ASIAGO SCHMIDT SURVEYS OF VARIABLE STARS AND SUPERNOVAE

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Survey methods used at Asiago for finding supernovae and new variable stars are reviewed. Some by-products of the supernova searching are indicated. It is shown that the use of infrared emulsions is particularly effective for the discovery of new Mira-stars in Milky Way fields.

1. INTRODUCTION

Large fields telescopes are particularly suited for statistical researches over wide sky areas. I shall give here briefly some notices on the researches carried out at Asiago with the Schmidt telescopes of the Astrophysical Observatory on variable stars and supernovae.

The following Schmidt telescopes are available at Asiago:

a) Schmidt telescope 40-50-100 cm. Mean limiting magnitude B $\sim$ 17.5. The telescope has been recently transferred to the Mount Ekar Station,1350 m on the sea level, 5 km from Asiago,far from the city illumination. With this telescope we have obtained since 1958 more than 15,000 photographs, each photograph covering an area of about 50 sq.degrees. In addition, nearly 2000 photographs have been obtained through an UBK7 objective prism of 12°,giving a dispersion of 45 nm/mm at H_γ .

b) Schmidt telescope 67-92-215 cm . Mean limiting magnitude B $\sim$ 18.5 . With this telescope we have obtained since 1963 more than 12,000 plates, each covering a field of 28 sq.degrees. The telescope is equipped with an UBK7 prism of 4° and with a second prism of flint of 1°.1;

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 301–309.

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combining the two prisms we can obtain the following dispersions (at H_γ):39.5, 65, 100 and 186 nm/mm.

In conclusion more than 27,000 Schmidt plates are available at Asiago with some thousand objective prism photographs. These plates are catalogued in order of R.A. and are easily available for studies and consultation.

2. SUPERNOVA SURVEY

The systematic search of supernovae at Asiago began in 1959 with the 40 cm telescope. Later, also the 67 cm telescope was occasionally employed. In the first years the search was limited to a dozen fields rich of galaxies, but gradually in the following years the number was increased to 66. The distribution of these fields in the sky relative to the galactic equator is shown in fig.1. Dark square represent fields covered by more than 200 photographs. White squares are fields recently introduced in the survey, covered by a minor number of plates.

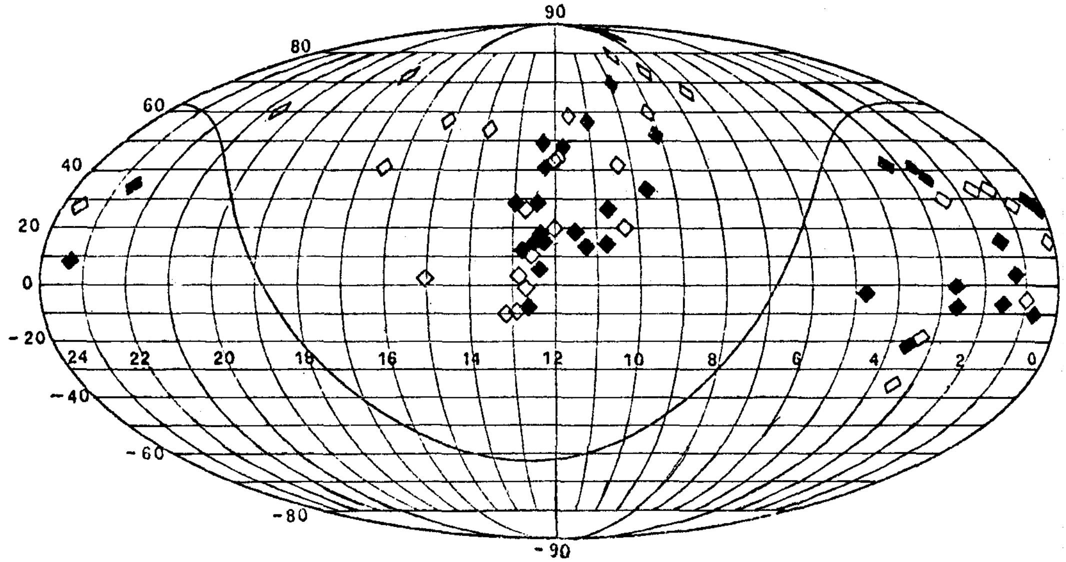

Fig.1 - Distribution of 66 fields for supernova survey.

