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OBSERVATIONS OF VARIABILITY IN OJ 287

S. GOLDSMITH AND D. WEISTROP
The Florence and George S. Wise Observatory, Department of Physics and Astronomy, Tel-Aviv University, Israel
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ABSTRACT

Photographic observations in *V* and *B* of the radio source OJ 287 have been made in 1972 February–May. The shortest period in which the variations were looked for was 5 minutes. On a timescale of days OJ 287 seems to have periods of intensive activity, variations of 0.3 mag, and periods of inactivity. The data do not indicate variations over a period of minutes.

Subject headings: radio sources — variable stars

I. INTRODUCTION

Recent investigations of OJ 287 have indicated that this object is exceptionally active, showing strong variability in both optical and radio wavelengths (Kinman and Conklin 1971; Andrew, Harvey, and Medd 1971; Bertaud and Pollas 1972). Kinman and Conklin have reported variations of the order of 0.2–0.3 mag taking place over periods of a few days. These results are supported by the observations of Bertaud and Pollas, which show similar short-term variations. Andrews *et al.* find long-term changes of a factor of 3 in the radio flux density, for observations made during 1970 and 1971. There is also some indication that the optical and radio variations are correlated. To further investigate the nature of the optical variations of OJ 287, a program to monitor this object was initiated at the Wise Observatory in 1972 February. We report here the results of this program for the recently completed observing season.

II. OBSERVATIONS

Photographic observations of OJ 287 were made at least once a month from February through May of 1972, using the Cassegrain camera of the 40-inch (102-cm) telescope at the Wise Observatory. Observations in February consisted of a series of plates taken in *V* (emulsion 103a-D + Wratten 12 filter) and *B* (emulsion 103a-0 + Wratten 47 filter). In March, April, and May, observations were made in *B* only. Details of the observations are presented in table 1, where we present the date and time for each observation, the length of the exposure, and the magnitude of OJ 287. In many cases several exposures were made on one plate, the procedure being to move the telescope 12 arc seconds after each exposure.

All plates were measured using the astrophotometer at the observatory. Calibration was provided by eight standards in the field, which have been measured photoelectrically by Wing (1972). Photoelectric values for the blue magnitudes of four of these standards have previously been published by Kinman and Conklin. Each set of observations on each plate was reduced independently by the method of least squares. The standard deviation of all measurement was calculated to be 0.06 mag in *B* and 0.05 mag in *V*. Because Wing had indicated the possibility that his faintest standard might be variable, original data reductions were made assuming the magnitude of this star was to be derived. While we cannot draw any definite conclusions concerning the variability of the star from our calculated magnitudes, it was found that for four observations out of 59, the derived magnitudes deviated by more than 3 σ from the

TABLE 1

V AND *B* MAGNITUDES OF OJ 287

Date UT (1972)	Exposure (min)	*B*	*V*
Feb. 13.945....	15	13.07	...
Feb. 14.032....	30	...	12.65
Feb. 14.975....	10	13.03	...
	10	13.03	...
	10	13.09	...
Feb. 20.781....	5	...	12.77
	5	...	12.81
	5	...	12.76
	5	...	12.82
Feb. 20.811....	30	...	12.74
Feb. 20.900....	5	...	12.86
	5	...	12.85
	5	...	12.86
	5	...	12.79
Feb. 20.978....	5	...	12.70
	5	...	12.74
	5	...	12.75
	5	...	12.75
Feb. 21.751....	5	...	12.70
	5	...	12.75
	5	...	12.70
	5	...	12.72
Feb. 21.856....	5	...	12.78
	5	...	12.70
	5	...	12.79
	5	...	12.78
Feb. 21.880....	5	...	12.82
	5	...	12.88
	5	...	12.85
	5	...	12.78
Feb. 22.764....	5	...	12.78
	5	...	12.79
	5	...	12.71
	5	...	12.84
Feb. 22.796....	5	...	12.82
	5	...	12.87
	5	...	12.86
	5	...	12.86
Feb. 22.823....	5	...	12.81
	5	...	12.78
	5	...	12.84
	5	...	12.91
Mar. 12.738...	5	13.15	...
	5	13.13	...
	5	13.16	...
	5	13.21	...
Apr. 9.788....	4	13.44	...
Apr. 9.804....	10	13.49	...
Apr. 12.719...	10	14.03	...
	10	13.93	...
May. 15.759...	10	13.62	...
	10	13.60	...
	10	13.62	...
May 16.755...	10	13.31	...
	10	13.31	...
	10	13.27	...
May 17.776...	10	13.67	...
	10	13.70	...
	10	13.60	...

mean magnitudes. If the star were constant, statistically we would expect no more than one observation to deviate by such an amount from the mean. Tests run on other standards did not indicate significant deviations from the mean magnitudes. We have therefore concluded that enough evidence exists for the variability of this star to justify excluding it from the reduction of the observations of OJ 287. In the final reductions the calibration curve is therefore determined using the seven remaining photoelectric standards. The magnitudes calculated for OJ 287 are presented in table 1. We note that the blue magnitudes determined for February 13 and 14 agree quite well with the results of Williams *et al.* (1972) for these dates.

