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THREE SOMEWHAT OVERLOOKED FACETS OF VY CANIS MAJORIS

1. SECULAR CHANGES IN LIGHT?

The first record of VY Canis Majoris seems to be in the star catalogue of Lalande, which contains a measurement on March 7, 1801, of its position and an estimate of its magnitude as 7. My search of the literature has uncovered 24 additional magnitude estimates made during the following century. Though most were by meridian observers and were incidental to the positional determinations, the work was carried out with similar instruments (typically about six inches in aperture). This is fortunate, since visual magnitude estimates of red stars are particularly sensitive to changes in apparent brightness. For this reason, the magnitudes cited by double star observers - who used large telescopes at high power - are excluded from the following discussion. The 19th-century magnitudes, together with 14 later ones, are collected in Table I.

Of course, no uniform photometric system prevails, yet rough transformations to the Harvard Photometry are possible. The original observations were adjusted in two ways: by using the transformation curves and tables cited by Lundmark (2,3,9) and/or by applying a correction based on the individual observer's magnitudes for nearby stars.

In Table I, the third column contains the original magnitude estimate. If is a mean value, the total number of observations is given in parentheses, and the results is plotted as a large dot in Fig.1. Robinson's results are from Harvard yellow-sensitive patrol plates. In the fourth column are magnitudes reduced to the Harvard Photometry. If two independent reductions were made, as described in the previous paragraph, the mean is given. The last two columns contain references to the source of the original magnitudes and to the reduction procedure, respectively.

TABLE I

Date	Observer	Obs. Mag.	Red. Mag.	References	
1801/3/7	Lalande	7	6 1/2	1	2,3
1830+	Herschel	7	6 1/2	4	5
1847/12/6	Major	6	6 1/2	6	5
1848/1/22	Major	6	6 1/2	6	5
1848/1/29	Beecher	7	6 1/4	6	5
1851/2/18	Argelander	6 1/2	6 1/4	7	3
1872/12/12	Gould	7 1/2	7 1/4	8	5,9
1873/1/23	Thome	7 1/2	7 2/3	10	5,9
1873/3/14	Birmingham	7.0	6 1/4	11	12,3
1873/4/3	Gould	7 1/2	7 1/4	13	5,9
1875/2/3	Bigelow	7 3/4	7 2/3	14	5,9
1875/2/5	Bachmann	7 1/4	7	14	5,9
1875/2/6	Bachmann	7 1/4	7	14	5,9
1875/2/7	Thome	7 1/4	7 1/3	14	5,9
1875/2/18	Bachmann	7 1/4	7	14	5,9
1875/2/20	Bachmann	6 3/4	6 1/3	14	5,9
1875/2/21	Bachmann	7 1/4	7	14	5,9
1876/3/10	Copeland	8.0	7 3/4	15	12,3
1879/1/8	Dreyer	7±		15	
1879/3/1	Dreyer	7.0	6 1/2	15	12,3
1880/2/21	Bachmann	8	7 3/4	16	5,9
1880/2/22	Davis	7 1/2	8	16	5,9
1880/2/23	Bachmann	7 3/4	7 2/3	16	5,9
1890+	CD	7.7	7.4	17	5,9
1893.7	Cordoba A	7.5	7.4	18	5,9
1914.2	Robinson	7.8(11)	8.5		
1917.2	Guerin	< 8-8 1/2	< 8 1/4	19	5,9
1917.3	Perrine	< 8 1/2	< 8 3/4	19	5,9
1917.7	Robinson	7.5(35)	8.2		5
1920.4	Robinson	7.7(3)	8.4		5
1932.0	Florja	9.1(20)	9.1	20	5
1933.0	Florja	8.8(35)	8.7	20	5
1935.1	Florja	9.3(11)	9.3	20	5
1937.7	Robinson	8.3(3)	9.0		5
1959.0	Cragg	8.6(9)	8.6	21	5
1961.9	Cragg	8.5(13)	8.5	21	5
1967.1	Cragg	8.8(21)	8.8	21	5
1970.4	Cragg	9.0(2)	9.0	21	5
1971.1	Locher	8.7(55)	9.4	21	5