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The plates are examined as soon as possible or with the negative on positive method (alternatively, negative on negative) which is rapid and effective, or with the blink microscope. A supernova is accepted only when it is visible at least on two different plates and when all controls are made in order to exclude that the object may be a spurious image or a normal variable star or an asteroid.

All the supernovae discovered at Asiago or elsewhere which may be accessible to the instruments and latitude of Asiago are followed as long as possible in UBV with the Schmidt telescopes and the 182 cm parabolic telescope, in order to obtain an extended light curve and the spectrum at different phases.

Supernova search is not an easy task. Supernovae are rare in galaxies, perhaps less frequent than generally estimated. In several thousand plates or films obtained for the supernova survey in the last 24 years we were able to discover only 25 SNe,which is a rather low rate. This is partly due to the fact that the period from April to June,when the Coma and Virgo fields are passing in the meridian during the night, is the worst at Asiago for observing conditions. The detection threshold in the 40 cm Schmidt plates is about 15.5 and in the 67 is about one magnitude more. Supernovae weaker than this, even if their images are present in the survey plates, are generally overlooked. For a thoroughly discussion see Rosino et al. (1974). The increasing illumination of Asiago is another negative factor. Now that the 40 cm Schmidt has been moved from Asiago to the Mount Ekar where the sky is darker, we hope to improve the efficiency of the research. The quick reduction of the plates is another problem. To intercompare a pair of plates we employ from 30 to 60 minutes, even more if the plates are taken with the larger Schmidt. It is a fatiguing work and it is possible that some weak supernova in the plates may have been missed. A revision of the plates hitherto obtained is in programme.

The situation in the other few Observatories which still are continuing the photographic supernova search is not much better. As shown in fig.2 the number of supernovae discovered every two years has had a sudden drop

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after the death of Dr.Zwicky and the interruption of the survey with the 48-inch Palomar Schmidt. The drop would have been even steeper without the contribution (after 1979) of Maza et al. at the Cerro El Roble Observatory in Chile.

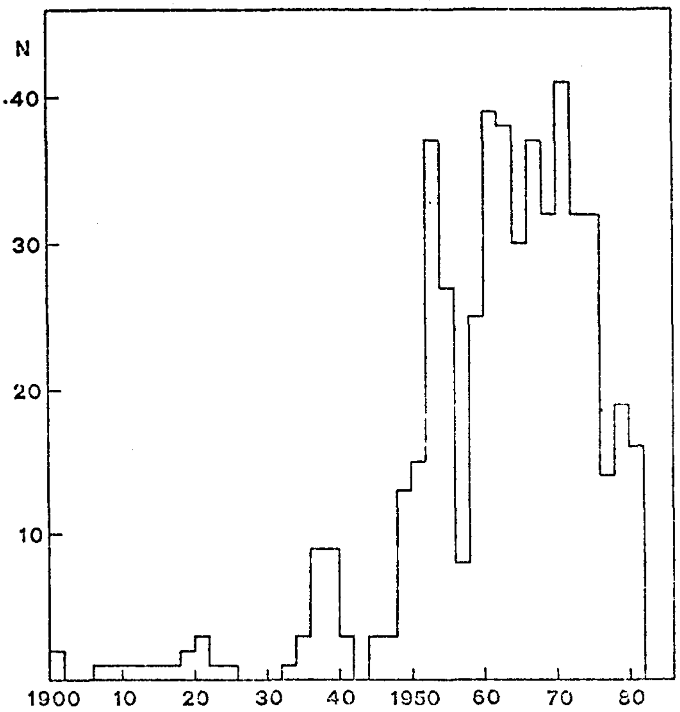

Fig.2 - Number of supernovae discovered every two years starting from 1901.

An important question at this point is whether it may be worthwhile to continue a survey which implies an enormous amount of telescope time,expensive photographic material and hard reduction work. Personally I think that every effort should be made to carry out the systematic search of supernovae at least for some more years. Several of the brightest and most interesting supernovae in the last years were found in the course of surveys with relati-

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vely small telescopes. Moreover, the occurrence of types I and II in galaxies of different classes, their frequency, the absolute magnitude at maximum, the shape of the light curve of some peculiar supernovae and the possible existence of new types are problems still partly open.