III. DISCUSSION

The *V*-magnitudes of OJ 287 are plotted as a function of time in figure 1. The total length of the error bar in the figure is 2 σ. All magnitude variations in *V* are within 2 σ of the mean value, indicating the absence of variability greater than 0.2 mag during the period of the observations. From the data, we cannot exclude variations of less than 0.2 mag. It is interesting to note that the blue magnitudes observed by Williams *et al.* on the same nights indicate similar quiescent behavior. In general, our data indicate that detectable variations occur over a period of hours, not minutes, in agreement with the results of Kinman and Conklin.

The blue magnitudes as a function of time are plotted in figure 2. Perhaps the most

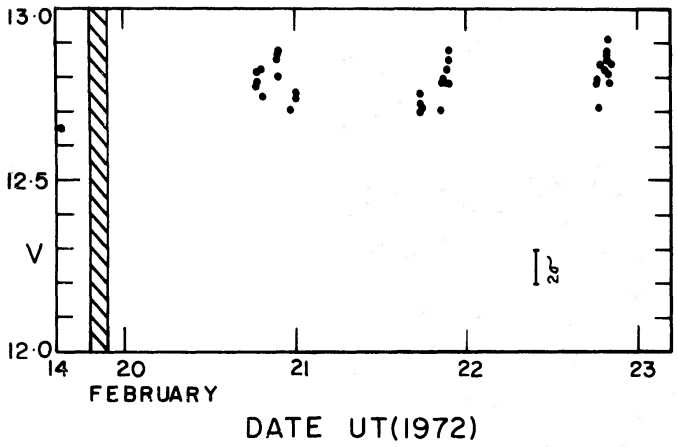

FIG. 1.—*V* magnitude of OJ 287 as a function of time

striking aspect of the figure is the strong variability displayed by OJ 287 over a four-day period in April, and a three-day period in May, in contrast to the quiescent behavior exhibited in February. Thus, OJ 287 seems to have periods of intensive activity and periods of inactivity, and conclusions drawn from limited amounts of data must be considered tentative at best. The data indicate daily variations of 0.3 mag and a change of 0.5 mag over one period of four days. Kinman and Conklin have observed variations of 0.3–0.4 mag over periods of a few days, while Williams *et al.* have observed variations of about 0.1 mag with a timescale of six to seven days. In addition, we note a change in magnitude greater than 0.8 mag for the period between March 12 and April 12, and a variation of about 0.7 mag between April 12 and May 16. Comparison of the February data with that for May indicates a decrease in brightness of at least 0.2–0.3 mag. The data of Bertaud and Pollas for 1971 October–December indicate variations of less than 0.2 mag around a mean value of $B = 12.80$. Thus, the combined data seem to indicate that, since the end of 1971, OJ 287 has been growing fainter. Tsesevich (1972) has suggested the presence of a $26^{d}2$ period, with amplitude of about 1 mag. Comparison of the results for February 14 with those for March 12 indicate that these data are consistent with such a period. However, comparison of the blue magnitudes on March 12 and April 12 seem to contradict a periodicity of 26 days even taking into account daily changes of 0.2 mag. If we assume a periodicity of 26

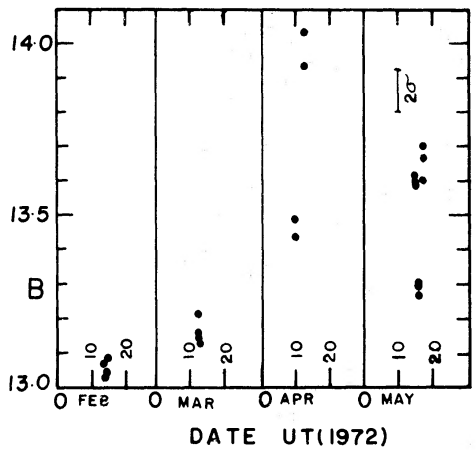

FIG. 2.—*B* magnitude of OJ 287 as a function of time

days, we must conclude that the object's intensity has decreased by 0.9 mag in the five days preceding April 12, a larger change than would have been expected from Tsesevich's results. More extensive observations will be required to determine what part of these variations are due to daily changes in magnitude, and what part to longer-term variations.

Observations of the radio spectrum of OJ 287 (Blake 1970) have indicated that the source has a very unusual spectrum, not at all the type expected if the radiation is due to synchrotron emission. We suggest here that the unusual nature of the radio spectrum is partly due to the fact that observations at different frequencies were made at various times, in some cases a year or more apart, and that the unusual spectrum may just reflect variations with time in the source. We do not suggest that the low flux at 178 MHz results from such variations.

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