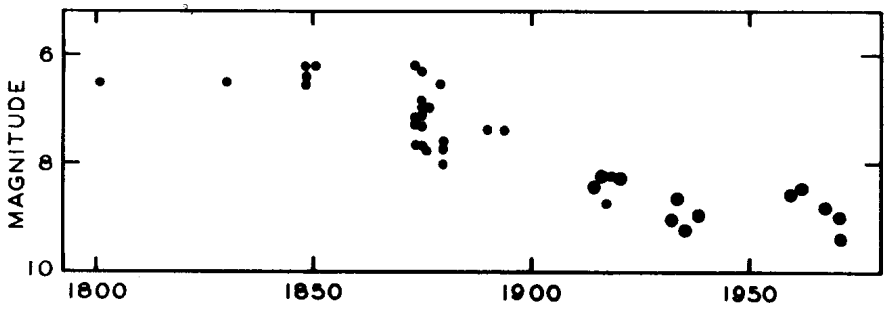

Fig. 1

The transformation of the older observations tended to increase the brightness of VY Canis Majoris slightly.But wether the original or adjusted magnitudes are examined, a definite fading is evident since at least 1850. The average decline is about two magnitudes per century, though there is the suspicion that the rate has slackened during the last several decades. Earlier, the interpretation of the light curve is ambiguous, though the average rate of change could not have persisted or VY Canis Majoris would have been seen as a conspicuous naked-eye object.

Some of the scatter in Fig.1. is due to intrinsic variation. The cluster of points in the 1930's, for example, lies below a regression line because the average brightness of VY Canis Majoris was less during those years, as found by Robinson (22).

The possibility of a long-term fading had previously been suggested by Perrine (19) and by Herbig (21).

2. AS A MULTIPLE STAR

For about three quarters of a century double-star observers have measured several discrete components of VY Canis Majoris. The general characterristics of the six components that have been observed since 1897 are given in Table II, compiled from (23-39, 46).

TABLE II

	Max.	Min.	Obs.	Seen	Not seen	θ(A-)	ρ(A-)
A	7.0	8.8					
B	8.0	10.5	1927-1970	to 1970.0	1971.0	0.4-0.8	165-210
C	11.0	14+	1897-	1897-1932.1 1933.2-1958.2 1968-	1932.8-1932.9 1958.3	2.0-2.8	290
D	9	15	1897-1937	1897-1928.2 1936.1-1937.3	1930.3-1932.9 after 1937	2.6-3.6	10-345
E	10	12.4	1897-1917	1897.8-1917	after 1917	6.8	30
F	10.8	12.5	1936-1971	1936.1-1937.0 1946.2-1971	1944.1	1.2	105

In Fig.2 the primary is marked A, and the small enclosures represent the domains of the other components. The measures of position angle are quite consistent, but the separations scatter considerably. Further, the companions visible through the 1960's seem to have become increasingly illdefined and difficult to measure.

There is now general agreement that the companions of VY Canis Majoris are bright "knots" in the nebulosity that shrouds the entire system. From observations with telescopes from 36 to 120 inches aperture, Herbig found (38): "The image of the variable is neither stellar nor round, and attached to this elongated blob is a curved nebulous tail extending toward p.a. 290°, as well as lesser extensions in 90° and 200°."

Arrows marking the directions of these wisps are shown in Fig.2. Note that Herbig's main "tail" lies in the same direction as the C component. The lesser wisps match the position angles of B and F quite nicely, and together perhaps define one curving nebulous filament. It is interesting that only B, C, and F, which have been visible in relatively recent times (see Table II), correspond to the three wisps identified by Herbig.

Unlike the other components, the position angle of B varies erratically. The position angle of C and E did not change during 73 and 35 years, respectively, while D had only a constant westward drift from 10° to 345° between 1897 and 1937.

F. Not seen previous to 1936, this component was conspicuos 12th-magnitude companion at the time of its discovery by van den Bos. In 1944 it was not visible but seems to have persisted since 1946.

The light changes of some of these components can be quite spectacular. For example, C must have faded by at least 2.5 magnitudes in less than 0.7 year, for it was visible to Finsen (24) at magnitude 12.5 on 1932.11 but invisible to Voute (33) on 1932.85. (The derived range assumes the magnitude limit to have been 15 in the large refractors used by both observers.)