Anyway, the material obtained for the supernova survey is far from being wasted.I mention here some by-products of this material:

a) Control of SNe discovered by other observers and photometry of SNe below the detection threshold.

b) Variability of compact galaxies,quasars, BL Lac objects, etc.

c) Study of variable stars of high galactic latitude and discovery of new variables.

d) Study and discovery of asteroids and comets.

Finally I should like to mention that extensive searches of SNe with electronic and automatic devices have been recently developed. They should reduce the work and allow the discovery of many weak supernovae. However, these techniques are still in the experimental stage. The automatic search of SNe has been successful only at the Corralitos Observatory,where 12 SNe were discovered from 1968 to 1976,when this programme was interrupted. For the moment the supernova survey is entirely based on the conventional photographic techniques.

3. FLARE STARS IN YOUNG ASSOCIATIONS.

Another interesting field of researches with Schmidt telescopes is the survey of flare stars in young galactic clusters and stellar associations, particularly in the Orion Complex, in the Monoceros region (NGC 2264) and also in the Pleiades,Iades and Praesepe. The technique for the finding of flare-ups is that of multiple exposures firstly introduced by Haro. With this method hundredths of flare stars and repeated flare-ups in active stars have been detected. In a recent paper of Haro,Chavira and Gonzales (1982) a Catalogue has been presented of 519 flare stars discovered in the Pleiades through the coordinate work of the Observatories of Tonantzintla,Byurakan and Asiago.

An interesting result is that in the Pleiades region at least 37% of the flare stars are non-members of the cluster. This means that the occurrence of the flare phenomenon is high in low luminosity stars of late spectral type independently on the fact that they belong or not to a cluster.

From the programme of survey of flare stars in young associations,which has been recently joined also by the Observatories of Budapest,Abastumani,Rojen and Sonneberg,it is possible to derive a number of valuable informations on the physical characteristics of the flare stars, their possible relation to nebular variables, the occurrence in clusters of different age, the relative frequency of the flare-ups, the absolute magnitudes and spectral types.

The systematic searching of flare stars, although important for the obvious implications in the theories of stellar formation and early evolution, implies an enormous amount of telescope time and requires a strenous work of observation. So in these last years we have progressively reduced at Asiago the time dedicated to the flare survey,continuing however the photographic observations of the variables of the RW Aur or T Tau type embedded in nebulosities. The researches have been mostly concentrated in the Orion Nebula and the neighbourhood regions including the Horsehead Nebula, NGC 1999 with the Herbig-Haro objects. Hundredth of new variable stars have been identified in blue and infrared plates and partly published. The number of variables in the Trapezium Region is so high that it is very difficult to find in the rich field non-variable stars for comparison.

But this leads me to speak briefly of another field of interest for Schmidt surveys,that of variable stars in rich Milky Way areas.

4. VARIABLE STARS IN MILKY WAY AREAS

Large field telescopes are the best instruments for the discovery,classification ,photographic and spectroscopic study of variable stars. In the past the surveys were made with astrographs. But the Schmidt telescopes are best suited because in general they are more powerful and allow the discovery of weak variable stars and the analysis of their light curves not only in the photographic and visual regions,but also in the near infrared. The use of objective prisms gives also large possibilities of identifying variable stars by their spectra.

At Asiago we have selected a number of Milky Way Areas which we are systematically surveying in B,V and I (Kodak IN plates + RG5) mostly with the 67 cm Schmidt. They are shown in fig.3. Some significant results have been already obtained by Maffei and by the writer.

