COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS

Number 3146

Konkoly Observatory
Budapest
9 February 1988

HU ISSN 0374-0676

TW HYA: A T TAURI STAR FAR FROM ANY DARK CLOUD UBVRI OBSERVATIONS IN 1986 AND 1987

TW Hya is one of the most interesting objects among young late-type stars. Herbig (1978) pointed it out as a possible candidate for being one of – then very rare – post-T Tauri stars. However, a multi-angled investigation of Rucinski and Krautter (1983; hereinafter RK) definitely showed it to be an absolutely normal T Tauri star. The main point here is that TW Hya is quite far ($\simeq 13^0$) from any dark cloud, star formation complex, or other concentration of young proto-stellar material. Yet, it is definitely not "naked" – as defined by Walter (1987) for stars which exhausted supplies of the circumstellar accretable matter – and shows clear signatures of a classical T Tauri stage. TW Hya may have formed in an isolated small cloud, as de la Reza *et al.*, (1986) suggest, but it must have retained enough circumstellar matter to insure the continuing accretion.

The variability of TW Hya was observed in 1982 to be quite erratic (RK). Short time-scale trends of a few hours in duration were seen to be superimposed on, or combined with longer night-to-night variations. The total range was $10.9 < V < 11.3$. The colours were redder for lower brightness, but parallel trends in colour–magnitude plots on individual nights suggested a few sources simultaneously contributing to the variability. Dr. F. Vrba (private communication) noticed a possible periodicity of about 2 days in the RK data which could have been the spot modulation, as observed in other T Tauri and naked T Tauri stars (Bouvier *et al.*, 1986a, 1986b; Herbst 1986; Rydgren and Vrba 1983; Rydgren *et al.*, 1984). An independent analysis of the RK data has shown that such a periodicity is definitely present. Unfortunately, its reality may be questioned because it is practically identical with the quasi-Nyquist frequency for the data sampled in close groups at one-day intervals.

The present observations were obtained in June 1986 and in March 1987 at the Las Campanas observatory using the 61 cm telescope of the University of Toronto and the single-channel photometer. The E regions were observed to place the observations in the Cousins $UBVR_CI_C$ system. The weather conditions were quite poor during both runs. The observations were made differentially relative to the same comparison stars as used in 1982. The new determinations of the $UBVRI$ data for the comparison stars were made on 7 nights in 1986 and 5 nights in 1987 (Table I). When compared with the 1982 data which were obtained during perfect weather conditions at ESO, the new data reveal a generally good agreement of colours but some shifts in the V magnitudes. Since the magnitude difference between the comparison stars also changed, we may suspect some small long-term variability (by about 0.04 – 0.08 in V) in one or both stars. This would not entirely unexpectable in view of both comparison stars most probably being late-type giants.

The new data for TW Hya are listed in Table II and are shown in graphical form in the figure. The picture is exactly the same as in 1982. The range of variability

Table I

THE COMPARISON STARS FOR TW HYA

$U-B$	$B-V$	V	$V-R_C$	$V-I_C$	Reference
C1 (SAO 202005)					
1.095	1.172	9.116	0.599	1.139	Rucinski and Krautter (1983)
1.071	1.152	9.072	0.586	1.163	Las Campanas 1986
1.080	1.156	9.090	0.570	1.158	Las Campanas 1987
C2 (HD 95470, SAO 202001, K 2/3 III)					
1.412	1.307	8.744	0.678	1.273	Rucinski and Krautter (1983)
1.406	1.275	8.652	0.662	1.300	Las Campanas 1986
1.418	1.278	8.664	0.647	1.288	Las Campanas 1987

