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Project Kalki—a sky survey with 45 cm Schmidt telescope. 1

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Abstract. A brief description of the sky survey project taken up with the 45 cm Schmidt telescope of the Vainu Bappu Observatory at Kavalur is given. Positions of 11 asteroids detected on plates taken during 1987 February–March are reported.

Key words : solar system—asteroids—comets—Schmidt sky survey

1. Introduction

A new, 45 cm Schmidt telescope built in the Institute was commissioned in 1985 December at Kavalur. After the apparition of comet Halley the Schmidt was put to regular use for studies of solar system objects and variable stars. In 1987 January the project was named *Kalki* (Kalki is the mythical tenth yet-to-come reincarnation of Vishnu). Regular photography of regions near opposition was planned with the same region being repeated after a one-day interval, so that closeby moving objects could be detected. This would also ensure the detection of any planet, beyond Pluto that may exist, brighter than our plate limit of $m_V = 18.0$.

Members of the Bangalore amateur astronomy association were involved in blinking pairs of plates of the same region. Simultaneously attempts are being made to solve the problem of blinking and consequent fatigue by introducing electronic image processing techniques and television system which would digitally substract the images of the two photographs and display on a monitor screen.

In order to work with the maximum detection efficiency, the plan envisages photography, using 098–02 plates, with no filter in the light path. Future plans are to introduce hypersensitizing techniques for IIIa-J, IIIa-F, 098–02 and other emulsions to improve speed, detective quantum efficiency and signal-to-noise ratio. The results of these experiments will be reported as and when they become available.

In this paper, we report the results obtained with the observations made during 1987 February 19–March 9.

2. The project

The project is aimed at detecting new near-earth asteroids, comets, and any new planet that may be there beyond the orbit of Pluto. Photography of regions in opposition, along the ecliptic, with one hour exposures of a 3° × 3° field, is expected to yield two to three new asteroids and one or two comets per year. This estimate is based on the assumption that about 600 dark hours are available for photography, the assumed limiting magnitude being $V = 17.0$ (T. Gehrels, personal communication).

The proposed steps of the survey envisaged in the project is as follow : (a) Selection of areas along the ecliptic with suitable bright ($m_v < 9.0$) guide stars; areas to be chosen should have at least half a degree overlap; (b) obtaining plates exposed to sky limit; (c) making copies of Palomar charts reduced to the same scale as the Schmidt photographs; (d) comparison of the photographs obtained, with Palomor copies to check for variable and moving objects; (e) blinking two plates of the same region taken atleast a day apart; and (f) measuring the coordinates of the moving objects detected with respect to the background standard stars.

We expect to find a new planet if it exists in the surveyed region within 100 a.u. from sun provided it is brighter than magnitude 18.0. At our plate scale, the daily change in position of such an object will be around 220μ.

3. Observations and results

A limiting exposure of one hour with 098–02 plate of the region around M67 shows that all the faint stars listed by Eggen & Sandage (1964) can be easily detected on the plate indicating that under good conditions the limiting magnitude is about 18.0.

The regions to be observed, about three degrees on either side of the ecliptic, are numbered K-1, K-2, etc. The odd (even) numbers refer to regions north (south) of the ecliptic. More than three photographs for each region from K-1 to K-8 and two for K-15 were obtained during the period 1987 February 19 to March 9 (see figure 1). The initial phase of these observations was combined with improving the quality of the focus and tilt of the plate holder. This had adversely affected the progress of our observational coverage during the initial period.