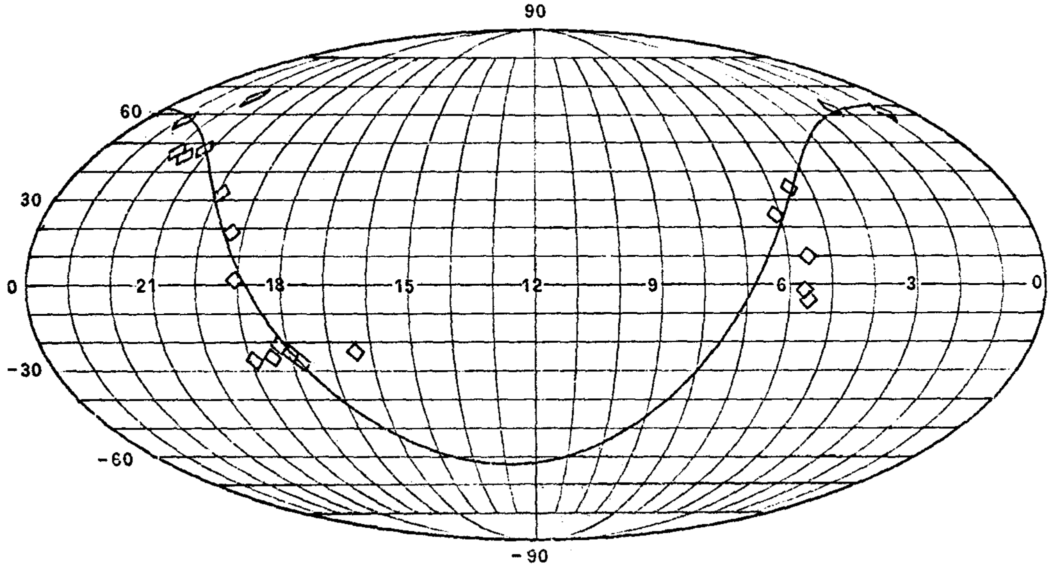

Fig.3 - Distribution of variable star fields in the Milky Way.

In an area with its centre at $18^h 15^m$ -15° (1950) Maffei (1975) has found in the infrared 198 new variable stars, of which at least 108 are Mira-type. Only a few Mira variables were previously known in the same area (28 sq.degr.). Similar results have been obtained by Rosino et al. (1976,1978) examining blue and infrared plates centered in Cassiopeia at $23^h 18^m$ +61° and Sagitta at $19^h 15^m$ +18° which led to the discovery of more than 160 Mira stars. Another area which after a preliminary survey appears extremely rich of Mira variables is centered at

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$19^h 00^m$ +2°.0 (1950).In this area 150 new Mira variables have been identified. The photographic researches in B,V and I are integrated by determinations of spectral types on objective prism plates also obtained in the near infrared. Most of the Mira variables discovered in the surveys have spectral types later than M5 and in the blue are barely perceptible and sometimes invisible even near maximum. The period distribution show a maximum frequency for stars with periods between 350 and 400 days, somewhat longer than found for the Mira variables (with period larger than 250 d) listed in the General Catalogue of Variable Stars of Kukarkin *et al*.(1968). It should be finally remarked that the period distribution and the number of Mira variables strongly depend on the galactic longitude and the presence of obscuring clouds in each selected region. But this is a point which is now under investigation.

The enormous increase, at least by a factor 50-100, in the number of Mira variables in some Milky Way areas, when observed in the near infrared, indicates that these stars represent an important component of the disk population and gives new insights on the possible course of star evolution. The shift of the periods of maximum frequency,on the other hand,particularly in the direction of the galactic center,suggests that low temperature Mira of advanced spectral type are likely to be much more frequent than estimated in the past.

In addition to the Mira stars these surveys of Milky Way areas operated with large field Schmidt telescopes in B and V give also the possibility of detecting other types of variable stars, from RR Lyr to U Gem, and offer the possibility of a comparison with other fields of high galactic latitude.

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DISCUSSION

P. WILD: I should like to give cordial thanks to all our colleagues at Asiago for much encouragement and for prompt and very friendly help that I have received from them in our supernova search of Bern since more than 20 years. You were able to confirm quickly several supernovae, when our weather had deteriorated right after a discovery. I also want to report the first case (to my knowledge) of radio astronomers having outrun the optical supernova searches: comparison of a Berkeley radio picture (January 1982) and a newer Westerbork radio picture (spring 1983) showed that a point source in NGC ... had disappeared (or nearly so) in the meantime. We were asked to go through our optical files, and sure enough, there had been a supernova of mag. 17 in fall of 1981, which we had missed. It proves that the optical search could well be checked and complemented by radio observations.

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