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NOTES FOR THE OBSERVER

by T. P. Prabhu

1. Cataclysmic variables

Chinese and Japanese annals are replete with the descriptions of sudden appearances of 'guest stars' in the sky. While some of these could merely be comets, a few like the one in Lupus (1006 A.D.) and another in Taurus (1054 A.D.) are identified with supernovae which are stellar explosions occurring at the exhaustion of nuclear fuels. The only modern examples of such an event in our own Galaxy are those of Tycho Brahe's star in Cassiopeia (1572) and Kepler's star in Ophiuchus (1604). Such a star was initially called a 'nova stella', a new star, and later shortened simply to a 'nova'. The latter term is currently applied to stellar eruptions of a lower degree, more commonly seen in the Galaxy. The explosions of a higher degree, like the events of 1572 and 1604, are now called supernova events.

The first recorded nova in the modern times is CK Vulpeculae observed by Anthelm. Though this was the first variable discovered in Vulpecula, it carries a designation much later in the chronology of variable stars, because it was named only after novae were included in the category of variable stars. Another nova (WY Sagittae 1783) was observed in the following century by D'Agelet again named only much later. Several bright novae were discovered in the nineteenth century. The total number of confirmed novae now reaches nearly 200.

Two pioneer variable-star observers of this century, Cecelia Payne-Gaposchkin and Sergei Gaposchkin devised the term 'cataclysmic variables' to encompass a whole group of variable stars consisting of novae and systems similar to them. Four major classes of cataclysmic variables are (i) classical novae, (ii) recurrent novae, (iii) dwarf novae and (iv) novalike variables. Among these, the first three show eruptions whereas the last class is quiet, with spectroscopic resemblance to the minimum times of the other classes of cataclysmic variables.

The magnitudes and timescales of eruption vary among the three classes of novae; the more violent eruptions last less longer and repeat less often. The eruptions of classical novae release an energy of more than 10^{44} erg; the star brightens by more than nine magnitudes. A recurrence of the event has not been observed in the recorded history. The recurrent novae, on the other hand, repeat their performance every few decades. The range of the outburst lies between 7–9 magnitudes. The dwarf novae have further subgroups named after the prototypes U Geminorum and Z Camelopardalis. The U Geminorum type stars have an amplitude of 2–6 mag and recurrence times of 15–500 days while the Z Camelopardalis stars have slightly smaller amplitudes on an averge and recurrence times of 10–50 days.

A. H. Joy found in 1952 that the dwarf nova SS Cygni is a spectroscopic binary. Several cataclysmic variables have subsequently been discovered to be binary stars. The orbital periods are quite short —1–16 hours—with the exception of T Coronae Borealis which has a period of 227.5 d. With these observations, it appears fairly well established that cataclysmic variables are all binary systems. Currently well-accepted model for these systems is that of a white dwarf accreting matter from a companion filling its Roche lobe. In this model, the matter from the companion streams through the inner Lagrangian point and forms an accretion disc around the white dwarf because of its residual angular momentum. Further loss of angular momentum leads to its deposition on to the white dwarf. After a critical amount of matter is accumulated, the temperature at the inner region of the resultant envelope (which is in contact with the surface of the white dwarf) rises sufficiently to ignite thermonuclear reactions, This 'thermonuclear runaway' releases a large amount of energy in a short period of time causing an explosive ejection of the envelope in classical novae.

The evidence for a white dwarf primary comes basically from the rapid coherent oscillations observed in the light, generally during the outburst but at times even during the quiescent stages. Though such oscillations have been observed in only a few systems so far, they are observed from the representative members of each sub-class of cataclysmic variables. The amplitudes range from 0.001 to 0.04 magnitudes and periods from 16 to 71 seconds (Z Camelopardalis and nova DQ Herculis respectively). All the models advocated to explain these oscillations involve a white dwarf, nonradial pulsations of the white dwarf and accretion by a magnetic white dwarf being two of the possibilities.