Even more dramatic was the subsequent rise 1932.85-1933.16, from invisibility to magnitude 11.0, as recorded by these same observers. It is improbable that Voute could have missed C had it been brighter than 14th magnitude, since he remarked: "Though atmospheric conditions (were) perfect, I could never see (on four nights) the 3 companions C. D. and E."

Another example of rapid variability is described by Wallerstein (39): Star C was visible from October (1957) to February (1958) but was not seen in early March at the coudé focus of the 200-inch telescope .... confirmed at the Newtonian focus of the 100-inch telescope."

Finally, observations with relatively small telescopes shed some light on this facet of VY Canis Majoris. In 1917 Guerin was uring the new 7.5-inch meridian circle at Cordoba Observatory, which replaced the 5-inch that had been in operation for several decades, when he noticed "three nuclei, the preceding of which is the brighter and the point ... observed for position," as recounted by Perrine (19). In (44) we further learn that it was the south nucleus that was measured. Hence, the "preceding", "brightest," and "south" references must be to AB, indicating that the other two nuclei must have been D and E, if we restrict ourselves to the six aforementioned components.

The implication is that C was so faint as to be invisible, but more important that D and E were unusually conspicuous. That a pronounced change occurred is further suggested by an observation of Innes (26). In 1900 he found D and E to be 9th and 10th magnitude, respectively, whereas See in 1897 (27) had called them 12 and 12.4! (Though Cogshall (25) also observed in 1900 he makes no mention of magnitude.)

Such a dramatic change could explain why the lesser components had escaped Herschel and many other 19th century observers. It should be recalled that VY Canis Majoris had been known as a red star since 1847 and accordingly was carefully scrutinized by several experienced observers in the late 1870's, using apertures similar to Guerin's. Since

1957 T.A. Cragg (21) has observed VY Canis Majoris with the 6-inch visual refractor at Mt. Wilson and has "never seen it as anything but a single star". Unfortunately, the history of this system between 1900 and 1917 is impossible to reconstruct, since no observation of any kind appears to have been made.

3. THE EXTENDED NEBULA

On the night in 1917 when Guerin observed the three bright objects described in the previous section he also called attention to the fact that they were embedded in a small (8" by 12") red or scarlet nebula (dotted outline in Fig.2) that pointed toward the east (19). Even more remarkable was his discovery of a faint red sinuous tail that extended southward 2'. Perhaps it is apropos to note here that Guerin was regarded by M.L. Zimmer (40) as "one of the best meridian circle observers."

Like the secondary components, why had this inner nebulosity not been reported earlier? And what about the 2' extension, which is indirectly confirmed by H-alpha photographs? In the Mt. Stromlo atlas (41) VY Canis Majoris is seen situated on the western side of a bright arc that extends northsouth roughly 1° along the eastern part of RWC 15. (A fuller description of the surrounding nebulosity is given by Herbig (38)).

Except for Guerin's observation, there is no other visual record of his extended nebula, which indicates that it too must have been extraordinarily conspicuous around 1917. It seems that D and E also perticipated in this singular happening. But by 1927 van den Bos (28) stated: "With low power the nebulous look was plainly seen, but no extended nebula could be perceived." Neither the integrated yellow nor blue light curves have any pronounced features around 1917 (22).

The inner portion of the nebulosity is likewise enigmatic. As already mentioned, Guerin likened it to a comet with an eastward-pointing tail. Yet in 1926 and 1927 (presumably) van den Bos (42) described the nebula as: "the most striking feature, fan-shaped like a comet with the close pair (AB) as nucleus." Finsen and Klerk (23) add the fact that the tail extended to the northwest and involved C and D.

In the 1930's van den Bos continued to describe the nebula as pointing toward the northwest. But in 1956, after a decade hiatus in his observations, he remarked (34): "tail now looks more towards 270°, or even slightly south preceding." In other words, between 1917 and 1927 the tail swung

