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## ROSS VARIABLES IDENTIFIED WITH MINOR PLANETS

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Of the 379 candidate variables listed by F.E. Ross during 1925–1931, 97 appear in the NSV catalogue, and 51 of these were recorded on a single night. Ross recognized that some of the single-nighters were likely to be minor planets, and a few years ago J.R. Bedient identified six such cases. The present author has identified nine further Ross objects as long-known minor planets.

Bedient (2003) identified six of the “New Variable Stars” listed by Ross (1925, 1926a, 1926b, 1927a, 1927b, 1928a, 1928b, 1929, 1930, 1931) as minor planets. These were cases where F.E. Ross’ comparison of plates taken with the Bruce photographic telescope at the Yerkes Observatory by E.E. Barnard during 1904–1915 and those taken by Ross himself with the same instrument during 1924–1930 showed the “variable” to be present only on a single night. Photographic defects had (presumably) been eliminated, since each observation consisted of a pair of duplicate images with 10-inch and 6-inch lenses. In the preamble to his third list Ross (1926b) had remarked that “while a certain small percentage of the stars listed as variables in the present survey may actually be asteroids [sic], to prove that such would be the case for any individual star would be an exceedingly difficult matter”.

The majority of the 379 objects have either been fully recognized as variables or been shown not to vary, but as many as 97 remain in the *New Catalogue of Suspected Variable Stars* (Kukarkin et al., 1982), and of the latter, the 51 objects collected in Table 1 are single-night detections. In such cases the non-detection was indicated either by a limiting magnitude (invariably 15 for the cases of interest) or – for the third through seventh lists – by the notation “n.s.” (not seen), where it is also reasonable to presume a limiting magnitude of 15.

Table 1. Single-night Ross objects in the NSV catalogue

Ross 5 = NSV 01488	Ross 114 = NSV 13523	Ross 231 = NSV 04352
Ross 11 = NSV 02913	Ross 115 = NSV 13558	Ross 249 = NSV 11953
Ross 17 = NSV 02911	Ross 130 = NSV 14097	Ross 271 = NSV 12941
Ross 21 = NSV 08638	Ross 136 = NSV 00308	Ross 279 = NSV 13086
Ross 24 = NSV 09124	Ross 144 = NSV 01760	Ross 301 = NSV 10876
Ross 25 = NSV 09194	Ross 152 = NSV 01809	Ross 310 = NSV 11971
Ross 26 = NSV 09248	Ross 160 = NSV 03506	Ross 321 = NSV 12374
Ross 29 = NSV 09437	Ross 166 = NSV 04168	Ross 323 = NSV 12985
Ross 30 = NSV 09457	Ross 168 = NSV 06188	Ross 324 = NSV 13021
Ross 36 = NSV 09668	Ross 182 = NSV 00907	Ross 326 = NSV 13047
Ross 38 = NSV 04748	Ross 190 = NSV 02777	Ross 329 = NSV 13179
Ross 39 = NSV 04796	Ross 204 = NSV 04018	Ross 331 = NSV 13449
Ross 40 = NSV 04849	Ross 206 = NSV 05338	Ross 344 = NSV 14721
Ross 41 = NSV 09200	Ross 208 = NSV 08001	Ross 349 = NSV 01797
Ross 77 = NSV 12634	Ross 218 = NSV 12168	Ross 352 = NSV 01982
Ross 79 = NSV 12682	Ross 225 = NSV 14640	Ross 353 = NSV 02490
Ross 89 = NSV 13752	Ross 230 = NSV 04333	Ross 369 = NSV 06249

Following the recent publication (Samus and Antipin, 2007) of the identity of DU Aqr with (57) Mnemosyne, Samus (2007) suggested to the present author that Ross 168 was likely to be a minor planet and requested assistance in identifying it. In response, and unaware of the work by Bedient (2003), the present author quickly identified Ross 168 and, further, checked to see which of the 50 other objects listed in Table 1 were detections of identifiable minor planets. The work was simplified by the availability of a new on-line version of the NSV catalogue that includes equinox 2000.0 versions of the equinox 1875.0 positions originally provided by Ross.

The other prerequisite was the availability of computer files at the Minor Planet Center containing osculating J2000.0 orbital elements of all 155,368 numbered minor planets for epochs at 200-day intervals back in time to well before Barnard exposed his plates.

This of course rendered it an “exceedingly *easy* matter” to conclude that just 15 of the 51 entries in Table 1 refer in fact to minor planets. Seven of the minor planets were recorded during 1904–1915, seven during 1925 or 1927 and – intriguingly – one in 1925 *and* 1927. The observations of these minor planets are listed in Table 2.