The spectral type of the secondary is known only in a few cases. It is easier to observe the secondary when it is a late-type star, since one can look for its light in the red–infrared region of the spectrum. Late-type giants have been detected in recurrent novae T Coronae Borealis, RS Ophiuchi, V 1017 Sagittarii and in the slow nova RR Telescopii. On the other hand, the secondary of the nova GK persei is a K2 dwarf and that of Z Camelopardalis is a G dwarf. Thus it is not necessary for the secondary to be a late-type giant or even a late-type dwarf. The only requirement is that it fill its Roche lobe. The fact that cataclysmic variables are short-period binaries with one companion filling its Roche lobe helps us to pick out objects that may be either very old novae, or potential novae. If such objects are monitored, and they subsequently erupt, we will be able to understand better the physical processes that lead to the nova phenomenon. The binaries one should look at are the short-period W Ursae Majoris and Algol-type systems with a blue star. C. Payne-Gaposchkin has suggested monitoring the binaries V 523 Cassiopeiae, BF pavonis, EQ Tauri, AB Telescopii and V1961 Sagittarii.

A large amount of observational data has been accumulated in the past during the outbursts of novae since the increase in brightness helps us in obtaining better resolution and higher accuracy in observations. The time evolution of brightness and spectrum also induces interest in these transient events. However, modelling these systems only from the data obtained during an outburst is forbiddingly difficult. Light at these times is a sum total of contributions from the primary, the secondary, the accretion disc with a hot spot and the expanding envelope. The photometric and spectroscopic observations during the quiescent phase are of great use in understanding the physical structure of these systems. Spectroscopic observations in the red and infrared region, particularly during the minimum times of the eclipsing cataclysmic variables, would yield information on the secondary star. Photometric observations at every timescale and resolution are useful since the different components of the system cause light variations at different timescales.

2. Photoelectric photometry

The accuracy of visual estimation of stellar magnitudes is limited to about 0.1 mag for an experienced observer. This, coupled with the limited range of spectral sensitivity of human eye and differences in the responses of the eyes of different observers, led the astronomers of the last century to seek a more objective detector that would lead to better quantitative estimates. The photographic plate, though first such detector to be used, reached and surpassed the magnitude limit of the eye only in this century. Further, the accuracy of photographic magnitudes could be improved only after the 'microphotometer' was invented which is in principle a photoelectric photometer. Thus, the advantages of photographic photometry lie now only in the faintest end of the magnitudes that a given telescope can reach (advantage of prolonged integration) and in the two-dimensional format of the photographic plate which helps in registering a large number of stellar images in a single exposure. Photoelectric method, on the other hand, has the advantage of linear response and a large dynamic range. Simple photoelectric photometers can very easily be built and find great use in a large number of research programs on variable stars even with a small or medium-size telescope.

The first attempt of measuring photoelectrically the power radiated by the stars was by G. M. Minchin who used a selenium photocell in 1895. Joel Stebbins, beginning with 1907, studied the properties of selenium cell thoroughly, and discovered that the signal-to-noise ratio improved with the decreasing temperature and the decreasing area of the cell. Later, Stebbins experimented with new potassium hydride photoemissive cells also. However, the first rugged and reliable photoelectric photometer became possible only in 1932 when Albert whitford provided evacuated sealed enclosures for the photocell and developed a thermionic amplifier, while John Hall developed the more efficient cesium-oxide-silver photocell. With these developments in hand, Stebbins and Whitford fabricated the first dry-ice-cooled photoelectric photometer for astronomical use and began the era of six-colour photometry.

A simple photoelectric photometer is easy to construct. One such instrument has been fabricated by Patel & Kulkarni and already described in this column (1982, *Bull. Astr. Soc. India* **10**, 360). That instrument was an integrated telescope-cum-photometer designed to measure sky brightness in a spectral band of interest. The differences between this and a conventional photoelectric photometer are described below.

(i) The photometer is designed as an independent unit to be attached at the focus (generally Cassegrain) of the telescope.

(ii) A mirror inclined at 45 degrees to the incoming beam is placed just above the focus of the telescope to deflect the beam to a wide-angle eyepiece with crosswires. This helps in viewing the star field so that the object of interest can be centred. The mirror can be shifted or flipped so that the beam can continue in the original direction after the object is centred.

