PUBLICATIONS OF THE
ASTRONOMICAL SOCIETY OF THE PACIFIC

Vol. 73 June 1961 No. 432

THE 1960 PALOMAR SUPERNOVA SEARCH

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During 1960, nineteen supernovae were found with the 48-inch Schmidt telescope at Palomar. One of these was found by P. Wild at the Berne Observatory[1] two days before it was found independently at Palomar. All of the supernovae have been confirmed on two or more plates. No supernovae were found with the 18-inch Schmidt telescope where the brighter galaxies are being searched by H. S. Gates.

The number of galaxies searched and the frequency of the observations were about the same as given in last year's report,[2] except that several clusters of galaxies are now being observed more extensively by Gomes. Weather permitting, nightly observations of the cluster fields are made by Gomes on the last three or four nights of the direct runs, and a single observation of the Gomes fields is made by Humason at the beginning of the direct runs. The interval between observations in the direct runs is about one week, the interval between the direct runs about two weeks. With this spacing of the observations it should be possible to find all of the supernovae that appear in these fields during the observing seasons. The possibility of discovering a supernova during its rise to maximum brightness should also be greatly increased.

The supernovae found in 1960 are listed in Table I. The estimates of the magnitudes of the galaxies have been made by E.

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TABLE I

SUPERNOVAE FOUND IN 1960

No.	Galaxy	m_{neb}	Type	α (1950)	δ	Supernova First Obs.	Supernova m_{pg}	Discoverer
1	Anon.	16.0	S0	$2^h\ 34^m.5$	+ 1° 7′	Dec. 5, 1958	18.0	H
2	Anon.	15.0	SBc	2 47.2	− 0 43	Dec. 26, 1959	18.5	H
3	Anon.	16.5	Sc:	2 32.8	+ 1 53	Jan. 20, 1960	16.0	H
4	Anon.	15.5	Sb:	12 4.6	+17 16	Feb. 20, 1960	17.0	H
5	Anon.	15.5	Sb:	12 32.2	+ 9 10	Feb. 20, 1960	16.0	K
6	NGC 4321	10.8*	Sc	12 20.4	+16 6	Feb. 21, 1960	17.5	H
7	Anon.	15.5	SBc	8 17.4	+21 2	Mar. 20, 1960	16.0	H
8	NGC 4496	12.0*	SBc	12 29.1	+ 4 12	Apr. 17, 1960	12.0	H
9	Anon.	16.0	Sc	11 29.3	+18 40	Apr. 19, 1960	17.5	H
10	NGC 4096	12.2*	Sc	12 3.5	+47 45	June 18, 1960	14.5	W-H
11	Anon.	14.5	SBb	12 24.4	+48 34	June 18, 1960	18.5	H
12	NGC 4375	14.0	Sa	12 22.2	+28 50	June 18, 1960	18.0	H
13	Anon.	15.5	SBc	22 37.7	+34 8	June 18, 1960	19.0	H
14	NGC 7177	12.1*	Sb	21 58.5	+17 29	Aug. 14, 1960	16.0	H
15	NGC 2565	13.5	SBb	8 16.9	+22 10	Oct. 26, 1960	17.0	G
16	Anon.	15.0	Sc	8 23.2	+21 37	Oct. 26, 1960	16.5	G
17	Anon.	17.0	Sc:	23 33.9	+27 39	Nov. 10, 1960	18.5	H
18	Anon.	17.5	Sc	1 3.5	+31 8	Nov. 22, 1960	17.5	G
19	Anon.	18.5	Sb:	1 33.4	− 5 45	Dec. 13, 1960	17.5	H

Herzog, except for the four starred values taken from the Shapley-Ames catalogue. The types of the galaxies have in most cases been estimated from 48-inch plates. A colon indicates that the type is uncertain. Column seven gives the date for the plate on which the supernova was found; this does not always correspond to the date of discovery (see the note for supernova No. 1). Column eight contains the estimated magnitudes of the supernovae for the dates given in column seven. They are not maximum magnitudes, although in several cases the supernova may have been near maximum light. Column nine contains the initial of the observer who discovered the supernova: H = Humason, W-H = Wild-Humason, G = Gomes, K = Kearns.

