

## THE ORBITS OF THE SPECTROSCOPIC BINARIES 1 HYDRAE AND 75 CANCRI<sup>1</sup>

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### ABSTRACT

*Orbits of the spectroscopic binaries, Boss 2227=1 Hydrae and Boss 2447=75 Cancri.*—These stars are of classes F1 and G2 and of visual magnitudes 5.7 and 6.0, respectively. Twenty-seven spectrograms of each give for the periods, 1.563 and 19.46 days; for  $e$ , 0.05 and 0.206; for  $K$ , 30.3 and 20.2 km/sec.; and for  $\gamma$ , +71.3 and +12.3 km/sec., respectively. Attention is called to the large  $\gamma$  for Boss 2227, and to the fact that Boss 2447 is a dwarf star. Radial velocity-curves are shown.

A previous paper<sup>2</sup> discusses the orbits of seven spectroscopic binaries; the present note gives the orbits of two additional binaries. The general remarks which precede the discussions of individual stars in the first paper are equally applicable here and need not be repeated.

The data in Table I, except for the last column which gives the number of revolutions of the star in its orbit between the first and last observations, are taken from the list of spectroscopic

TABLE I

| Name                | Vis.<br>Mag. | $\alpha$ (1900)                  | $\delta$ (1900) | Spectral<br>Class | Vis.<br>Abs.<br>Mag. | $\mu$  | $\pi_{sp}$ . | No.<br>Rev. |
|---------------------|--------------|----------------------------------|-----------------|-------------------|----------------------|--------|--------------|-------------|
| Boss 2227-1 Hydrae  | 5.7          | 8 <sup>h</sup> 19 <sup>m</sup> 6 | - 3°26'         | F1                | +3.6                 | 0".216 | 0".038       | 340         |
| Boss 2447-75 Cancri | 6.0          | 9 2.9                            | +27 3           | G2                | +4.1                 | 0.404  | 0.042        | 59          |

parallaxes of 1646 stars.<sup>3</sup> Figures 1 and 2 show the radial velocity-curves. In the following pages the derivation of the orbits of these two spectroscopic binaries is discussed.

### BOSS 2227

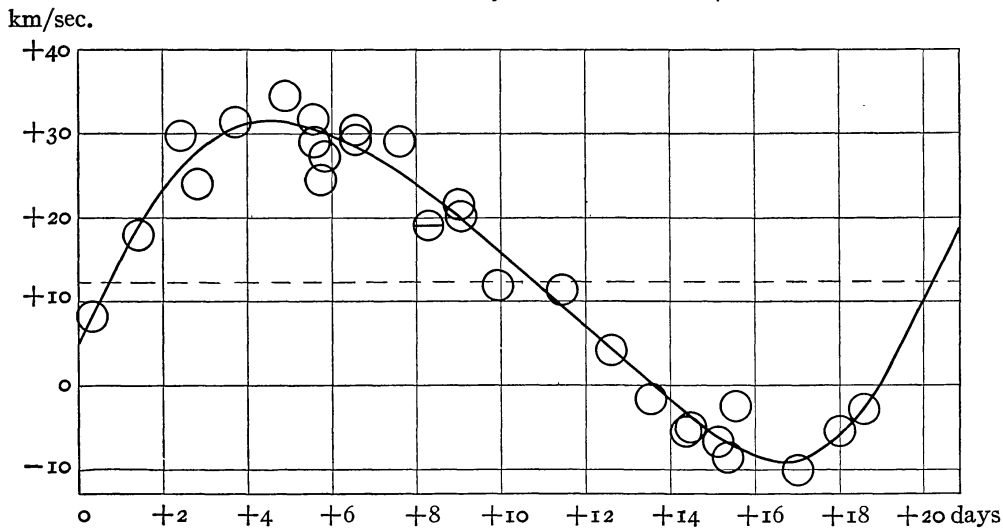
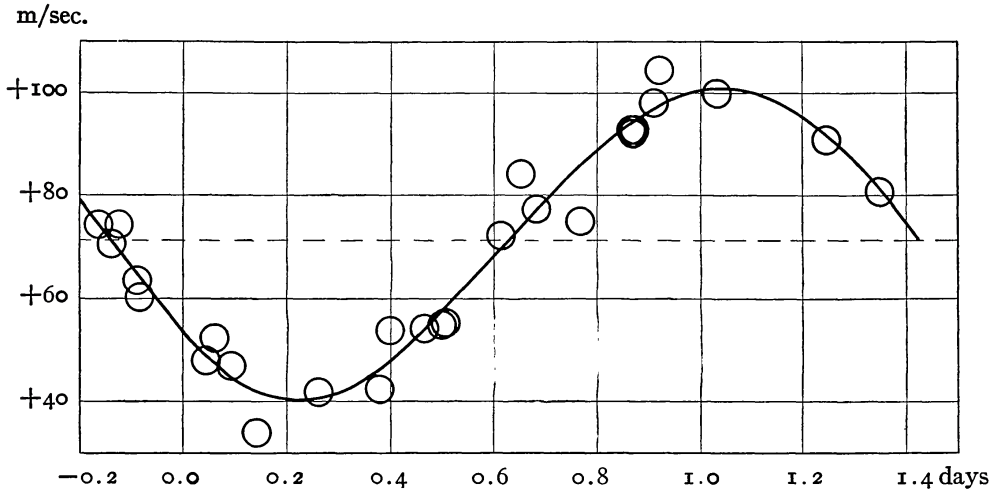
Measures of the first two spectrograms of this star by Professor H. C. Wilson showed that its radial velocity is variable. Accordingly observations were started immediately for the determination

