NSV 19431 and YY Centauri—Two Mira Variables

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Abstract Visual observations of NSV 19431 and YY Cen spanning the twenty-eight years 1980 through 2007 are discussed. These show NSV 19431 is a Mira star of mean period of 298.1 days and visual brightness range of 10.8 to fainter than 15.0. Elements for determining the dates of maximum brightness are JD 2447700 ± 298.1 days (±10 days). The O–C diagram shows what appear to be random cycle-to-cycle fluctuations with a current mean cycle of 298.1 days, evident from the maximum of JD 2447700 (1989).

YY Cen is a Mira star of mean period 371.3 days and brightness range 10.6 to fainter than 15.0. On at least three occasions during this twenty-eight years YY Cen has experienced individual cycles that are significantly longer or shorter than the 371.3-day mean period. Subsequent cycles remain close to the mean period but there is a resulting clear shift in the O–C values. Elements for predicting the dates of maximum brightness are JD2446897 ± 371.3 days (±10 days), but they should be treated with some caution due to the random instances of long/short cycles observed thus far and which may prove to be a long term characteristic of YY Cen.

1. Introduction

During the course of determining the *V*-magnitude comparison star sequence for the Mira star YY Cen at the Auckland Observatory, a new large amplitude variable star was discovered (Bateson *et al.* 1979). This new variable was plotted on Chart 449 of the Variable Star Section, Royal Astronomical Society of New Zealand (VSS RASNZ; Bateson *et al.* 1979). It was referred to as YYA Cen within the database of the VSS RASNZ and as 1230–54B (Var SE) in the AAVSO database. It subsequently received the designation NSV 19431 (Samus 2010) and listed as a possible Mira star of maximum *V*-magnitude 12.7 and position as $23^h\ 36^m\ 20.7^s$ –54° 36' 38" (J2000). Chart 449 of the VSS RASNZ with the *V*-magnitudes shown thereon has been used for these observations.

YY Cen appears in the *General Catalogue of Variable Stars* (GCVS; Kholopov *et al.* 1985; Samus 2010) as a probable Mira variable of photographic range 12.5 to fainter than 14.3 but no period is indicated. It is located at $12^h\ 35^m\ 41.8^s$ –54° 34' 52" (J2000).

NSV 19431 and YY Cen are both conveniently located within the same telescopic field of view. Each has been observed on a regular basis by the author during the twenty-eight year interval 1980 through 2007.

The normal observing season is February through August with less frequent observation outside these months when the field is only accessible in the morning sky. A seasonal gap is therefore present in both sets of data.

Observations for each star were plotted on large scale light curves with a scale typically near 1mm equal to 4.7 days and the dates of maximum brightness measured directly from the curve at the mid-point between the rise and fall branches of the curve, typically one magnitude below the maximum of the smoothed curve. A symmetrical shape to the light curve was assumed; it appeared appropriate in the case of both YY Cen and NSV 19431. This procedure also eliminated the necessity for a high density of data points around the time of maximum, providing for an internally consistent set of dates. Where an individual cycle had insufficient observations, a mean light curve was overlaid on the available observations as a "best fit" and the date of maximum measured from this. For both stars the errors in the derived dates are believed to be of the order of ±3 days, based on the scale of the light curves from which the dates were measured.

The observed characteristics of NSV 19431 and YY Cen are discussed below.

2. Discussion

2.1. NSV 19431

As described below, a mean period of 298.1 days has been determined with individual cycles ranging from 254 to 327 days. At maximum brightness NSV 19431 ranges between magnitude 10.8 and 12.8 and falls to fainter than 15.0 at minimum.

Details of the observed maxima are shown in Table 1. Where column 1 lists the cycle number relative to the well observed maximum of JD 2447700, column 2 the date of maximum, and column 3 the reliability of this date, weighted 1 = good for well observed cycles, to 3 = poor where only the rise or fall, or part of each, was recorded and the determined date of maximum is based largely on overlay of the mean light curve (and takes into account the upper limits where the variable was invisible, and which placed constraints on the derived dates). Column 4 lists the interval to the following maximum, with values shown in brackets where one or more cycle has passed unobserved. Column 5 is the maximum magnitude, column 6 the calculated date of maximum relative to the epoch of JD 2447700, and column 7 the O–C value based on the derived mean period of 298.1 days.

A number of O–C diagrams were constructed for various periods between 296 and 302 days but none of these was considered truly reliable over the full 33 observed cycles. Mean periods were then determined over four portions of the overall interval. Here, cycles –11 to 0(E) gave a mean of 302.0 days, cycles 1 to 11 gave 298.5 days, cycles 12 to 18 gave 299.7 days, and the overlapping cycles 16 to 22 gave 296.5 days.