The magnitudes and colors of several supernovae have been measured and spectroscopic data obtained whenever possible. The results will be published later by those who have made the observations.

NOTES TO TABLE I

No. 1. Appeared 1″ west and 7″ north of the nucleus of a small faint S0 galaxy. No prediscovery plate. Visible December 1958, January 1959. Below plate limit (20±) March 2, 1959. This supernova was found on October 14, 1960, at which time the 1958 plate was re-examined.

No. 2. Appeared 28″ east and 20″ north of the nucleus of a faint SBc galaxy. Not visible November 24, 1959. Visible December 26, 1959, January and February, 1960. Below plate limit March 20, 1960.

No. 3. Appeared 5″ east and 8″ south of the nucleus of a small faint Sc galaxy. Not visible December 26, 1959. Visible January, February 1960. No plates obtained from March to October 14, 1960, at which time the supernova was not visible.

No. 4. Appeared 4″ west and 9″ north of the nucleus of a small but relatively bright Sb galaxy. No prediscovery plate. Visible February 20 through May 17, 1960. Below plate limit June 1, 1960.

The spectrum of the galaxy was photographed by Zwicky at the 200-inch and measured by Humason. The uncorrected redshift is +6740 km/sec. Not a member of the Virgo cluster.

No. 5. Appeared 5″ east and 6″ south of the nucleus of a small but relatively bright Sb galaxy. No prediscovery plate. Visible February and March, 1960. Below plate limit April 16, 1960.

The spectrum of the galaxy was photographed by Zwicky at the 200-inch and measured by Humason. The uncorrected redshift is +12,920 km/sec. Not a member of the Virgo cluster.

No. 6. Appeared 58″ east and 21″ south of the nucleus of the large bright Sc galaxy NGC 4321. Not visible on nearest prediscovery plate of August 3, 1959. Visible February 21 through June 17, 1960. Below plate limit July 19, 1960. Probably at maximum in the late summer or fall of 1959. NGC 4321 is a member of the Virgo cluster; its uncorrected redshift is +1620 km/sec (Humason).

Because of its faintness this star was at first thought to be a bright ordinary nova. Fortunately, Zwicky photographed the spectrum and found it to be that of a type I supernova at a late stage of development. The magnitude of the supernova is estimated to have been about 18.0 when it was observed by Zwicky at the 200-inch.

No. 7. Appeared 18″ east and 26″ south of the nucleus of a faint SBc galaxy. Not visible February 20, 1960. Visible March 20 through May 17, 1960. No observations from June to October, 1960, at which time the supernova was below the plate limit. The galaxy is near the center of the Cancer cluster and probably a member of it.

No. 8. Appeared 38″ east and 24″ north of the nucleus of the Sc galaxy NGC 4496. Not seen on a plate taken March 20, 1960. Visible April 17 through July 18, 1960. No observations from August through December, 1960. Still visible at about magnitude 20.0 on January 15, 1961. A member of the Virgo cluster, NGC 4496 is the larger member of what appears to be a double galaxy. The smaller member of the double is situated at the south-following edge of NGC 4496 and intermingled with it. The supernova almost certainly belongs to NGC 4496 as its distance from the companion galaxy is large.

The spectrum of the supernova has been photographed by Greenstein at the 200-inch; he classifies it as of type I.

No. 9. Appeared 14″ east and 16″ south of the nucleus of a small faint Sc galaxy. No prediscovery plate. Visible April 19 through May 17, 1960, at which time it was near the plate limit.

No. 10. Appeared 67″ east and 114″ north of the nucleus of the large Sc galaxy NGC 4096. First found by Wild at the Berne Observatory on June 16, 1960. Independently discovered at Palomar on June 18, 1960. Not present April 18, 1960. Visible in July 1960. No observations from August through December, 1960. Not visible January 14, 1961.

