Astronomy at the Kiso Observatory

Ishida, Keiichi

Kiso Observatory, University of Tokyo

Major facilities and status of operation of the Kiso Observatory, and some highlights of the astronomical research at Kiso are summarized.

1. Facilities

Our major facilities are Schmidt telescope, Image Processing System, and Plate Library. (Takase, B., Ishida, K., Shimizu, Maehara, H., and Hamajima, K. 1977, Annals Tokyo Astron. Obs., **16**, 74-109: Kiso Information Bulletin, Tokyo Astron. Obs., **1**, No. 1, June 1979, pp. 1-46, No. 2, March 1980, pp. 47-72, No. 3, July 1980, pp. 73-88, No. 4, March 1981, pp. 89-120, No. 5, August 1981, pp. 121-136, No. 6, April 1982, pp. 137-158, No. 7, Dec 1982, pp. 159-174, No. 8/9, August 1983, pp. 175-200, No. 10, March 1984, pp. 201-250, 2, No. 1. June 1984, pp. 1-14, No. 2. June 1985, pp. 15-37)

1-1. Schmidt Telescope

The Schmidt telescope has 1.05-m correcting plate. Focal length is 3.3m and plate scale is 62.5 arcsec/mm. Kodak 14-inch plate covers 6 degree square field. Nikon made the Schmidt with close contact with Tokyo Astronomical Observatory. Mechanical parts were made by Mitsbishi electric company, and control system by Oki electric company. The longer focal length avoids risk of plate to break down which is mechanically bent to fit along the focal plane of spherical surface in plate holder. As a result, focal ratio is 3.1. We expect that it gives better optical quality for wider wavelength range than the case of the faster focal ratio, especially in ultraviolet wavelength band.

Two objective prisms were made by Grubb-Parsons for the Schmidt. The vertex angles are 2 degrees and 4 degrees, while the dispersions are 800Å/mm and 170Å/mm both at H gamma, because the 2 degree prism is made of Crown glass BK7 and the 4 degree prism Flint glass F2. Both are supplied by Schott glass company. In case they are used at near-infrared wavelength, the dispersion is much reduced. It is 1,000Å/mm at A band when the 4 degree prism is used for red giant survey.

1-2. Measuring Instruments

At the initial stage of the project to construct the Schmidt system, it was 15 years ago, we found that we need measuring machine for 14 inch plate We considered two alternate ways of designing measuring instrument. One way was to be conservative by making just copy of existing types of measuring instruments. Another way was to make a universal type automatic measuring machine, because we already knew a possibility and some attempts of Galaxy machine in the United Kingdom. However it was urgent to arrange some of the measuring instrument ready to use, and we were too busy because we were just a small group of five people including two technicians. We decided to have some of semi-automated classical type measuring instruments, and one new type machine in hoping to grade up in future to universal high speed machine which was called iso-photometer at the moment.

We have designed microdensitometer, iris-photometer, blink-comparator. The point was how to keep 1 micron accuracy during more than several hours to scan 14 inches plate. We adopted a fairly rigid structure of triangular column which contained optical parts and the light source bulb was attached out on top in the big box to avoid to give thermal effect. The photographic plate is set on the inclined back side and the observer sits in front side to watch screen, and to operate by key buttons. Preset data of coordinates are fed by paper tape or by ten keys and displayed by diode segment lamps and measurement data are punched on paper tape, which can be used as a preset tape later on, when one measures same field. They are still useful and working very well in these days. The input and output devices will be replaced by a personal computer with disket controller sets in near future.

1-3. Image Processing System

The we-call iso-photometer has been used as a converter from analog data on plate to digital data on magnetic tape to take out the data to manupilate by computer. This has been graded up to a universal type automatic machine. The detector used is charge-coupled device of Fairchild CCD121H which is one dimensional 1728 solid photodiode elements.