This merely demonstrates the instability of pulsations in NSV 19431, a well-known feature of the Mira-type stars. Here, the changing slope of the O–C

curve may simply represent random cycle-to-cycle fluctuations in the observed period, as first described by Eddington and Plakidis (1929) and further discussed by Percy and Colivas (1999) and Templeton *et al.* (2005). It is unfortunate that NSV 19431 had not been noted earlier and under observation over a longer time span to allow for better study of this feature.

The O–C diagram shown in Figure 1 is based on the period 298.1 days, representing the mean period of cycles 0 through 22; the earlier cycles are clearly of longer mean length.

The variations in the O–C data suggest NSV 19421 may be an interesting star for ongoing study, and observers are therefore encouraged to obtain brightness measurements on a regular basis.

Nothing can be said about the behavior of NSV 19431 when at minimum but the shape of the light curve suggests it falls well below the threshold magnitude 15 of the telescopes used. The observed upper limits, where the variable star was invisible and typically fainter than visual magnitude 14 to 15, do, however, exclude a cycle length shorter than the value derived here.

Elements for determining the dates of maximum brightness are currently satisfied by JD 2447700 ± 298.1 days (±10 days).

2.2. YY Centauri

YY Cen is found to be a Mira variable of mean period 371.3 days over the 27 observed cycles spanning 10,024 days, with maximum visual brightness ranging between 10.5 and 12.0. During the twenty-eight years 1980 through 2007 individual cycles ranged between 345 and 397 days, with unusually short or long cycles resulting in a marked shift in the O–C dates of subsequent maxima.

Details of the 28 observed cycles are listed in Table 2 in the same format as given for NSV 19431.

The resulting O–C diagram is shown as Figure 2. Here, the cycles of markedly longer or shorter period are marked and clearly indicate turning points in the O–C curve, as would be expected. As is the case with NSV 19431, it is unfortunate that the available observations do not cover a much longer time span to allow for a better understanding of this star's behavior. Observers are therefore encouraged to monitor YY Cen on a regular basis.

For the purposes of determining the dates of maximum brightness the elements are JD 2446987 ± 371.3 days (±10 days). This is, however, subject to some uncertainty due to the demonstrated behavior of this star which may result in substantial shift in the O–C values.

No information is available regarding minimum brightness as YY Cen falls below the limiting magnitude of the telescopes used. The upper limits when the variable is invisible do exclude a period shorter than that derived here.

3. Conclusion

Both NSV 19431 and YY Cen are shown to be typical Mira type variables. Elements for determining the dates of maximum brightness of NSV 19431 are JD 2447700 ± 298.1 days (±10 days). At maximum it ranges between visual magnitude 10.8 and 12.8 and falls fainter than 15.0 at minimum.

The dates of maximum brightness for YY Cen are determined by the elements JD 2446987 ± 371.3 days (±10 days). It has a maximum visual brightness ranging between 10.5 and 12.0 and falls below magnitude 15 at minimum.

Both NSV 19431 and YY Cen have shown changes in their O–C values that appear to be random cycle-to-cycle variations and both stars may be interesting objects for ongoing study.

References

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Table 1. Details of observed cycles for NSV 19431, 1980 through 2007.

Cycle	*JD 2400000+*	*Weight*	*Interval*	*Mag.*	*C (298.1) 2400000+*	*O–C*
–11	44378	1	239	11.4	44420.9	–42.9
–10	44667	1	306	12.0	44719.0	–52.0
–9	44973	2	(593)	11.5	45017.1	–44.1
–7	45566	1	327	12.8	45613.3	–47.3
–6	45893	1	292	11.3	45911.4	–18.1
–5	46185	2	(593)	11.6	46209.5	–24.5
–3	46778	2	(625)	11.6	46805.7	–27.7
–1	47403	1	297	11.4	47401.9	–1.1
0	47700	1	296	11.6	E	E
1	47996	1	284	11.5	47998.1	–2.1
2	48280	3	(943)	11.5	48296.2	–16.2
5	48223	1	275	11.6	49190.5	+32.5
6	49498	1	306	11.6	49488.6	+9.4
7	49804	3	(1179)	10.8	49786.7	+17.3
11	50983	1	306	11.6	50979.1	+3.9
12	51289	1	298	11.6	51277.2	+11.8
13	51587	2	(638)	11.9	51575.3	+11.7
15	52225	1	254	11.5	52171.5	+53.5
16	52479	1	298	11.4	52469.6	+9.4
17	52777	1	304	11.4	52767.7	+9.3
18	53081	3	(881)	13.0	53065.8	+15.2
21	53962	1	296	11.3	53960.1	+1.9
22	54258	1	—	12.1	54258.2	–0.2

(Weight 1 = best, 3 = worst)

Table 2. Details of observed cycles for YY Cen, 1980 through 2007.