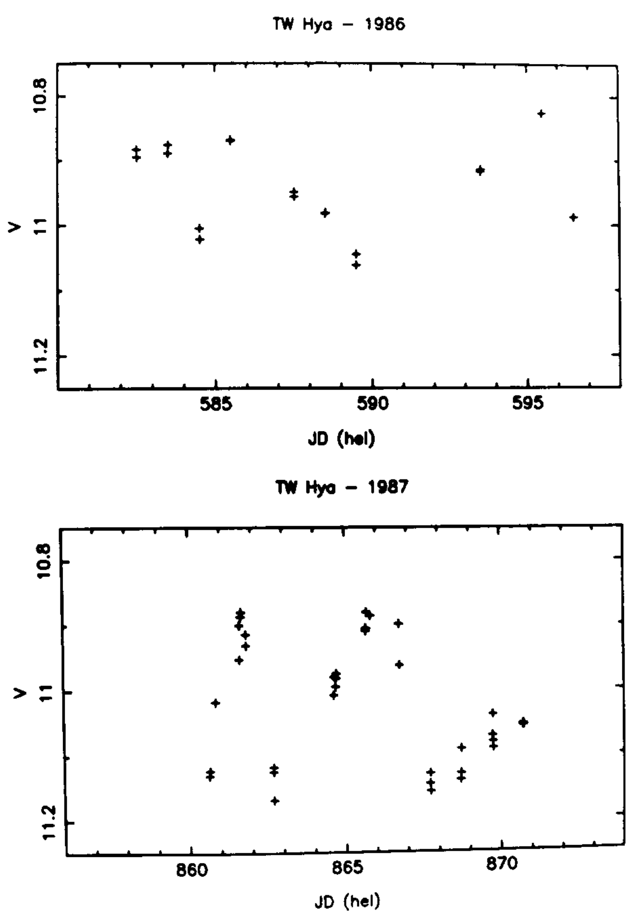

Figure 1

Table II

$UBVR_CI_C$ OBSERVATIONS OF TW HYA

JD(hel) 2 446 000 +	$U-B$	$B-V$	V	$V-R_C$	$V-I_C$
582.523	–0.44:	0.930	10.884	0.850	1.586
582.527	–0.36:	0.891	10.896	0.850	1.575
583.506	–0.27	0.983	10.890	0.845	1.575
583.514	–0.29	0.987	10.877	0.845	1.572
584.507	–0.28	1.085	11.005	0.905	1.678
584.518	–0.26	1.091	11.022	0.907	1.679
585.494	–0.27	0.867	10.871	0.837	1.544
585.498	–0.33	0.885	10.869	0.819	1.522
587.512	–0.30	1.020	10.950	0.878	1.630
587.516	–0.30	1.056	10.957	0.886	1.637
588.507	–0.20	1.022	10.983	0.885	1.635
588.518	–0.14	1.016	10.982	0.877	1.617
589.493	–0.20:	1.122	11.062	0.933	1.696
589.498	–0.31:	1.087	11.045	0.926	1.674
593.501	–0.31:	1.003	10.917	0.875	1.590
593.510	–0.40:	0.982	10.913	0.866	1.621
595.493	–0.58	0.921	10.826	0.893	1.556
596.512	–0.22:	0.993	10.987	0.895	1.642
860.637	0.06	1.186	11.130	0.945	1.712
860.657	–0.09	1.150	11.122	0.935	1.705
860.853	–0.05	0.999	11.017	0.885	1.628
861.616	–0.31	0.932	10.952	0.867	1.564
861.624	–0.24	0.974	10.900	0.845	1.577
861.668	–0.31	0.916	10.887	0.827	1.545
861.676	–0.26	0.937	10.880	0.816	1.545
861.823	–0.21	0.941	10.914	0.851	1.555
861.831	–0.28	0.957	10.931	0.865	1.565
862.682	0.12	1.197	11.124	0.932	1.707
862.689	0.06	1.164	11.117	0.947	1.735
862.698	0.18	1.131	11.168	0.937	1.710
864.631	–0.24	1.074	11.007	0.900	1.623
864.642	–0.30	1.093	10.979	0.893	1.626
864.696	–0.38	1.037	10.994	0.889	1.618
864.704	–0.21	0.988	10.981	0.895	1.619
864.716	–0.26	1.010	10.974	0.892	1.611
865.667	–0.35	1.053	10.909	0.845	1.576
865.675	–0.40	0.937	10.905	0.841	1.561
865.688	–0.30	0.935	10.880	0.825	1.532
865.813	–0.28	0.954	10.885	0.825	1.545
866.736	–0.34	0.971	10.898	0.908	1.568
866.748	–0.47	0.991	10.961	0.941	1.612
867.708	0.09	1.175	11.144	0.900	1.717
867.716	0.21	1.148	11.128	0.914	1.693
867.731	0.39	1.281	11.156	0.928	1.706
868.689	–0.04	1.166	11.138	0.921	1.705
868.706	0.40	1.211	11.128	0.904	1.659
868.714	0.27	1.221	11.090	0.900	1.685
869.722	0.15	1.015	11.070	0.874	1.654
869.730	0.23	1.241	11.038	0.879	1.632
869.738	–0.19	1.120	11.079	0.910	1.658
869.746	0.17	1.226	11.089	0.907	1.695
870.707		1.131	11.055	0.917	1.658
870.714		1.039	11.052	0.909	1.663
870.722		1.046	11.054	0.916	1.646

is similar, as is a general relationship between brightness and colours. The data were analysed for periodicity but, contrary to the 1982 observations, they do not reveal any clear signal of a few days in duration. This does not prove that the 2-day periodicity observed before was entirely spurious because this time scale is actually the hardest to prove or disprove anyway. A visual inspection of nightly data again seems to suggest existence of trends with a characteristic scale of about 0.2 day.

This work has been supported by an operating grant of the Natural Sciences and Engineering Research Council of Canada.

S. M. RUCINSKI
David Dunlap Observatory
University of Toronto
P. O. Box 360
Richmond Hill, Ontario L4C 4Y6
Canada

References:

Bouvier, J., Bertout, C., and Bouchet, P. 1986a, Astron. Astrophys. **158**, 149.

Bouvier, J., Bertout, C., Benz, W., and Mayor, M. 1986b, Astron. Astrophys. **165**, 110.

de la Reza, R., Quast, G., Torres, C. A. O., Mayor, M., Meylan, G., Llorente de Andrés, F. 1986, in *New Insights in Astrophysics*, ESA SP-263, p.107.

Herbig, G. H. 1978, in *Problems of Physics and Evolution of the Universe*, ed. L.V.Mirzoyan, Publ.Armenian Acad.Sci., Yerevan, p.171.

Herbst, W. 1986, Publ. Astron. Soc. Pacific, **98**, 1088.

Rucinski, S. M., and Krautter, J. 1983, Astron. Astrophys. **121**, 217.

Rydgren, A. E., and Vrba, F. J. 1983, Astrophys.J. **267**, 191.

Rydgren, A. E., Zak, D. S., Vrba, F. J., Chugainov, P. F., Zajtseva, G. W. 1984, Astron. J. **89**, 1015.

Walter, F. M. 1987, Publ. Astron. Soc. Pacific, **99**, 31.