Very recently we have acquired a super-mini-computer with graphic image display devices in this year. It is Facom s-3, 500, 32 bit machine of 3. 0mips speed, with 8 Mbytes main memory. Storage capacity is 1. 4 Gbytes on 5 disk drives. It has 5 TSS terminals to access to the CPU, a 20-inch 7-color graphic display of 1024×1024 bits with a color hard copy unit, a graphic 20-inch image display system of $1024\times1024\times4$ bits$\times3$ colors, and a Calcomp XY plotter of 62cm$\times$122cm with 4 pens.

Software systems are being developed by several graduate students under the supervision of Drs. S. Okamura and M. Hamabe. One nearly completed is the Surface Photometry Interactive Reduction Advanced Library (SPIRAL), that is to carry out surface photometry of galaxies on the bases of PDS scans of photographic plates. All the programs are integrated under a Control Language procedure. Users can perform variety of processings by simply entering command menu number or command name through one of five terminals. Other software systems for Astrometry, Iris-photometry, Plate Search, Hartmann Test and others are also available in the same fashion.

Latest event is the installation of microdensitometer PDS 2020GMS last month. It has a large table for 20 inch plate, made of granite of 2 tons, and a magnetic tape unit to receive output data. This will be a great help for us to work on image processing.

1-4. Plate Library

All the 4, 500 plates taken by the Schmidt telescope are stored in the main building, in order of observing date with their serial number. The plate data is stored in a magnetic tape which is up-dated frequently. You can get a plate list with quality instruction from a computer, right after you tell name of object or coordinates of alpha and delta, color bands, exposure time, and others you wish to specify.

1-5. Status of Operation

We have darkrooms for photographic works, major publications and books, and personal computers for desk works. We are still a small group of four astronomers, four technicians, a few of part time workers for canteen and others. We accept 20-30 research projects from 30-40 astronomers. To proceed those researches we had about 1000 man-day visitings last year, Which consists of, on average, 200 of 5-day visitings, or 5-day visitings of 25 persons by 8 times per year. In other words we have 3-4 visitors at any time of a year on average. If we break down the visitings to their home institutes 36% is from other sections of Tokyo Astronomical Observatory, 13% from University of Tokyo, 35% from other universities and institutes, and 11% from foreign countries.

Kiso Observatory is one of the branch observatories of the Tokyo Astronomical Observatory. Kiso is named after the province, where is a mountain area of main island about 200km west of Tokyo, and where we enjoy clear dark sky to observe faint astronomical objects. There are three buildings including the Schmidt dome, the main building, and the night sky laboratory. The beautiful Mt. Ontake is seen at 17km northwest from the observatory site.

The Schmidt dome has a diameter of 16m sitting at 1, 120m above sea level. The Schmidt has been regularly operated since 1973. Observing schedule is fixed every 3months. Dead line date for application of observation to be submitted is one and half months before the period starts.

We are used to meet in September at symposium to exchange information related to the observational researches with the Schmidt telescope every year. Number of people to get together is about 60-70. and about 50 reports are presented.

2. Researches

Some of the recent astronomical results at Kiso will be introduced below.

2-1. Asteroids

A survey observation of 2, 700 asteroids were carried out. Observational material is 176 plates for 54 fields. Each plate was exposed 20min for B color bands. Observed fields are distributed widely from the opposition point to 30 degrees in ecliptic latitude and to 50 degrees in ecliptic longitude. Number of asteroids found in a field of 36 square degrees is varied from 1 to 212. Their apparent magnitudes distribute from 10 mag to 19 mag. The size distribution of asteroids and space number density distribution to reproduce observed number counts and surface distribution on the sky, were solved by a least-squares method. It is found that the size distribution expressed by an inverse power relation with diameter shows a complex behavior requiring at least three different indices for different diameter ranges. (Ishida, K., Mikami, T., and Kosai, H. 1984, Publ. Astron. Soc. Japan, **36**, 357-370)