The majority of the asteroids were picked up by examining the plates with an eye-piece as these objects are seen as elongated while the star images look circular. Pairs of plates of the some region are blinked with the Carl Zeiss blink comparator (model number '16 36 10 B'). We mark the position of the same asteroid seen on different plates on a print of that region and choose SAO standards registered on the same plate. All these plates are later measured on the Zeiss X-Y measuring engine which can take plates up to 30 cm × 30 cm. Comrie's (1929) method is adopted to calculate the position of the asteroids. The asteroid is carefully centered and more than four measurements are taken and averaged. Combinations of three stars at a time are taken with the asteroid image within the triangle defined by the three standard stars. We use all possible combinations of

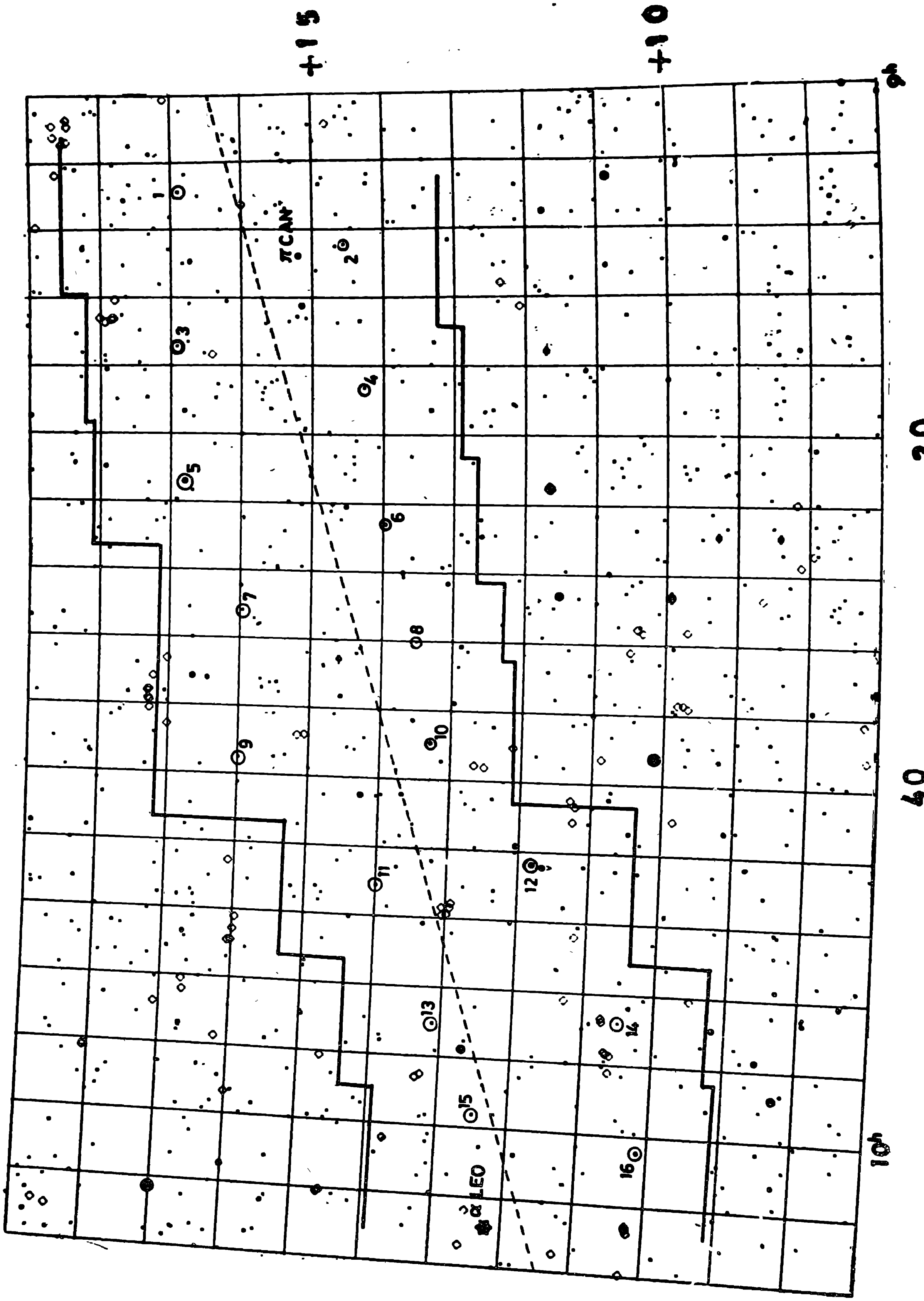

Figure 1. A schematic diagram of the region of the sky photographed during the period 1987 February 19 to March 9. The dotted line shows the ecliptic. The regions are numbered K-1, K-2, etc.

