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A SUPERNOVA SEARCH WITH PUBLIC ASTRONOMICAL OBSERVATORIES IN JAPAN

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ABSTRACT

We are promoting a supernova(SN) search project with medium size (60cm – 105cm) telescopes belonging to public observatories in Japan. The main purpose is to measure the SNe Ia rate, which plays an important role in the chemical and dynamical evolution of galaxies. We expect to measure the SN rate in E/S0 galaxies within the 35% error after 2 years run, and the longer run will give the smaller error.

Key Words : Supernovae, Clusters of galaxies

I. WHY DO WE USE THE PUBLIC TELESCOPES ?

For the last decade, many public astronomical observatories have been constructed in Japan. There are more than 40 public telescopes with the aperture larger than 60-cm. Though the main purpose of these observatories is the social education, they have enough potential for scientific research. Nowadays, with the evolution of the computer networks, the connection between the public observatories becomes active and firm. It is the time to promote a single observational project wuth plural observatories.

For such project, a survey-like observation is preferable, because the efficiency will be greatly increased by sharing the observing time. The typical field of view (~10 □′) of these public observatories has made us to choose the central regions of cluster of galaxies as the target.

On these backgrounds, we promote a SN search project in early type galaxies located in the central region of nearby clusters of galaxies ($z \leq 0.1$). Early type galaxies have small internal absorption, and produce only SNe Ia which is the brightest among all types of SNe.

II. SCIENTIFIC SIGNIFICANCE

SNe Ia plays significant roles in many regions of astrophysics. Recent X-ray observation suggests that the early type galaxies are surrounded by hot gas. To the energy source and the chemical evolution of this hot gas, it is doubtless that SNe Ia contribute prominently, but the quantitative discussion requires, especially, the accurate SN rate that currently has a factor of few uncertainty. It is one of our main purposes to estimate this rate to a better accuracy.

SNe Ia are also noticed as the standard candles for the cosmolosical distance measurement. Basically, the homogeneity of their maximum brightness is supported by various observational evidence. On the other hand, the 'personalities' of the light curves have been reported in the recently appeared SNe Ia[1]. For the deeper understanding of the nature of SNe Ia, it is necessary to discover and study more SNe Ia. As our targeting SNe will be brighter than $V_{\rm max} \sim 18 - 19$, such personalities will be able to be investigated systematically after our discoveries.

Other SN search projects are in progress. The monitor of the distant ($z \geq 0.3$) clusters (High-Z Supernova Search at Cerro Tololo: about the recent discoveries, see [2]) will tell us the time history of the SN rate by comparing our results. The Mount Stromlo Abell Cluster Supernova Search (for the recent discoveries, see [3]) is our competitor because the distance range of the targets is same. Their targets are the southern clusters so they and we will complement each other.

III. SEARCH PROCEDURE

(a) THE FIELDS

The survey fields are selected so that each field of view contains more than 20 E/S0 galaxies (the bright galaxy is converted as $M_{\rm B} = -19.5$ per one galaxy). For the central region of Coma cluster such field expands 30 □′ (for $H_0 = 75$ km s^{-1} Mpc^{-1}), so we can use as the survey fields the central regions of the cluster which located 3 times deeper than Coma, i.e., $z > 0.07$.

For the clusters nearer than $z < 0.07$, some of them give us 2 target fields, and some cannot be used as the target fields. Actually, however, there often exist bright galaxies in the center of the cluster,then we can get one field in such region.

ACO catalog gives 159 clusters in the northern sky (Richness Class > 1) within $z < 0.1$. As the observable field is 1/4 for each season, we can monitor at least 40 fields at all times.

(b) AUTOMATED SOFTWARE

We constructed the automated software to search SNe in order to diminish the working hours of the public observatories. The software is able to do flat-fielding, photometry of the indivisual object, and comparison with the previous images to pick up the candidate for a SN. After these procedure, the final check is done by eye.

(c) BAND AND EXPROSURE

Because the color of the early type galaxies is redder than that of SNe, using B band would be advantageous in principle. But considering the quantumn efficiency of the CCD camera in some observatories, we decided to use R band for usual monitor.

Test observations (see Sec. V) tell that the observational limit will reach 20th magnitude by 15-minutes exposure for larger (90 – 105 cm) telescopes. We adopt the exposure time of 15 minutes for monitoring. For smaller (60-cm) telescopes, we will allocate closer clusters.

Our targeting SNe are bright as $m_{\rm max} \leq 19$, and around the maximum, it glows about 20 days above the $m_{\rm max} + 1$ magnitudes. If the monitoring is done is once in 10 days, SNe in our target clusters that appear during this project will be scarcely missed. Even if the weather do not allow this interval, we can estimate the SN rate using a simple simulation.

IV. SN RATE

We estimated the expected SN rate for this project. As one field contains $11h^{-2}$ galaxies, our monitor is equivalent to see $440h^{-2}$ galaxies at all times ($h \equiv H_0/100$ km s^{-1} Mpc^{-1}). The conventional SN rate is $0.98h^2$ per century per one $M_{\rm B} = -19.5$ galaxy [4]. Then we expect to discover 4.3 SNe Ia per year. After two years run, the error of the SN rate should be less than 35%, and can be reduced for the longer run.

V. CURRENT STATUS

Four public observatories gave response to the first call for the collaboration in last winter. Test observations to choose the color band and exprosure time had been carried out by 3 observatories in this spring. Some observatories have no auto-guiders, and could not take the 15-minutes exprosure in one time. At such observatories, three 5-minutes exprosure images will be composed by the automated software.

We have gotten other three participate observatories which responded to the second call for participant in this spring.The list of observations is given in Table 1. Now we are setting up hardware environments including photometric filters and peripheral devices of computers. Test observations for these observatories will be carried out during this summer.

The monitor run will start in the end of August, 1996. We hope to give some reports at the IAU meeting in Kyoto, 1997.

Table 1. The participate observatories. The asterisks show that test observations have been done. The first four responded to the call in last winter, and the latter three joined this spring.

Observatory	Aperture (cm)
Ayabe *	95
Bisei	101
Kuma *	60
Misato *	105
Kawabe	100
Nishi-Harima	60
Saji	103

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