2-2. Emission Line Stars and Herbig-Haro Objects

(Ogura, K. and Hasegawa, T. 1983, Publ. Astron. Soc. Japan, **35**, 299-316, 1983; Ogura, K., and Hidayat, B. 1985, Publ. Astron. Soc. Japan, **37**, 537-543)

2-3. Carbon Stars

Carbon stars are most easy to find at large distances among other types of stars because of its distinguished spectral feature. The 4 degree prism was used at wavelength range of 4, 500 Å to 7, 000 Å with Kodak 103a-F emulsion through Schott GG455 glass filter. Many faint carbon stars were detected in Cassiopeia region and classified in the C-classification system. This is a first step to investigate rotation curve of our Galaxy at the outer edge of the disk, which is important to know the mass of our Galaxy. (Maehara, H. 1985, Publ. Astron. Soc. Japan, **37**, 333-344)

2-4. Red Giants

Overall shape of inner part of our Galaxy looks like an edge-on galaxy which was shown up by small balloon-born telescopes of Nagoya and Kyoto Universities in the near-infrared wavelength. It is interesting to see what kinds of objects are the source of the near-infrared radiation.

Point source survey was conducted by ground-based observations, and a part of the surface brightness observed by balloon-born telescopes was resolved into point sources with K magnitude down to 7 mag. and H-K color.

The 4 degree prism spectra of wavelength between 6900 Å and 9000 Å secured on Kodak IN emulsion through RG695 were used to see spectral type of near-infrared point sources. And all of those identified were found to be red giants. The number counts of the near-infrared point sources and the surface brightness distribution of the near-infrared radiation are consistent with the Galaxy model of the same stellar content as those in the solar neighborhood. (Mikami, T., Ishida, K., Hamajima, K., and Kawara, K. 1982, Publ. Astron. Soc. Japan, **34**, 223-229).

2-5. UV Excess Objects

White dwarf is one of the major contributors to the mass density in the space of the solar neighborhood and it is not precisely known. The estimation which appeared in recent publications distributes from 0.005 $M_{\odot}$ pc^{-3} to 0.018 $M_{\odot}$ pc^{-3}.

A UGR three color survey has been on going to list up blue objects mainly in a belt region through the galactic pole and the galactic center. Number of objects published in the first catalogue is 588 in 700 square degrees with limiting magnitudes of 16.3 to 18.5. The proper motion measurements were carried out for two pilot regions with plate pairs of the Palomar and Kiso Schmidt. The time span of the plate pairs is about 30 years, which is long enough to see if the majority of them is white dwarfs or other distant objects like blue subdwarfs, horizontal branch stars or QSO. The statistical distances and colors correspond just with those of white dwarf sequence. Our observation shows 0.008 $M_{\odot}$ pc^{-3} for mass density of white dwarfs. (Noguchi, T., Maehara, H., and Kondo, M. 1980, Annals Tokyo Obs., **18**, 55-70(I), Kondo, M., and Maehara, H. 1984, **20**, 130-189(II); Noguchi, T., Yutani, M., and Maehara, H. 1982, Publ. Astron. Soc. Japan, **34**, 407-415. Ishida, K., Mikami, T., Noguchi, T., and Maehara, H. 1982, Publ. Astron. Soc. Japan, **34**, 381-388).

2-6. UV Excess Galaxies

Blue galaxies are searched for on the plates of the UGR three color survey. Survey catalogues of blue galaxies have been published for 1841 galaxies in 900 square degrees. The limiting magnitude is 17 to 17.5 mag. This is an extension of Markarian survey, as the criterion is calibrated with the Markarian galaxies found in the same field and Kiso survey detects nearly ten times large number of blue galaxies in each field. The number ratio of the Kiso UV galaxies in each field. The number ratio of the Kiso UV galaxies to all the field galaxies is 0.25 on average. The small ratios are found in cluster regions of Coma and other five Abell clusters, as from 0.16 to 0.20. (Takase, B. 1980, Publ. Astron. Soc. Japan, **32**, 605-612; Takase, B., Noguchi, T., and Maehara, H. 1983, Annals Tokyo Astron. Obs., **19**, 440-462; Takase, B. and Miyauchi-Isobe, N. 1984, Annals Tokyo Astron. Obs., **19**, 595-638(I), **20**, 237-281(II), **20**, 335-392(III)).