Cycle	*JD 2400000+*	*Weight*	*Interval*	*Mag.*	*C (371.3) 2400000+*	*O–C*
–7	44304	2	374	10.6	44297.9	+6.1
–6	44678	1	379	11.6	44669.2	+8.8
–5	45057	1	379	10.8	45040.5	+16.5
–4	45436	2	359	12.0	45411.8	+24.2
–3	45795	1	369	10.8	45783.1	+11.9
–2	46164	1	388	11.4	46154.4	+9.6
–1	46552	1	345	11.0	46525.7	+26.3
0	46897	1	379	11.5	E	E
1	47276	1	379	11.0	47268.3	+7.7
2	47655	2	354	10.7	48639.6	+15.4
3	48009	1	369	11.4	48010.9	–1.9
4	48378	1	367	11.0	48382.2	–4.2
5	48745	1	364	10.8	48753.5	–8.5
6	49109	1	364	10.6	49124.8	–15.8
7	49473	1	372	10.8	49496.1	–23.1
8	49845	2	362	10.7	49867.4	–22.4
9	50207	1	364	12.0	50238.7	–31.7
10	50571	2	384	10.6	50610.0	–39.0
11	50955	1	371	10.8	50981.3	–26.3
12	51326	1	367	10.7	51352.6	–26.6
13	51693	1	378	10.6	51723.9	–30.9
14	52071	1	374	11.3	52095.2	–24.4
15	52445	1	369	10.6	52466.5	–21.5
16	52814	1	379	10.8	52837.8	–23.8
17	53193	1	397	11.0	53209.1	–16.1
18	53590	1	367	11.3	53580.4	+9.6
19	53957	1	371	11.2	53951.7	+5.3
20	54328	2	—	10.8	54323.0	+5.0

(Weight 1 = best, 3 = worst)

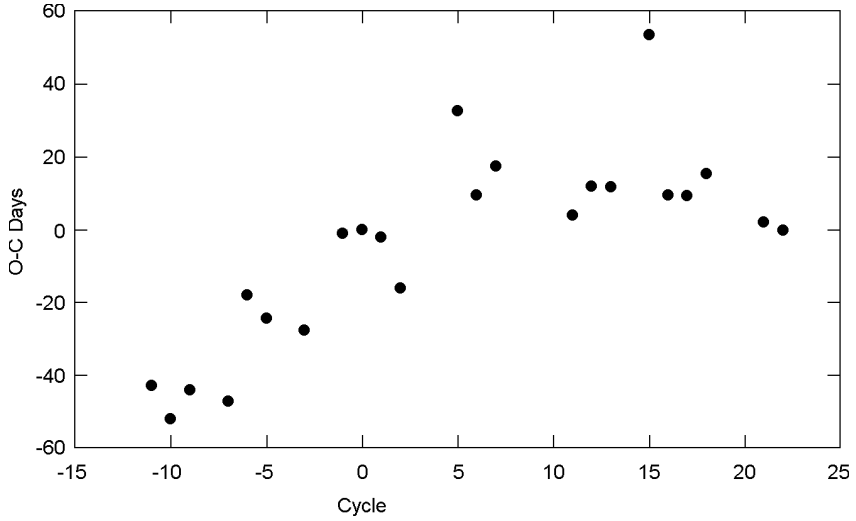

Figure 1. O–C diagram for NSV 19431, period 298.1 days.

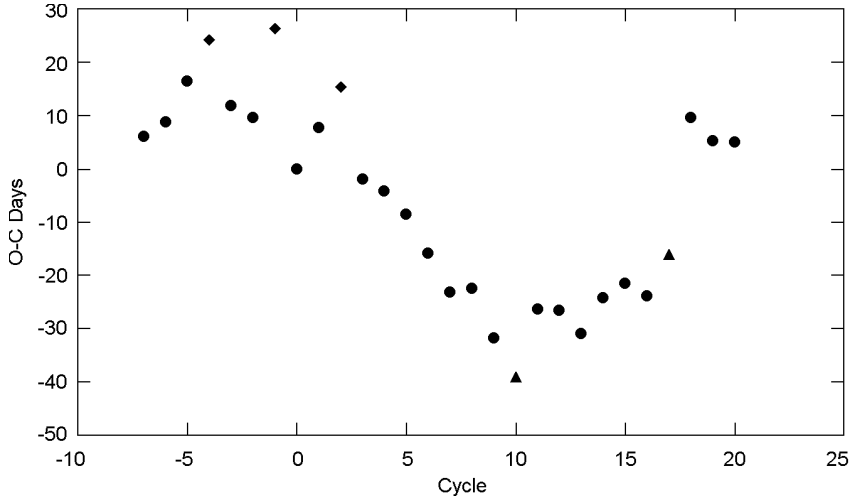

Figure 2. O–C diagram for YY Cen, period 371.3 days. Circles, near average cycle; diamonds, short cycle; triangles, long cycle.