<sup>1</sup> *Contributions from the Mount Wilson Observatory*, No. 221.

<sup>2</sup> *Mt. Wilson Contr.*, No. 201; *Astrophysical Journal*, 53, 201, 1921.

<sup>3</sup> *Mt. Wilson Contr.*, No. 199; *Astrophysical Journal*, 53, 13, 1921.

of the elements of its orbit. Twenty-seven suitable spectrograms are listed in Table II. The derivation of the correct period presented some difficulty at first because of its shortness. Finally,



all observations were gathered into one period in a satisfactory manner when  $P=1.562975$  days was used. Since approximately 340 revolutions of the star in its orbit occurred between the first and last observations it seemed needless to endeavor to correct the period, and therefore the value given above has been taken as final.

With preliminary elements derived by Russell's method, an ephemeris was computed and the residuals (O-C) derived. The spectrum is of Class F<sub>1</sub>, with only one set of lines which at best yields a velocity of only fair precision and which varies so in quality

TABLE II  
OBSERVATIONS OF BOSS 2227

| Plate No.   | Date         | G.M.T.                         | Phase              | Weight | Velocity | O-C     |
|-------------|--------------|--------------------------------|--------------------|--------|----------|---------|
|             |              |                                |                    |        | km/sec.  | km/sec. |
| γ 8860..... | 1919 Nov. 12 | 0 <sup>h</sup> 43 <sup>m</sup> | 0 <sup>d</sup> 062 | 0.75   | + 52.2   | + 4.9   |
| 9109.....   | 1920 Apr. 4  | 15 11                          | 0.870              | 0.75   | + 92.6   | - 1.8   |
| 9666.....   | Oct. 26      | 0 19                           | 0.501              | 1.00   | + 54.6   | - 2.7   |
| 9687.....   | 29           | 0 24                           | 0.380              | 0.75   | + 42.4   | - 3.9   |
| C 741.....  | Nov. 1       | 0 40                           | 0.262              | 0.75   | + 41.8   | + 1.3   |
| γ 9705..... | 2            | 0 13                           | 1.246              | 1.00   | + 90.6   | - 1.2   |
| 9723.....   | 20           | 0 36                           | 0.506              | 0.50   | + 55.0   | - 2.8   |
| 9732.....   | 20           | 23 58                          | 1.479              | 0.75   | + 60.3   | - 3.6   |
| 9738.....   | 21           | 22 47                          | 0.867              | 1.00   | + 92.8   | - 1.4   |
| 9747.....   | 23           | 1 06                           | 0.401              | 0.50   | + 53.7   | + 5.8   |
| C 778.....  | 24           | 1 28                           | 1.416              | 1.00   | + 70.9   | - 0.8   |
| γ 9809..... | Dec. 22      | 22 55                          | 0.614              | 1.00   | + 72.1   | + 2.4   |
| 9893.....   | 1921 Feb. 15 | 16 47                          | 0.653              | 0.50   | + 84.0   | + 9.9   |
| 9897.....   | 17           | 15 22                          | 1.031              | 0.75   | + 99.9   | - 0.7   |
| 9934.....   | 21           | 18 20                          | 0.466              | 0.75   | + 54.1   | + 0.4   |
| C 897.....  | 22           | 18 29                          | 1.473              | 1.00   | + 63.5   | - 1.2   |
| γ 9940..... | 23           | 18 32                          | 0.910              | 1.00   | + 98.0   | + 1.2   |
| 9957.....   | 25           | 19 46                          | 1.400              | 0.75   | + 74.2   | - 0.2   |
| 9995.....   | Mar. 16      | 14 50                          | 1.439              | 1.00   | + 74.4   | + 5.2   |
| 9999.....   | 16           | 18 52                          | 0.045              | 1.00   | + 48.0   | - 0.9   |
| 10003.....  | 17           | 14 42                          | 0.871              | 1.00   | + 92.8   | - 1.6   |
| 10012.....  | 19           | 15 42                          | 1.349              | 0.75   | + 80.6   | - 0.2   |
| 10046.....  | 24           | 15 19                          | 0.095              | 1.00   | + 46.9   | + 1.8   |
| 10091.....  | Apr. 17      | 16 25                          | 0.682              | 0.50   | + 77.3   | + 0.1   |
| 10099.....  | 18           | 17 03                          | 0.143              | 0.50   | + 33.9   | - 8.0   |
| 10124.....  | 25           | 17 40                          | 0.920              | 1.00   | + 104.4  | + 7.0   |
| 10139.....  | 28           | 17 04                          | 0.768              | 0.75   | + 75.0   | - 11.0  |