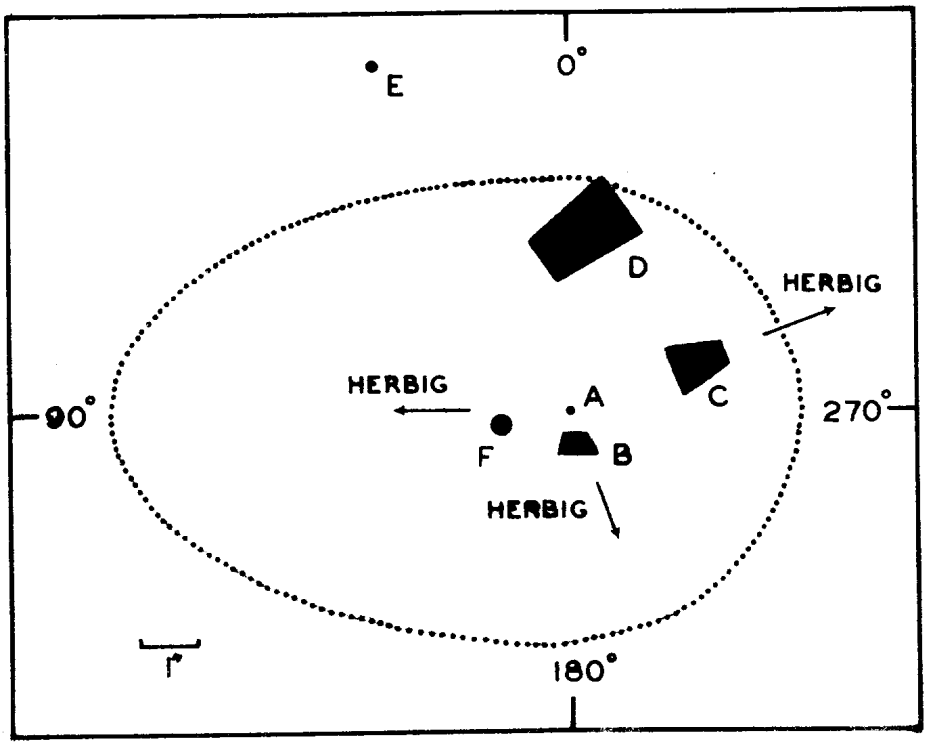

Fig. 2

Plotted in Fig.3 are the measured separations of AB (top) and position angles. There seems to be a mutual dependence, as if B were a bright spot moving along a discrete filament of nebulosity. The correlation is surprisingly good, considering the difficulty of the measurements.

Following are brief historical resumes of the well-documented companions.

B. The primary was itself discovered to be a close double (0".5) by van den Bos late in 1926 (28, 45), using the 26.5-inch refractor at Union Observatory. Until recently, the magnitude difference between these components had been about one, so it is surprising that B had not been found earlier, especially since See, the first person to catalogue this object as a multiple star, had discovered

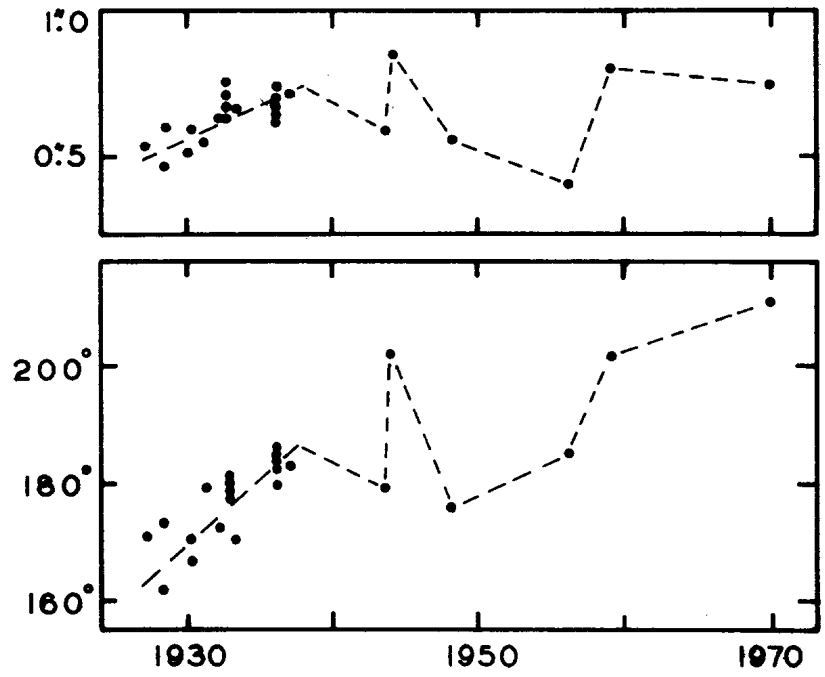

Fig. 3

many comparable doubles. This opinion was shared by Voute (33), who measured the AB pair in 1932 with the 24-inch refractor at Bosscha Observatory. In 1931 the pair was even measured by Dawson with the 17-inch refractor at La Plata Observatory (36).

