JAPANESE NATIONAL LARGE TELESCOPE (JNLT)

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Abstract

A brief background and a description are given of the plan to build a large telescope of 5m to 7.5m class as the Japanese National Large Telescope.

<u>1. Introduction.</u> Japan's Largest optical telescope is the 1.9m reflector at the Okayama Astrophysical Observatory built in 1960. Other major optical and infrared telescopes available in Japan are summarized in table 1. Since 1960, optical astronomers in Japan have tried to build a 3m class telescope of the conventional type.

Table 1. Optical and infrared telescopes

Telescope	Location	Administration
188cm reflector	Okayama	Tokyo Astro. Obs.
105cm Schmidt	Kiso	Tokyo Astro. Obs.
100cm infrared reflector	Agematsu	Kyoto University
91cm reflector	Dodaira	Tokyo Astro. Obs.
91cm reflector	Okayama	Tokyo Astro. Obs.

In the meantime, the new rapid development in Japan of X-ray astronomy by the launching of the satellites Hakucho and Temma, and of radio astronomy by the construction of a 45m millimeter-wave radio telescope have made it necessary and desirable for optical and infrared astronomers to build a telescope with an aperture much larger than those available at present. In 1982, optical and infrared astronomers concluded that the following steps are to be taken in this sequence considering the fact there is a big leap in the size of the aperture from presently available 1.9m reflector.

1) Construction of a telescope with a 3m aperture within Japan based on new technology.
2) Construction of a telescope with a 2m aperture outside of Japan, where the observing conditions are better than those in Japan.
3) Initiation of a project which will lead eventually to the construction of a very large telescope at one of the best overseas sites.

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Unfortunately, this conclusion failed to receive a unanimous approval of the Committee of Astronomy, the Science Council of Japan at its meeting in January 1983. As a result all through 1983 a new approach to plan future optical and infrared astronomy was conducted, and the primary goal was set to the realization of the Japanese National Large Telescope (hereafter refered to as the JNLT) with a diameter of 5m to 7.5m for the primary mirror at one of the best sites in the world. In this decision we also included the previous conclusion, that is, to construct a sub-telescope(s) of moderate size and future participation in an international collaboration to construct a very large telescope.
In this paper, we will show the concept of the JNLT, although it is still in a preliminary phase.

2. Telescope performance. Since the JNLT will be the only large national telescope for the coming decades, it should be versatile enough for research in a wide range of fields of astronomy:
1) cosmology, especially studies of the formation and evolution of galaxies, 2) physics under extreme conditions existing in cosmic environments, 3) formation and evolution of stars, and 4) exploration and study of the origin of the solar system. However, priorities are given to the study of formation processes of galaxies and stars. For this purpose, the telescope should be designed to have a high angular resolution for optical and infrared observations and also a wide field in the optical region. Since objects at their formation processes are generally very faint, we should have a telescope with a large effective aperture.
A comparison of the limiting magnitudes for a given exposure time for different apertures is given in figure 1. Although there are some projects in the world to build gigantic telescopes with effective apertures of 10m to 25m such as segmented mirror telescopes (SMT) and multiple mirror telescopes (MMT), we have settled on a telescope with a single primary mirror. There are two main reasons for this choice: 1) The telescope structure with a single primary mirror is much simpler than those of SMT and MMT to achieve the observational requirements mentioned above; 2) Since we have experience only in a 1.9m telescope with a single primary mirror and of equatorial mounting, there are too many technical difficulties to be solved for us to realize an SMT or MMT. The maximum size of a mirror blank producible on a commercial basis is a thin

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7.5m mirror, although there is no concrete design for a mirror supporting system at present. Therefore, we will set the maximum aperture for the JNLT to be 7.5m and the minimum to be 5m. The length of the period for technical development will be the deciding factor for the size of the mirror. There will be another possibility to obtain a 7.5m mirror, if Dr. Angel at the Steward Observatory is successful in casting a honeycomb mirror with that aperture. If his production schedule runs well, a honeycomb mirror with a 7.5m diameter will be available in 1986. Since optical and infrared astronomers in Japan strongly wishes to have the JNLT operational by early 1990's, the production period of a honeycomb mirror may not fit the time schedule of the JNLT. In either case, we intend to realize