Table 2. Ross objects that are minor planets

Object	R.A.(2000)Decl.	Obs. mag.	Minor planet	UT	Computed position	V mag.
Ross 11	06 <sup>h</sup> 19 <sup>m</sup> 40 <sup>s</sup> +25°43′7″	13	(449) Hamburga	1925 Feb. 17.1	40/43.4	12.9
Ross 38*	10 08 14 +12 28.0	11.5	(24) Themis	1925 Mar. 31.0	14/28.0	11.5
Ross 39*	10 15 27 +12 10.5	10	(39) Laetitia	1925 Mar. 31.1	27/10.5	11.0
Ross 40	10 25 20 +17 45.9	11	(162) Laurentia	1907 Apr. 1.0	20/45.6	12.8
Ross 89*	21 31 18 –17 47.4	11	(115) Thyra	1904 June 20.3	19/47.4	11.4
Ross 136*	00 49 19 +04 51.4	12	(137) Meliboea	1925 Nov. 14.2	19/51.4	12.6
Ross 168	13 20 01 –03 19.1	11	(106) Dione	1905 Feb. 13.3	01/19.3	11.1
Ross 190	06 00 50 +15 48.0	13	(714) Ulula	1909 Nov. 12.3	50/48.0	12.8
Ross 204	08 21 09 +17 31.3	12	(554) Peraga	1927 Mar. 9.1	09/31.3	12.5
Ross 206*	11 47 43 +05 31.3	11	(26) Proserpina	1909 Apr. 10.1	43/31.3	11.1
Ross 230	08 59 06 +07 45.0	10	(389) Industria	1915 Mar. 20.2	06/45.0	11.8
Ross 231	09 02 06 +02 22.2	12	(242) Kriemhild	1915 Mar. 20.1	04/22.2	13.3
Ross 329	20 37 43 –19 24.0	12	(24) Themis	1927 Oct. 18.1	44/24.0	13.2
Ross 344	23 49 32 –06 34.3	12	(59) Elpis	1927 Nov. 26.0	32/34.2	12.2
Ross 352*	05 26 37 +26 43.5	11	(451) Patientia	1927 Feb. 22.1	37/43.3	11.8

Here the equinox 2000.0 positions in the on-line NSV catalogue have been rounded to the precision of the 1875.0 positions tabulated by Ross. The observed magnitude is that for the positive observation supplied by Ross; it should be noted that the NSV catalogue deliberately gives a number 1<sup>m</sup>.0 fainter. Since the precise time of observation is unknown, the UT date given corresponds to when (to 0<sup>d</sup>.1) the computed position (for which just the end figures in R.A. and Decl. are given) was closest to the observed position of the indicated minor planet. These UT dates are one day later than the local dates provided by Ross. To start the local date at noon was standard astronomical practice during 1904–1915, and it appears that Ross continued this practice following the actual introduction of UT in 1925. The computed magnitudes for the minor planets are in the *V* system.

It should be noted that all these minor-planet identifications are absolutely sure, and that no remotely questionable cases were found among the other 36 Ross objects. For six of the minor planets, (26), (59), (115), (389), (449) and (451), astrometric positions are available from other observatories (mainly Heidelberg, but also Greenwich, Marseilles and Algiers) at the same opposition. The 1909 observation of (714) Ulula, the minor planet with the highest number in the whole set, is in fact the earliest known for that object, which was discovered from Heidelberg in May 1911. By curious chance, (24) Themis was observed both as Ross 38 on 1925 Mar. 31 and as Ross 329 on 1927 Oct. 18. That Ross 39 should turn out to be (39) Laetitia is also fortuitous.

In no case was the computed  $V$  brightness more than  $1^m8$  different from the observed magnitude given by Ross. The mean brightness discordance was  $0^m6$  in the sense that the computed  $V$  magnitude was systematically fainter than the Ross magnitude. Given that the Ross observations are photographic, it would be reasonable to use the computed  $B$  magnitude, which is typically  $0^m8$  fainter than  $V$ . The mean discordance would therefore be  $1^m4$ . Although the brightness discordance is obviously affected by the low precision of the Ross values, the computed magnitudes do support the decision by the compilers of the NSV catalogue consistently to add  $1^m0$  to the Ross figures.

The six cases previously identified by Bedient (2003) are indicated in Table 2 by means of asterisks following the Ross number. Ross 352 was also independently identified by Schmeer (2003). However, four more of the objects, Ross 40, 168 (the object that inspired this investigation), 230 and 329, were incorrectly characterized by Bedient in his Table 2 as “not to be solar system objects”. They are most certainly (162) *Laurentia*, (106) *Dyone*, (389) *Industria* and (24) *Themis*, respectively. The present author also disagrees with the notation in Bedient’s Table 3 that Ross 231 and 344 “had ambiguous search results” and “cannot be characterized”. The present work clearly shows that they are (242) *Kriemhild* and (59) *Elpis*, respectively.

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