(iii) The beam would then go through a filter. Generally it is desired to measure the brightness of the object in a set of standard spectral bands. Hence one mounts all the desired filters on a frame which can either be slided or rotated such that different filters can be brought into the path of light with minimum delay. Note that the filter was fixed in front of the objective in the sky photometer—which is not very convenient when a larger telescope is used.

(iv) The beam would then come to a focus, where a diaphragm is placed. Often several diaphragms of different sizes are made available in a photometer. These are again mounted on a slide or wheel so that one can choose a diaphragm size of interest. It is difficult to centre a star accurately on a very small diaphragm. Further, the oscillations of the stellar image due to the seeing make it necessary to employ a diaphragm of at least a few seconds of arc so that the star does not oscillate in and out of the diaphragm. A larger aperture may be desired when the telescope is not able to track the star accurately. The diaphragam is then chosen such that the star does not drift appreciably during the time needed for the measurement. The diaphragm actually allows the starlight as well as the skylight to the photometer. If the star is not very bright, the amount of skylight let in may be much higher than the starlight when a large aperture is used. 'The signal' from the star would then be buried in that from the sky and it becomes imperative to use a smaller diaphragm. Further, if one is observing extended objects like nebulae or galaxies, one may like to select an aperture based on the spatial resolution required and the detection limit imposed by the system. Multi-aperture photometry is employed in the observation of galaxies both to obtain the radial distribution of light as well as to obtain magnitudes over a standard fraction of the size of the galaxy.

Beyond the aperture, a diaphragm-viewer is placed to ascertain whether the star is centred with respect to the aperture Once the viewer is withdrawn, the light falls on to a Fabry lens which images the starlight-illuminated objective of the telescope on to the cathode area of the photomultiplier. This ensures that the light from the object falls over the same area of the detector irrespective of its position in the diaphragm. The errors that might have been introduced due to the nonuniform response of different parts of cathode are thus avoided. The output of the photomultiplier is then amplifed and measured or recorded in analog or digital form as desired.

3. Chemical abundances in stellar atmospheres

S. Giridhar of Indian Institute of Astrophysics, Bangalore, writes:

The curve-of-growth method of determining the chemical abundances in stellar atmospheres assumes—in its simplest form—that the lines are formed in a layer of the atmosphere characterized by a single value of temperature and pressure. But in reality the temperature and pressure increase with depth in stellar atmospheres, and spectral lines are formed over an appreciable range of the atmosphere. Hence one needs to undertake a *fine analysis* of the spectral-line formation in order to deduce accurate abundances.

The temperature distribution with optical depth can be obtained for the sun using limb-darkening data and the energy distribution at the centre of the disc. Using this distribution and the criterion of hydrostatic equilibrium, one can obtain the distribution with optical depth of gas pressure (p_g) and electron pressure (p_e). Semi-emirical models of the sun have thus been constructed by Gingerich *et al.* (1971, *Solar Phys.* **18**, 347), Holweger & Müller (1974, *Solar Phys.* **39**, 19), and Vernazza, Avrett & Loeser (1974, *Ap. J. Suppl. Ser.* **30**, 1). Only theoretical models can be calculated for other stars since limb-darkening data are generally lacking. These theoretical models are calculated assuming (i) plane-parallel geometry, (ii) hydrostatic equilibrium, and (iii) that the sum of the radiative and convective fluxes be depth- and time-independent. Parsons (1969, *Ap. J. Suppl. Ser.* **18**, 127) has computed model atmospheres for F-G supergiants. Models of O, B, A, F and G stars by Kurucz (1979, *Ap. J. Suppl., Ser.* **40**, 1) and of cooler stars by Gustafsson *et al.* (1975, *Astr. Ap.* **42**, 407), covering a large range in gravities, are currently in use.

The determination of composition of a stellar atmosphere using detailed models proceeds in the following steps. First, a curve-of-growth analysis supplies an approximate composition and temperature. Next, using a grid of model atmospheres, the theoretical line intensities of selected model-sensitive lines are computed. For example, for a star whose temperature is about 22,000 K one might employ lines of Si II, Si III and S IV which appear simultaneously in the spectrum. Also, the appropriate model should produce correctly the hydrogen line profiles, the discontinuity at the Balmer limit, and the energy distribution in the continuous spectrum. Once a suitable model is identified, a calculation of the theoretical equivalent widths is carried out, and abundances are derived from a comparison of the observed and predicted equivalent widths.