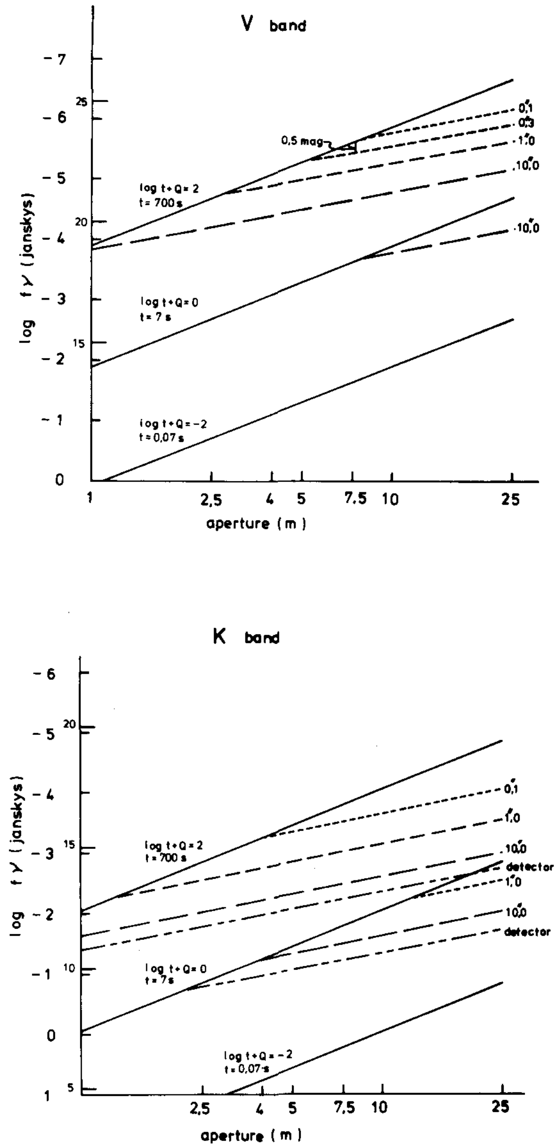

Figure 1. Relation between telescope aperture and the limiting magnitude for V band (upper) and K band (lower). The limiting magnitude depends on exposure time and seeing size. For K band, detector noise is also considerable. t is exposure time. Q is a scaling parameter, where

$$Q = - \log \left[R / (10^6 \delta^2 \eta_T \eta_D \nu) \right],$$

R is a spectral resolution, 10^3,
η_T efficiency of telescope and instrument, 0.3,
η_D quantum efficiency of detector, 0.3,
ν is input efficiency, 1, and
δ is accuracy, 0.03.

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a surface accuracy of the main mirror of less than $0''.2$ in order to make the best use of the excellent seeing on the top of Mauna Kea. The alt-azimuth mounting will be introduced in the JNLT. The pointing and tracking accuracies are aimed at $1''$ and $0''.1$, respectively, after the correction of systematic error by the computer contorol system. The field of view of the primary focus is intended to be $0^{\circ}.5$ in diameter to make possible direct imaging and spectroscopic observations with a medusa spectrograph. To match the image size of $0''.3$ obtained under the excellent seeing condition and the pixel size of electric detectors, a focal length of about 15m will be adopted, that is, F2 for the 7.5m primary mirror and F3 for the 5m primary mirror. The prime, Cassegrain, and Nasmyth foci will be provided. The coude focus may be introduced to keep a possibility of future coorporative interferometric observations with other telescopes at Mauna Kea. Since a considerable part of the telescope time of the JNLT will be allocated to infrared observations, the infrared background emissivity from the telescope itself should be less than 8%.

To achieve all the above requirements, there are some difficulties which should be solved. Then, in the course of a detailed feasibility study, we may have to down grade some critical specification.

3. Auxiliary instrments and site. The **observational efficiency** depends not only on the performance of auxiliary instruments and the ease of operation by observers. We have a plan to introduce at least the following main auxiliary instruments: 1) an infrared photometer and an infrared spectrometer at the Cassegrain focus, 2) a Medusa spectrograph with fiber optics at the prime focus, 3) a high-resolution spectrograph at the Nasmyth focus, and 4) imaging instruments such as photographic and CCD cameras at every focus. Since the site of the JNLT will be abroad and at high altitude, an automatic operation system so far as possible should be introduced for changing auxiliary instruments. A remote operation system will be introduced in order to have efficient collaborative work with radio and X-ray astronomers in Japan.

As mentioned already in this paper, the JNLT will be placed at Mauna Kea in Hawaii. We have been informed by the University of Hawaii that there is space for 13 telescopes on the top of the mountain in their developing plan until 2000. One of these can be

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the JNLT, but till now we have not exchanged any official documents with the University of Hawaii. We believe that Mauna Kea is the best available site for the JNLT because of its excellent seeing and its relatively short distance from Japan (approximately 9 hours by air).

4. Conclusion. We intend to build a large telescope with a single primary mirror of a 7.5m aperture. To do so, some new technologies should be developed in a few years. At the time of the final decision, some down grade of its aperture size and other specifications may be necessary after a detailed study in a few years. We will do our best to have the best telescope suitable for our astronomical goals in the coming 10 years.

This paper was written based on the conclusion of Group of Optical and Infrared Astronomers in Japan at the meeting held in March, 1984.

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