Table 1. List of asteroids measured

Asteroid	Plate No.	Date	Mid exp UT	Mag	α 1950	δ 1950
1045 Michela	79	1987 Feb 19	17^h 00^m	16.3	9^h 03^m $49^s.57$	+ 16° 23′ 13″.0
	84	Feb 21	18 02		9 02 4.23	+ 16 30 38.4
	87	Feb 22	16 30		9 01 17.57	+ 16 33 55.7
1094 Siberia	88	Feb 22	18 03	15.7	9 14 16.20	+ 13 47 8.0
	99	Feb 26	16 30		9 11 34.82	+ 14 31 18.9
	101	Feb 27	16 45		9 10 56.00	+ 14 42 19.0
1987 DE	97	Feb 25	19 52	15.2	9 19 8.76	+ 12 43 23.1
	102	Feb 27	18 07		9 17 57.53	+ 13 29 52.5
	107	Mar 2	17 31		9 16 18.17	+ 14 39 44.4
	113	Mar 3	18 00		9 15 47.37	+ 15 3 15.9
	117	Mar 4	19 25		9 15 17.30	+ 15 27 7.2
1987 BJ	97	Feb 25	19 52	15.8	9 22 38.80	+ 14 33 50.9
	102	Feb 27	18 07		9 21 20.80	+ 14 49 12.5
	106	Mar 2	16 10		9 19 34.56	+ 15 11 21.4
	107	Mar 2	17 31		9 19 32.20	+ 15 11 42.2
	112	Mar 3	16 41		9 19 01.43	+ 15 18 6.0
	113	Mar 3	18 00		9 18 58.9	+ 15 18 59.1
	117	Mar 4	19 25		9 18 25.54	+ 15 26 27.7
606 Brangane	108	Mar 2	18 55	14.7	9 28 41.09	+ 12 43 48.7
	114	Mar 3	19 58		9 27 49.28	+ 12 45 43.4
	118	Mar 4	20 36		9 26 59.09	+ 12 47 26.8
1987 DS	109	Mar 2	20 07	16.4	9 27 58.20	+ 17 12 59.1
	112	Mar 3	16 41		9 27 24.81	+ 17 16 5.2
	120	Mar 5	19 26		9 26 7.62	+ 17 23 1.3
2691 1974 KB	121	Mar 5	20 36	16.5	9 30 20.42	+ 13 27 7.4
	123	Mar 6	20 15		9 29 36.38	+ 13 27 47.9
1986 X02	121	Mar 5	20 36	14.0	9 33 53.46	+ 12 17 51.0
	123	Mar 6	20 15		9 33 18.20	+ 12 40 52.8
84 Klio	121	Mar 5	20 36	14.0	9 35 35.81	+ 13 49 40.8
	123	Mar 6	20 15		9 34 43.06	+ 13 51 27.6
917 Lyka	124	Mar 6	21 42	15.9	9 58 49.97	+ 13 45 27.2
	126	Mar 7	21 15		9 57 56.22	+ 13 48 30.5
656 Beagle	124	Mar 6	21 42	14.4	10 01 8.98	+ 11 42 55.7
	126	Mar 7	21 15		10 00 28.48	+ 11 46 50.6

standard stars, taken three at a time, to calculate the position of the asteroid so that we have n such derived coordinates for an asteroid on any given plate. These n positions are finally averaged to derive its position. Table 1 lists the measured positions of the various asteroids detected. All these calculations were carried out with the TDC-316 computer at Bangalore.

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