THE USE OF A THIN MIRROR IN THE NHO 4.2m TELESCOPE

General

The experience gained by Grubb-Parsons in figuring and polishing the unusually thin mirror of the UK Infra-red Telescope (UKIRT) suggests that it would now be quite feasible to figure also a mirror for a precision optical telescope that is significantly thinner than normal. Mirrors for optical telescopes usually have a diameter-to-thickness ratio somewhere between 6 and 8, while the recently-completed UKIRT mirror has a ratio of 15.

Analyses carried out at the RGO have shown that it would be possible to support a thinner-than-normal mirror in a telescope using the improved pneumatic system now available. It is the opinion of both opticians and telescope engineers that the primary mirror for a large optical telescope could now operate satisfactorily with a thickness ratio of about 12. It is felt that a mirror of ratio 15, although practicable for a flux collector such as UKIRT, could not at present be reliably figured to the higher accuracies required in a precision optical telescope.

There is little doubt that should the design of a new 4 metre telescope be commenced now a primary mirror of thickness ratio 12 would be chosen in order to take advantage of the lower weight and cost of the mirror blank, assuming that it was being cast specially for the telescope. The weight of a primary mirror influences, though it does not entirely control, the weight and therefore the cost of the telescope mounting structure, so that the use of a thin mirror could be expected to result in a reduction in the cost of the telescope, perhaps amounting to 10% or 15% of the total, excluding dome and building. However, the determination of the cost saving resulting from the selection of a thinner-than-normal mirror is not a simple matter and much depends on the availability of mirror blanks, the nature of the telescope and the requirements of the astronomers.

The Particular Case of the 4.2m Telescope

In the case of the NHO 4.2 metre telescope an option on an existing mirror blank has already been secured. This blank has a thickness ratio of 8 which is already larger than the 6.5 ratio blank of the AAT and the other large telescopes constructed in recent years. The cost of having a new blank of ratio 12 specially cast by the glass manufacturers would, despite its reduced thickness, be significantly greater than the cost of the existing blank which can be purchased at an advantageous price.

The existing blank could, in principle, be wire-cut to reduce its thickness at an additional cost. There are however considerable risks associated with slicing a blank in this way and it is to be expected that the manufacturer would insist on these being carried by the purchaser.

The design of the 4.2m telescope is virtually complete and it incorporates as a special requirement two Nasmyth observing stations in addition to the usual Cassegrain station.

The use of a thin mirror could only result in a reduction in the cost of the 4.2m telescope if it brought about a reduction in the weight of the telescope tube as a whole. Since the weight of the upper end of the tube is not affected, any reduction in the weight of the primary mirror and its cell would necessitate the repositioning of the altitude bearing axis at the new point of balance further away from the primary mirror. In the case of the 4.2m telescope such a change is not possible because the distance of the primary mirror from the altitude axis is fixed by the need to maintain equal optical path lengths to the Cassegrain and Nasmyth focal stations.

The use of a thinner mirror in the 4.2m telescope would therefore require the attachment of weights to the mirror cell in order to restore the balance which would of course bring the tube back to its original weight. The alternative would be for the astronomers to forego the facilities provided by the rapid interchange-ability between the Cassegrain and Nasmyth foci which is a valuable feature of this telescope.

Even if the astronomers were to accept a reduction in performance the saving in the cost of the telescope mounting structure would be offset by the following extra costs:-

1. Slicing the blank to make it thinner.
2. Figuring the thin mirror which is more difficult than figuring a thick mirror.
3. Providing a more complex support system for the thin mirror.
4. Re-designing the mirror cell, telescope tube and mounting structure.

Approximate estimates of the costs of these items suggest that the overall cost saving is likely to be nil and could even be negative.

Recommendation

Although it is acknowledged that designers of precision optical telescopes of apertures up to, say, 5 metres should now aim for a thinner primary mirror than has been the practice hitherto, the cost effectiveness of this action can only be evaluated after considering the astronomical requirements and the availability of existing mirror blanks.

In the case of the NHO 4.2m telescope, for which an acceptably-priced blank already exists, a change to a thinner mirror is not recommended as it ~~is unlikely to~~ would not result in any cost saving and would reduce the facilities available to the astronomers.

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