Greenstein has photographed the spectrum of the supernova and classifies it as of type I. The north-south distance of this supernova from the nucleus was erroneously published previously as 114″ south.[3]

No. 11. Appeared 5″ east and 11″ south of the nucleus of a small SBb galaxy. Not visible April 18, 1960. Visible on five plates taken in June. No observations from July through December, 1960. Not visible January 14, 1961.

No. 12. Appeared 37″ east and 17″ north of the nucleus of the relatively small bright Sa galaxy NGC 4375. Not visible April 18, 1960. Visible on two plates June 18–19, 1960. No observations from July through December, 1960. Not visible January 14, 1961.

No. 13. Appeared 10″ west and 6″ south of the nucleus of a small faint SBc galaxy. No prediscovery plate. Visible June 18 through October 14, 1960. Not visible November 10, 1960.

No. 14. Appeared 6″ east and 54″ south of the nucleus of the small bright Sb galaxy NGC 7177. No prediscovery plate. Visible August 14 through December, 1960. Near plate limit January 12, 1961. The uncorrected redshift of NGC 7177 is +1100 km/sec (Humason).

No. 15. Appeared 13″ west and 34″ north of the nucleus of the SBb galaxy NGC 2565. Found on October 26, 1960, when the magnitude was about 17.0. The supernova was already visible on a plate taken on September 28, 1960, when the magnitude was about 15.5; the September plate was taken for another purpose and was not searched for supernovae. Visible September 28 through December, 1960. Near plate limit January 13, 1961. NGC 2565 is a member of the Cancer cluster.

A spectrogram of the supernova and the galaxy was obtained by Zwicky at the 200-inch. The supernova was of type I; the redshift of the galaxy has not yet been measured.

No. 16. Appeared 11″ east and 12″ north of the nucleus of a small faint Sc galaxy. Not visible September 28, 1960. Visible October 26 through December, 1960. Near plate limit January 13, 1961.

Greenstein has photographed the spectrum of the supernova and galaxy at the 200-inch. He finds the supernova to be of type I. The redshift of the galaxy has not yet been measured, but is estimated to be of the order of +4500 km/sec, which would make this galaxy a member of the Cancer cluster.

No. 17. Appeared 1″ west and 10″ north of the nucleus of a very small faint Sc galaxy. May be barely visible on plates of October 26 and 27, 1960. Visible November 10 through December 13, 1960. Not visible January 12, 1961.

No. 18. Appeared 4″ east and 2″ north of the nucleus of a small faint Sc galaxy. Not visible October 13, 1960. Visible November 10 through December, 1960. About as bright as at discovery on January 13, 1961.