Therefore, previous to van den Bos' discovery, B must have been substantially fainter than A or nearer to it. Perhaps, a similar situation has existed during the past decade, since even the Lick 120-inch failed to resolve the pair regularly (38, 46).

C. This companion as well as D and E were discovered by See (27) in 1897. As Table II shows, C is very erratic, having completely disappeared twice.

D. About 1930 this component disappeared, was glimpsed in 1936 and 1937, and has not been seen since.

E. This object was observed with large apertures for only two years at the end of the 19th century, but probably persisted at least to 1917.

clockwise from east of the AB pair to the northwest, and by 1956 it has moved onward to the west.

Recently, Herbig (38, 46) described a curved nebulous tail extending toward the west-northwest. This is confirmed by Serkowski (43) in 1969, who also depicts a cloud approximately 8" by 6". Apparently, any rapid angular motion had ceased by the last decade.

I thank Dr. George Herbig for calling my attention to this wonderful object and for his continuing interest. Dr. Joseph Ashbrook was an excellent guide to the early literature.

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REFERENCES

1. J.Bossert, Paris Obs. Mem., 21, 1887
2. K.Lundmark, HdA, 5, 1932, page 264
3. K.Lundmark, HdA, 5, 1932, page 262
4. J.Herschel, Results of Observations....., 1847
5. HA, 50, 1908
6. Pub. USNO 2nd Series, 7, 1911
7. Argelander Zonen Beobachtungen, 1857
8. Res. Obs. Nac. Argentina, 2, 1881
9. K. Lundmark, HdA, 5, 1932, page 269
10. Res. Obs. Nac. Argentina, 3, 1884
11. Trans. Royal Irish Academy, 26, 1876
12. T. Espin, Cunningham Mem. Royal Irish Academy, 5, 1890
13. Res. Obs. Nac. Argentina, 4, 1884
14. Res. Obs. Nac. Argentina, 6, 1887
15. Astronomical Obs. and Red., Dunsink, 4th Part, 1882
16. Res. Obs. Nac. Argentina, 13, 1891
17. Res. Obs. Nac. Argentina, 16, 1892
18. Res. Obs. Nac. Argentina, 22, 1913
19. C. Perrine, PASP, 35, 232, 1923
20. N. Florja, Pub. Sternberg Astronomical Inst., 8, 2, 1937
21. Private communications
22. L.Robinson, IBVS 465, 1970
23. W.Finsen and M.Klerk, copy of data in Union Observatory card catalogue
24. W.Finsen, UOC, 92, 1934
25. W.Cogshall, AJ, 22, 1, 1901
26. R.Innes, MNRAS, 61, 587, 1901
27. T.See, AJ, 18, 1898
28. W. van den Bos, BAN, 118, 3, 1927

29. W. van den Bos, UOC, 78, 1928
30. W. van den Bos, UOC, 117, 1958
31. W. van den Bos, UOC, 100, 1938
32. W. van den Bos, UOC, 111, 1951
33. J.Voute, Annalen Bosscha Sterrenwacht, 6, 1932
34. W. van den Bos, UOC, 116, 1957
35. W. van den Bos, UOC, 118, 1959
36. B.Dawson, La Plata Serie Astronomica, 6, 6, 1937
37. J.Newburg, Republic Obs. Circ., 7, 130, 1970.
38. G.Herbig, Mem. Liege, 19, 1970
39. G.Wallerstein, PASP, 70, 479, 1958
40. Res. Obs. Nac. Argentina, 35, 1929
41. A.Rodgers et al., An Atlas of H-Alpha Emission in the Southern Milky Way, Mount Stromlo Observatory, 1960
42. W. van den Bos, BAN, 157, 261, 1928
43. K.Serkowski, ApJ. Letters, 158, L107, 1969
44. Res. Obs. Nac. Argentina, 34, 1934
45. R.Aitken, New General Catalogue of Double Stars, 1934
46. G.Herbig, preprint