Method of spectrum synthesis

The most complete study of high-resolution spectroscopic data is done by simultaneously computing all the lines over a portion of the spectrum. To apply this method of 'spectrum synthesis', most of the observed lines should be identified and must have known *gf* value. The spectrum is computed using a suitable model atmosphere, trial values of abundances, and atomic parameters of all the lines falling into the region of interest. The individual abundances are adjusted until a good agreement is obtained between the observed and the computed spectra. The major advantage of this method is that blending of the spectral lines—which has been a major handicap for the application of curve-of-growth method—is no longer a hindrance; one simply computes the blend as a whole and the comparison is made with the observational data.

The method of spectrum synthesis is more reliable than older methods because it takes into account all the known absorption features and tries to reproduce the observed spectrum as precisely as possible without attempting to compare the observed equivalent widths of individual lines with the computed ones. The latter process requires—particularly for cooler stars—a precise location of the continuum and the extrapolation of the profile of each line, because in reality none of the spectral lines shows the complete profile, the wings being generally blended with the neighbouring lines. The equivalent widths of weak lines required in the curve-of-growth method could be measured only on high-resolution spectra. Also, for spectral types later than G0, the crowding of the spectral lines becomes so severe that synthetic spectra become indispensible even if the observations are made at a high dispersion. The synthetic spectrum also makes it possible to determine

Table 1. Lunar occultation predictions for Kavalur

Date 1983		Time* UT h	m	s	Object	Mag⁺	Sp. T.	α h	m	s 1983	δ °	′	″	Alti-tude deg	Percentage illumi-nation
June	1	23	08	49	ϵ Capicorni	4.68	B 2.5 V pe	21	36	08.5	−19	32	29	57	68−
	2	0	10	03R										57	
	17	17	04	02	ν Virgins	4.03	M 1 III ab	11	44	59.5	6	37	28	27	48+
		17	47	42R										16	
	19	15	24	32	BD −3° 3462	7.1	K0	13	23	34.2	−4	13	15	67	70+
	20	20	32	24	BD −9° 3915	7.4	A 2	14	20	39.4	−10	17	44	7	80+
	24	22	12	36	CD −24° 13521	7.1	K 0	17	48	57.0	−24	12	10	23	100+
	29	23	53	05G	BD −17° 6441	7.4	G 5	22	07	32.1	−16	37	28	53	82−
	30	17	50	28	τ^2 Aquarii	4.01	M 0 III	22	48	42.7	−13	40	49	9	75−
		19	00	45R										25	
July	6	21	14	08	HR 1110	6.16	K 0 III	3	38	27.6	16	28	56	1	17−
		22	03	54R										13	
	8	22	57	44	HR 1951	6.59	B 8 p	5	40	52.0	23	19	07	0	3−
		23	23	00R										6	
		23	10	51	HR 1961	6.21	B 2.5 Ve	5	42	16.8	23	11	51	3	3−
	9	0	03	52R										15	
	13	13	59	15	BD 15° 2206	7.1	K 0	10	27	53.8	14	25	54	29	13+
		15	36	52	46 Leonis	5.46	M 1.5 IIIb	10	31	17.2	14	13	32	7	14+
	14	14	54	31	BD 9° 2494	6.8	K 0	11	25	25.3	8	45	13	28	23+
		15	52	20R										14	
	17	18	43	02	BD −8° 3696	6.6	A 0	14	05	24.5	−8	48	43	5	57+
	18	16	25	23	BD −12° 4152	7.4	F 0	14	51	17.7	−13	26	14	44	66+
	21	19	35	44	CD −23° 13409	7.4	F 0	17	29	49.5	−23	49	41	30	91+
	22	17	04	18	HR 6861	6.25	M 5 III	18	20	30.8	−24	55	26	53	95+
		19	25	33	M 28	7.3		18	23	34.1	−24	52	55	40	96+
	24	17	46	19	CD −23° 16012	7.5	F 8	20	07	37.7	−23	38	20	51	100+
	29	16	53	11	33 Piscium	4.61	K 1 III	0	04	29.5	−5	47	58	6	80−
		17	57	26R										22	
	31	21	13	43	ν Piscium	4.44	K 3 IIIb	1	40	33.8	5	24	15	51	61−
		22	41	07R										72	
August	4	22	33	45	108 Tauri	6.27	A 2 V	5	14	26.4	22	16	00	25	20−
		23	22	40R										36	
	5	21	50	54	8 Geminorum	6.08	G 8 III	6	15	16.6	23	58	36	2	11−
		22	44	26R										14	
	11	13	31	41	BD 6° 2529	7.5	K 0	11	55	56.0	5	26	24	28	11+
	14	16	20	57	HR 5455	6.20	F 5 V	14	36	06.1	−12	14	05	19	41+
	15	16	28	36	ζ^1 Librae	5.64	K 5 III	15	27	18.8	−16	39	33	26	15+
		17	32	45R										12	