from plate to plate that it has seemed advisable to assign weights to the measures of different plates. The best have been given weight unity and the rest weight 0.75 to 0.50, according to the inherent quality of the lines, or their quality as affected by photographic density, focus, etc., or a combination of these circumstances. The twenty-seven observations were converted into seventeen normal places, assigned proper weights and then used to correct the preliminary elements by the method of least squares. With the elements thus corrected the quantity  $\Sigma pv^2$  is about 75 per cent

of its value when derived with the preliminary elements. The residuals obtained by substitution of the unknowns in the equations of condition agree satisfactorily with the residuals from an ephemeris based on the final elements. In Table III are to be found preliminary elements, corrections, final elements, and their probable errors. The probable error of a single observation of velocity of weight unity is  $\pm 2.64$  km/sec. The absolute magnitude (+3.6) is very nearly that of Class F stars of greatest frequency and is therefore typical.

TABLE III

| Preliminary Elements |                  | Corrections   | Final Elements           |
|----------------------|------------------|---------------|--------------------------|
| $P$                  |                  | .....         | 1.562975 days            |
| $e$                  | 0.08             | -0.029        | 0.051 $\pm$ .035         |
| $\omega$             | 119°             | +4.92         | 123.92 $\pm$ 34.4        |
| $K$                  | 30.5 km/sec.     | -0.22 km/sec. | 30.28 $\pm$ 1.38 km/sec. |
| $T$                  | J.D. 2422650.073 | +0.009        | 2422650.082 $\pm$ 0.132  |
| $\gamma$             | +71.7 km/sec.    | -0.40 km/sec. | +71.3 km/sec.            |
| $a \sin i$           |                  | .....         | 650000 km                |
| $m^3 \sin^3 i$       |                  | .....         |                          |
| $(m+m_1)^2$          |                  | .....         | 0.0045 $\odot$           |

## BOSS 2447

This was announced as a spectroscopic binary in a list published by Adams and Joy.<sup>1</sup> The single set of lines appearing on its spectrograms, which show that its class is G2 and its absolute magnitude +4.1, is quite satisfactory for measurement on properly exposed plates. Table IV gives the data for the twenty-eight plates which have been obtained. With  $P=19.4589$  days all observations arranged themselves satisfactorily within a single period and furnished the basis for the preliminary elements. Since the observations extend over an interval of approximately sixty revolutions of the star in its orbit, this period was taken as definitive. By the method of least squares the other five elements were corrected, equal weights being given to all of the twenty-seven plates which were used. Plate  $\gamma$  6662, whose residual stood out as the only large one, was arbitrarily rejected from the least-squares solution, and Plate  $\gamma$  9997 was obtained after the elements were

<sup>1</sup> *Publications of the Astronomical Society of the Pacific*, 31, 41, 1919.

derived. Data for both plates are given in Table IV, however. The quantity  $\Sigma pv^2$  derived from the elements, corrected as indicated by the solution given above, is 18 per cent less than for the preliminary elements, and substitution of the unknowns into the equations of condition gave residuals comparable with those