2-7. Galaxy Photometry

Quantitative classification is undertaken for a large sample of galaxies with a uniform procedure. Digital surface photometry of 261 galaxies in the Virgo and the Ursa Major regions was carried out. Principal component analysis shows that major characteristic is described with average surface brightness and effective diameter. The luminosity profiles of all the galaxies are well reproduced with a composite model of exponential disk and de Vaucouleurs spheroid with different normalization factors. It is interesting that even E type galaxies are better simulated with two components of disk and spheroid rather than a single spheroid. Another important result is that disk component shows similar average surface brightness and effective diameters in all galaxies, while spheroid component shows higher concentration in the earlier type galaxies, and lower concentration in the later type galaxies. This project is now extended to 1000 galaxies in Shapely-Ames catalogue. (Watanabe, M., Kodaira, K., and Okamura, S. 1982, Astrophys, J. Suppl., **50**, 1-22(I); Watanabe, M. 1983, Annals Tokyo Astron. Obs., **19**, 121-253(II); Okamura, S., Kodaira, K., and Watanabe, M. 1984, Astrophys. J., **280**, 7-14(III); Hamabe, M., Kodaira, K., Okamura, S., and Takase, B. 1979, Publ. Astron. Soc. Japan, **31**, 431-450(I); 1980, Publ. Astron. Soc. Japan, **32**, 197-212(II); Hamabe, M., and Okamura, S., 1982, Annals Tokyo Obs., **18**, 191-204(III); Hamabe, M. 1982, Publ. Astron. Soc. Japan, **34**, 423-447(IV); Wakamatsu, K., and Hamabe, M. 1984, Astrophys. J. Suppl., **56**, 283-294(V))

2-8. Galaxy Counts

There is cD type supergiant galaxy in some 25% of number of galaxy clusters. It is considered either a product of galaxy cannibalism or a seed galaxy formed before galaxy cluster is formed. In this context, it is interesting that there are cD galaxies which are found not in rich cluster of galaxies. Some 20,000 galaxies were counted in the 16 regions of 1 square degree taking each of those lonely cD galaxies at their center, and a detailed statistical procedure was applied to single out number of member galaxies attached to the central cD galaxy if any, which turn out to be only a few percent of field galaxies. To do that Schmidt plates were measured by PDS micro-densitometer, and image detection, star/galaxy separation, and magnitude calibration were carried out in computer. The member galaxies of the poor clusters shows nearly identical (composite) luminosity function form to that of rich clusters. It seems that the result favors to the adiabatic theory which expects seed galaxy. (Yamagata, T. 1986, Annals Tokyo Astron. Obs., accepted)

3. Conclusions

Astronomy is an international science in nature. Every one who is interested in doing astronomical research with the Kiso Observatory is welcome to write to us, and it will be considered seriously by all staff members and visiting atronomers of the Observatory.

<硏 究 論 文>

Distance and Radius of the Dwarf Cepheid XX Cygni

Hong, Jung-Ho and Kim, Chulhee*

National Astronomical Observatory

Joner, Michael D.

Department of Physics and Astronomy, Brigham Young University

Photometric (BVR) observations of dwarf cepheid XX Cygni are described. The Surface-Brightness method has been combined with new BVR and uvbyβ photometry to derive a distance and radius for XX Cygni by using both $F_v-(V-R)_0$ and $F_v-(b-y)_0$ relationships. It was found that the $F_v-(b-y)_0$ relation is preferred to the $F_v-(V-R)_0$ relation. A radius of 2.8 $R_\odot$ and a distance of 1080 pc have been determined for XX Cygni.

* Now at the Department of Earth Science Education in the Chonbuk National University.