August	16	14	15	22	BD − 19° 4350	6.6	K 0	16	16	00.8	−20	03	50	55	61+
		16	10	46	HR 6076	6.29	K 5 III	16	18	09.2	−20	10	43	38	61+
	19	15	36	08	HR 7155	6.62	A 0	18	57	20.2	−24	54	00	52	87+
		17	07	14	HR 7168	6.36	g K 0	18	59	24.5	−24	57	59	48	87+
		18	40	19	HR 7195	5.65	K 3 III	19	01	27.6	−24	52	16	35	87+
		20	36	41	CD − 24° 15002	7.3	K 0	19	04	37.5	−24	42	04	13	87+
	20	18	14	34	HR 7578	6.18	K 2 V	19	53	19.1	−23	59	00	47	93+
	21	15	54	21	BD − 22° 5511	7.2	G 5	20	42	29.5	−22	30	50	48	97+
		18	36	33	BD − 22° 5526	7.2	K 0	20	45	33.4	−22	13	28	52	97+
		22	22	52	BD − 21° 5844	7.1	F 5	20	49	57.8	−21	22	26	12	97+
		22	58	46	BD − 21° 5852	7.3	K 0	20	51	25.3	−21	17	36	4	97+
	22	20	23	00	BD − 19° 6133	4.5	G 5	21	36	04.3	−18	49	04	46	99+
	28	19	23	45	ξ^1 Ceti	4.37	G 6 II-III	2	12	07.5	8	46	14	44	76−
		20	12	02R										56	
September	3	22	23	01	HR 3127	6.34	K 1 III-IV	8	00	00.2	23	37	51	11	14−
		23	22	55R										25	
	10	13	33	38	BD − 9° 3877	7.3		14	11	39.2	−9	49	17	28	16+
		13	59	26	κ Virginis	4.19	K 3 III	14	11	59.5	−10	11	44	22	16+
		14	55	07R										9	
	15	17	15	57	HR 7035	5.83	B 5 : V	18	43	48.8	−25	01	45	28	65+
	16	15	40	28	51 Sagittarii	5.65	Am	19	35	01.9	−24	45	24	50	74+
		16	24	46	52 Sagittarii	4.60	B 9	19	35	42.6	−24	55	18	45	74+
		17	14	06R										37	
	17	15	55	07	CD − 23° 16259	7.5	K 5	20	27	11.1	−23	04	11	54	82+
	18	16	08	01	BD − 20° 6178	6.7	K 0	21	17	30.8	−20	24	19	57	88+
	19	17	57	58	BD − 17° 6451	7.4	G 5	22	07	32.2	−16	37	25	57	94+
		22	06	17	BD − 16° 6046	6.6	G 5	22	13	45.6	−15	53	55	10	95+
	20	12	43	24	τ^2 Aquarii	4.01	M 0 III	22	48	44.1	−13	40	44	13	97+
		13	14	54R										20	
	21	13	10	57	BD − 9° 6220	7.3	F5	23	35	10.1	−8	51	21	10	99+
		17	03	17	BD − 8° 6166	7.1	F 8	33	39	58.6	−8	00	15	61	100+
		23	51	58	HR 9041	6.07	K 4 III	23	47	42.5	−6	28	14	8	100+
	28	21	56	18	121 Tauri	5.38	B 2.5 IV	5	34	26.5	24	01	48	61	60−
		23	18	26R										76	
	30	22	20	42	HR 2931	6.17	A 2 V	7	38	11.5	24	15	42	40	37−
		22	58	16R										49	
October	2	23	57	42	BD 19° 2254	6.9	K 0	9	44	55.9	18	45	42	35	16−
	3	0	53	26R										48	
	10	14	39	24	ω Ophiuchi	4.45	A 7 p	16	31	08.2	−21	25	55	14	20+
		15	28	17R										3	
	11	12	59	56	CD − 23° 13366	6.7	K 0	17	23	02.2	−23	49	49	42	28+
		13	24	15	HR 6474	6.19	g K 1	17	24	04.7	−24	13	49	37	28+
		14	33	18R										24	

