William Herschel's third (and last) catalogue of 500 new nebulae was already submitted in mid-1802 [10]. Too late for these objects. It is

not known, why John Herschel did not put these objects already in the Slough catalogue. The fourth of the list is our obscure No. 2507. Following his father's treatment, the nebulae were assigned to classes, based on their appearance. Two were put in class II („faint nebulae“), 5 in class III („very faint nebulae“).

And our candidate? It was put by John Herschel in class IV: „planetary nebulae“! This class was defined by William Herschel to contain “Stars with burs, with milky chevelure, with short rays, remarkable shapes, &c” – a ragbag of objects, which cannot be classified otherwise. As his 1802 catalog ends with IV 78, the additional object was named „IV 79“ by John Herschel. He adopts the description of Nov. 30, 1802: „A v B, beautiful ray of light, about 8' long, 2' or 3' broad; brightest in the middle of all its length. Follows 27 Ursae (G. 1563) 14^m 12^s, and is 2° 27' south of that star.” [11]. Particularly the phrase “ray of light” might have forced him to apply class IV. The position (for 1830) is that of M 82.

The next step is John Herschel's „General Catalogue“ (GC) of 1864 [12]. Now we have indeed three entries in the area: GC 1949, GC 1950 and GC 1953 (fig. 8). GC 1949 is h 649; the error in the Slough catalogue is corrected, the object is now identified as M 81 at the right place. The second object, GC 1950, is called „M. 82“. The Positions is fine too; the description is that of „IV 79“, presented in the Cape catalogue („beautiful ray“). John Herschel has obviously realized, that this is indeed M 82: the column „Other Authorities“ shows „M. 82“, and the next one („Sir W. H.'s Classes and Nos.“) confirms this: „IV 79 = 4 H. ON“ [13].

All questions answered? Unfortunately not – GC 1953 is still waiting! In the mentioned columns we read: „W.H. nova?“ and „M. 81??“. The position fits to M 81. What has happened? We have to go back to William Herschel's notes of Nov. 30, 1802. John Herschel now correctly identifies this „new“ object, presented in entry “1802a”, with M 82. But the the following entry „1802b“ says „No. 82 of the Connoiss.“. But John Herschel had M 82 already on his list (he was not aware, that this is actually M 81). What to do? He was forced to introduce another third nebula – this time not an offshoot of M 82 (such as IV 79), but rather one of M 81! What's about the description? The GC states: „vB; cL; mE; 5 or 6 st (?) inv.” Brightness and form fit to both nebulae (M 81 and M 82) in the first instance. But „5 or 6 stars“ are mentioned in William Herschel's last observation of M 82 – the same is true for his first (Aug. 6, 1783). If this is the very source, one may find the reason of John Herschel's confusion. The coordinates of M 82 are wrong in his Messier list of 1793: it is a little east of of M 81 – and there we meet GC 1953!

1949	649	.....	M. 81	9 43 48.9	5.066	1	20 16 10.0	16.70	1	!; eB; eL; E 156°0; g, symbMBrN.	4
1950	.....	{ IV. 79 = 4H. ON }	M. 82	9 43 52.3	5.142	1	19 34 16.3	16.71	1	vB; vL; vmE “a beautiful ray.”	2*
1951	650		9 44 0.3	3.497	2	60 7 7.4	16.68	2	F; S; sbM *12; bet 2B st ...	2
1952	3194	.....	B. 2686	9 44 1.8	1.975	2	145 45 42.8	16.66	2	Cl; pL; pRi; iF; st 11...12...	2
1953	.....	W. H. nova?	M. 81??	9 44 38.0	5.064	1	20 12 18.9	16.73	1	vB; eL; mE; 5 or 6 st (?) inv	1*

Fig. 8: Part of John Herschel's “General Catalogue”

John Herschel already feared, that something was going wrong, because in the notes to GC 1953 he states: „M. 81?? – A nebula observed by W.H. as described, but differing most materially in place from M. 81. It would certainly be very extraordinary should three nebulae so extremely remarkable as M. 81 and M. 82 and this be found to lie so near together.”

Dreyer has solved the problem in the “New General Catalogue“ of 1888 as follows [14]: NGC 3031 = GC 1949/53 = h 649 = M 81 bzw. NGC 3034 = GC 1950 = IV 79 = 4 H.O.N. = M 82. Nowadays all is reduced to the popular M- and NGC-numbers, so nothing is visible of the confusion this beautiful pair of galaxies once brought to the Herschel family.

Notes and References

- [1] Messier, C. (1781), Catalogue des Nébuleuses et des amas d'Etoiles, Connaissance des Temps 1784, 227-272
- [2] The original notes of William, Caroline and John Herschel are archived at the Royal Astronomical Society, London. For William Herschel's telescopes see: Bennett, J. A. (1976), Journ. Hist. Astron. 7, 75-108
- [3] „20ft 200“ means an observation with the „small 20ft“ at magnification 200
- [4] The nebula in „Orions swordhandle“ is M 42
- [5] PD = polar distance (= 90° - Deklination); for “27 Ursae” see [11].
- [6] “1st and 2nd powers” are the lowest magnifications
- [7] Herschel, J. (1833), Observations of Nebulae and Clusters of Stars, made at Slough, with a Twenty-foot Reflector, between the years 1825 and 1833, Phil. Trans. 123, 359-509
- [8] “pos = $156^\circ.0$ ” means position angle
- [9] Herschel, J. (1847), Results of Astronomical Observations Made During the Years 1834, 5, 6, 7, 8 at the Cape of Good Hope, Smith, Elder & Co., London
- [10] Herschel, W. (1802), Catalogue of 500 new Nebulae, nebulous Stars, planetary Nebulae, and Clusters of Stars, Phil. Trans. 92, 477-528
- [11] “27 Ursae (G. 1563)” means 27 UMa (from Bode's catalogue) and No. 1563 from the catalogue of Groombridge (north polar stars)
- [12] Herschel, J. (1864), Catalogue of Nebulae and Clusters of Stars, Phil. Trans. 154, 1-137
- [13] “4 H. ON” = fourth object from William Herschel's list „other nebulae“ (published in [9])
- [14] Dreyer, J. L. E. (1888), New General Catalogue of Nebulae and Clusters of Stars, Mem. Roy. Astr. Soc. 49, 1-237; for the history of the NGC see my website: www.klima-luft.de/steinicke