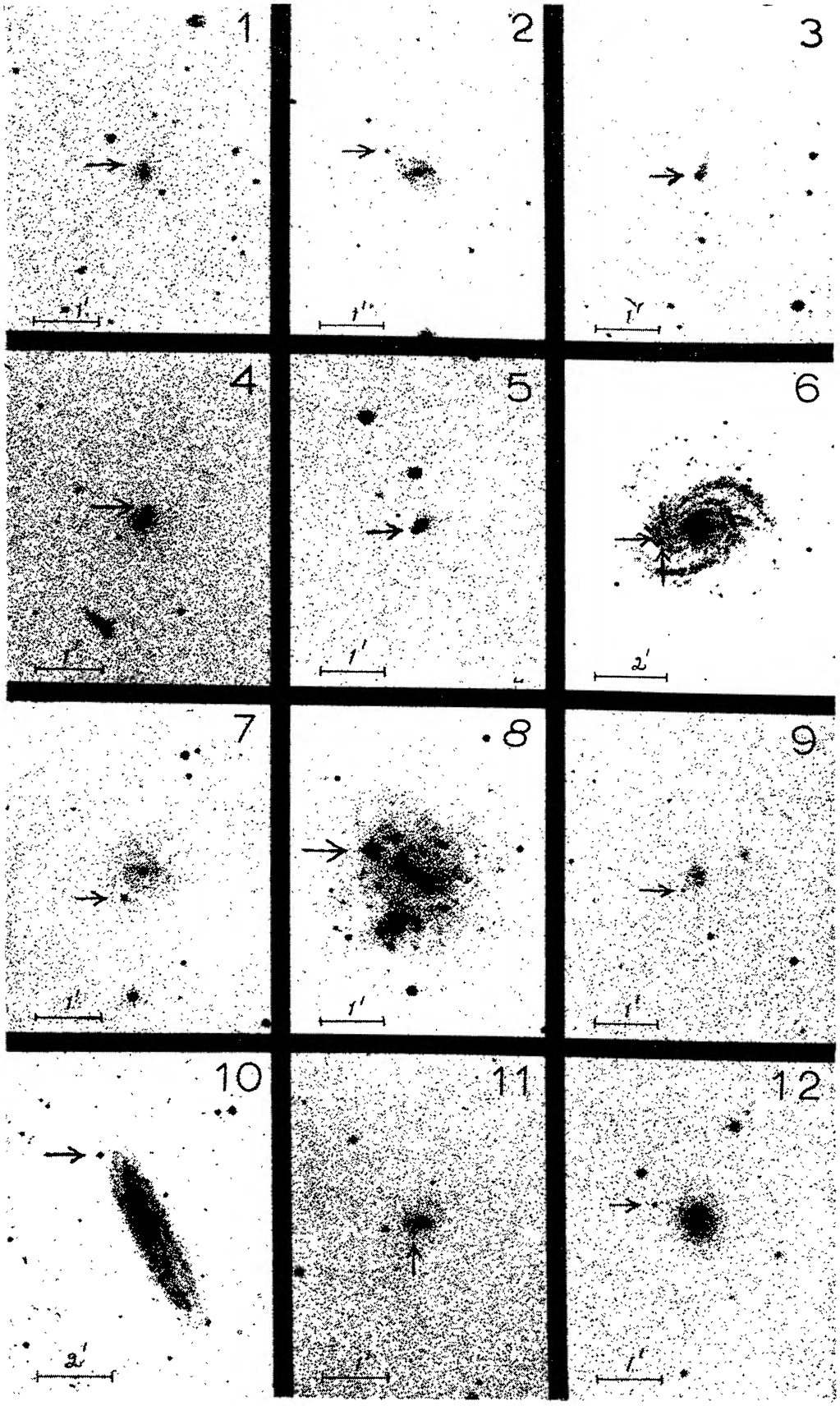
Spectra of the supernova and galaxy were obtained by M. Schmidt at the 200-inch. The supernova was of type I; the redshift, as yet unmeasured, is of the order of +4500 km/sec.

No. 19. Appeared 1″ east and 2″ south of the nucleus of a small faint Sb or Sc galaxy. At the time of discovery, the supernova was noticeably brighter than the galaxy in which it appeared (see photograph). Not visible November 10. Visible December 13 and 14. Much fainter December 23, 1960. Not visible January 12, 1961. The light of this supernova declined over three magnitudes in a period of only three weeks, a more rapid rate of decline than usual.

Charts for the supernovae appear in Plates I and II. North is at the top, west to the right. The chart for supernova No. 6 was made from a short-exposure plate in order to show the supernova.