(*Continued*)

Table 1—*Continued*

Date 1983	Time* UT h	m	s	Object	Mag†	Sp. T.	α h	m	s	δ 1983 °	′	″	Altitude deg	Percentage illumination
October	14	06	55	44 Ophiuchi	4.17	A 3 m	17	25	20.8	−24	09	42	30	29+
	15	20	22R										15	
12	12	29	07	HR 6846	6.51	g K 1	18	17	39.8	−25	36	46	50	38+
13	13	45	11	ψ Sagittarii	4.85	F 2 : +F 7 III	19	14	31.5	−25	17	13	48	48+
	15	20	13R										34	
16	14	31	28	BD −19° 6169	7.5	A 2	21	48	25.7	−18	27	49	58	75+
20	23	42	22	BD 1° 203	7.0	K 0	1	3	53.7	2	13	39	3	99+
27	22	13	36	57 Geminorum	5.03	G 8 III	7	22	28.5	25	05	00	65	63−
	23	49	32R										77	
November 11	15	31	39	BD −22° 5511	7.2	G 5	20	42	28.5	−22	30	55	29	40+
	17	16	42	BD −22° 5526	7.2	K 0	20	45	32.4	−22	13	33	7	41+
	18	09	52	BD −19° 6126	7.3	B 9	21	36	42.6	−19	18	24	7	51+
19	13	56	08	BD −13° 484	7.4	G 5	2	57	52.5	13	32	29	33	99+
December 8	15	03	47	CD −23° 16214	7.5	F 8	20	23	20.6	−23	31	50	8	16+
9	15	28	55	ϕ Capricorni	5.24	g G 9	21	14	41.3	−20	43	19	13	24+
13	17	16	43	BD 3° 38	7.1	K 0	0	20	14.2	−3	00	01	33	61+
15	15	23	14	BD 6° 279	7.3	G 0	1	49	05.1	7	08	38	82	79+
17	14	24	57	BD 16° 450	7.0	A 0 p	3	28	48.2	16	42	29	59	93+
19	20	24	34	BD 24° 868	7.4	K 0	5	34	04.9	24	16	53	60	100+
	20	55	02	121 Tauri	5.38	B 2.5 V	5	34	28.6	24	01	50	53	100+
20	23	09	55	ϵ Geminorum	2.98	G 8 Ib	6	42	57.1	25	08	54	37	99−
21	0	13	50R										23	
25	19	05	31	ω Virginis	5.36	M 4 III	11	37	37.3	8	13	26	16	60−
	20	04	38R										30	
31	0	28	24	BD −19° 4295	7.1	A 2	16	02	08.8	−19	47	46	26	10−
	1	22	56R										37	

* R = reappearance corresponding to the preceding occultation.
† V magnitudes are listed to the second decimal place.