TABLE IV  
OBSERVATIONS OF BOSS 2447

| Plate No.          | Date         | G.M.T.                         | Phase              | Velocity | O-C     |
|--------------------|--------------|--------------------------------|--------------------|----------|---------|
|                    |              |                                |                    | km/sec.  | km/sec. |
| $\gamma$ 6396..... | 1917 Nov. 27 | 0 <sup>h</sup> 01 <sup>m</sup> | 9 <sup>d</sup> 021 | +21.6    | + 1.5   |
| 6591.....          | 1918 Jan. 22 | 22 51                          | 7.598              | +29.1    | + 3.8   |
| 6662*.....         | 30           | 22 19                          | 15.574             | + 4.3    | +11.8   |
| 6706.....          | Feb. 28      | 20 43                          | 5.589              | +29.0    | - 1.4   |
| 6894.....          | May 1        | 16 59                          | 9.057              | +20.2    | + 0.3   |
| 6943.....          | 30           | 16 43                          | 18.589             | - 2.8    | - 0.3   |
| C 346.....         | 1920 Apr. 3  | 15 02                          | 11.456             | +11.4    | + 1.8   |
| 352.....           | 4            | 18 43                          | 12.609             | + 4.2    | - 0.1   |
| 356.....           | 5            | 17 00                          | 13.537             | - 1.6    | - 1.8   |
| $\gamma$ 9123..... | 6            | 15 22                          | 14.469             | - 5.0    | - 1.2   |
| 9130.....          | 7            | 17 04                          | 15.540             | - 2.5    | + 4.9   |
| 9179.....          | May 6        | 15 39                          | 5.563              | +31.7    | + 1.2   |
| 9186.....          | 7            | 15 35                          | 6.560              | +30.4    | + 2.0   |
| C 410.....         | 7            | 15 35                          | 6.560              | +29.3    | + 0.9   |
| $\gamma$ 9255..... | June 4       | 16 16                          | 15.130             | - 6.7    | - 0.5   |
| 9266†.....         | 6            | 15 58                          | 17.017             | -10.1    | - 1.2   |
| 9272.....          | 7            | 15 56                          | 18.016             | - 5.4    | + 0.6   |
| 9667.....          | Oct. 26      | 0 52                           | 2.813              | +24.0    | - 3.9   |
| 9688.....          | 29           | 1 03                           | 5.821              | +27.3    | - 2.7   |
| 9767.....          | Nov. 26      | 1 05                           | 14.367             | - 5.5    | - 2.1   |
| 9774.....          | 27           | 0 53                           | 15.359             | - 8.6    | - 1.8   |
| 9876.....          | 1921 Jan. 28 | 20 14                          | 0.326              | + 8.2    | - 0.1   |
| 9886.....          | 29           | 22 21                          | 1.414              | +17.9    | - 0.8   |
| 9889.....          | 30           | 22 33                          | 2.422              | +29.8    | + 3.9   |
| 9927.....          | Feb. 20      | 16 36                          | 3.716              | +31.4    | + 0.8   |
| 9935.....          | 21           | 20 56                          | 4.896              | +34.5    | + 3.3   |
| C 896.....         | 22           | 17 10                          | 5.739              | +24.4    | - 5.7   |
| $\gamma$ 9969..... | 26           | 21 46                          | 9.930              | +11.9    | - 4.4   |
| 9997‡.....         | Mar. 16      | 17 06                          | 8.277              | +19.2    | - 3.7   |

\* Not used in least-squares solution.

† Poor plate.

‡ This plate obtained after elements were derived.

derived from an ephemeris calculated with the corrected elements, which are therefore adopted as final. The preliminary elements, corrections, final elements, and probable errors are given in Table V. The probable error of a single observation of velocity of weight unity is  $\pm 1.74$  km/sec. The barred circle in Figure 2 represents the velocity from Plate  $\gamma$  9997.

TABLE V

| Preliminary Elements |                  | Corrections         | Final Elements                   |
|----------------------|------------------|---------------------|----------------------------------|
| $P$                  |                  | .....               | 19.4589 days                     |
| $e$                  | .200             | + .006              | 0.206 ± .002                     |
| $\omega$             | 248° 5           | +4° 00              | 252° 5 ± 7° 70                   |
| $K$                  | 20.5 km/sec.     | -0.29 km/sec.       | 20.21 ± 0.49 km/sec.             |
| $T$                  | J.D. 2422426.555 | +0 <sup>d</sup> 079 | 2422426.634 ± 0 <sup>d</sup> 384 |
| $\gamma$             | +12.49 km/sec.   | -0.16 km/sec.       | +12.3 km/sec.                    |
| $a \sin i$           |                  | .....               | 5295900 km                       |
| $m^3 \sin^3 i$       |                  | .....               |                                  |
| $(m+m_1)^2$          |                  | .....               | 0.0157 ☉                         |

MOUNT WILSON OBSERVATORY  
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