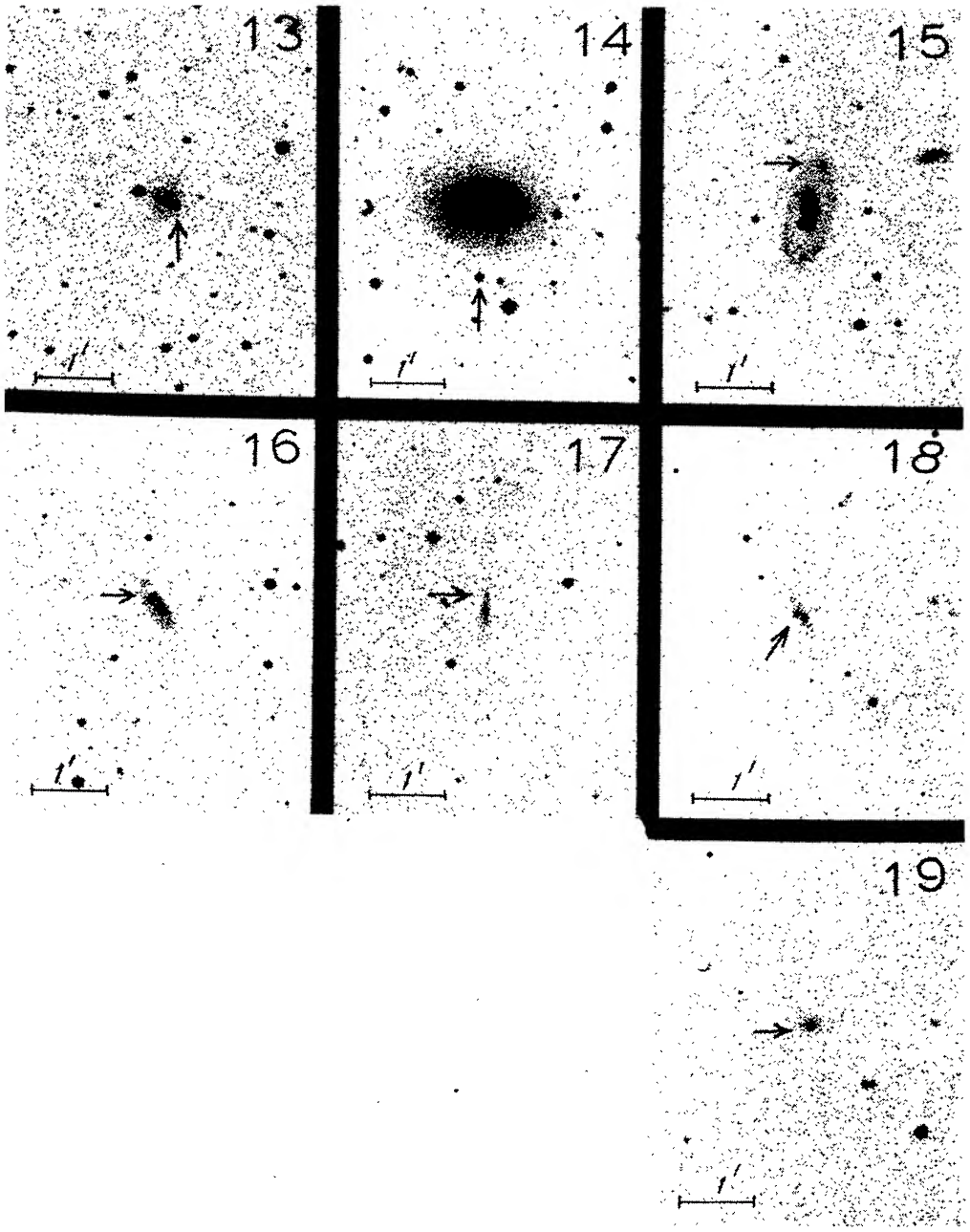
The Palomar supernova search is a part of a cooperative

PLATE I



PHOTOGRAPHS OF SUPERNOVAE
FOUND IN 1960

PLATE II



PHOTOGRAPHS OF SUPERNOVAE
FOUND IN 1960

international effort supervised by Dr. F. Zwicky. The project is partially financed by the National Science Foundation and the Swiss National Science Fund.

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[1] The Berne Observatory is one of the cooperating observatories participating in the International Supernova Search program.

[2] M. L. Humason and H. S. Gates, *Pub. A.S.P.*, **72**, 208, 1960.

[3] Reported by I. S. Bowen, *Carnegie Inst. Washington Yearbook,* **59**, 24, 1960. Eleven of the supernovae discussed in the present paper are listed in the above publication, but the magnitudes of a few of the supernovae and the positions of several have been recently revised.