Table 2. Additional information on stars being occulted

HR	Other name	Companion Δm	Companion Separation arcsec	Notes*
3	33 Piscium	2.5	0.0	SB; variable with amplitude 0.05 mag
649	ξ^1 Ceti	2.0	0.012	SB
1711	108 Tauri	6.2	1.9	SB
1875	121 Tauri			SB (7.83552d)
2230	8 Geminorum	0.0	0.1	
2473	ϵ Geminorum	6.0	110.3	SB; He 10830 emission OD 0.0018-0056 arcsec
3127		4.5	2.3	
4127	46 Leonis			VR; OD 0.056 arcsec.
4483	ω Virginis			VRV? ; variable : V=5.23 – 5.37 mag
4517	ν Virginis			VRV? ; variable with amplitude 0.08 mag ; OD 0.00565 arcsec.
6153	ω Ophiuchi			Variable V=4.45 4.51 mag
6861				VRV ; OD 0.032 arcsec
7035		0.2	0.04	VRV
7155		0.0	0.1	
7195		0.0	0.1	VRV? OD 0.002 arcsec
7292	ψ Sagittari	0.3	0.153	SB ; component A occultation double (Δm=0.0 mag, 0.001 arc sec) probable IR source
7431	51 Sagittari	2.0	0.0002	SB (8.1158d) ; primary variable with amplitude 0.015 mag
7440	52 Sagittarii	4.5	2.7	VRV
7578		4.0	31.5	SB ; optical double
8260	ϵ Capricorni	1.3	0.0047	SB? ; shell star ; variable with amplitude 4.44-4.72 mag ; third component Δm=4.8, 68 arcsec
8679	τ^2 Aquarii	4.5	132.5	Often referred to simply as τ Aquarii

*SB = spectroscopic binary ; OD = occultation diameter ; VRV = variable radial velocity.

accurate abundances from the low-dispersion spectra and even from the colours, without requiring a cumbersome empirical calibration based on stars studied at high spectral resolution, which may not always be available.

The method of spectrum synthesis is described by Ross & Aller (1968, *Ap. J.* **153**, 235) who used it to determine Cr I abundance in solar atmosphere. This technique has been applied by Sneden (1974, *Ph.D. thesis*) to determine C, N and O abundances in metal-poor stars. Luck (1979, *Ap. J.* **232**, 797) determined the abundances of light as well as heavy elements in the atmospheres of late-type supergiants and luck & Lambert (1981, *Ap. J.*, **245**, 1018) did a similar analysis of Cepheids. The important application of this method lies in the determination of abundances of rare-earth elements which present themselves in very few lines which are often blended with the lines of other elements. Abundances of rare-earth elements Y, Ba, La, Ce and Sm in the atmospheres of the distant Cepheids have been determined by Giridhar (1982, *Ph.D. thesis*). As the need for very high resolution is removed, reliable abundances could be determined in a vast number and types of stars without requiring telescopes of very large aperture.

The importance of abundance determinations lies in the clue the atmospheric abundances provide for the nuclear history of stellar matter, and more generally of the matter in the whole Galaxy. The trend of metallicity in the disc of our Galaxy has an important bearing on the problem of galactic evolution. The observed radial abundance gradient, abundance anomalies across the spiral arms and also the ratio of the abundances of the elements formed in primary and secondary nucleosyntheses provide the observational tests for the models of galactic evolution. A radical change in the understanding of nucleosynthesis in stars and of chemical evolution of the Galaxy may appear when more accurate abundance estimates for the stars of different age groups are available as a function of their galactocentric position.

4. Lunar occultations

Table 1 lists the lunar occulations predicted for Kavalur. The globular cluster M28 is being occulted on July 22. The cluster has a diameter of 4.7 arcmin; the occultation lasts 17.1 minutes centred around the time listed in table 1. A brighter globular cluster, M35, will be occulted on September 2 during the day-time $7^h00^m42^s$ UT, reappearance at $7^h57^m09^s$ UT) when the sun is high and the moon low over the horizon. The occultation of BD $-17°6451$ on June 29 would be a grazing one for observers along the line joining Trichur (Kerala) and Madras. The reappearance of BD $+19°2254$ on October 3 and of BD $-19°4295$ on December 31 take place after sunrise. The bright stars β^1 Scorpii (2.62 mag, B1 V) and β^2 Scorpii (4.92 mag, B2 V) are occulted on December 31 soon after sunrise $1^h28^m21^s$ and $1^h28^m35^s$ UT, with reappearances at $2^h38^m46^s$ UT and $2^h38^m10^s$ UT, respectively). Some additional information of interest on the stars being occulted is given in table 2.