

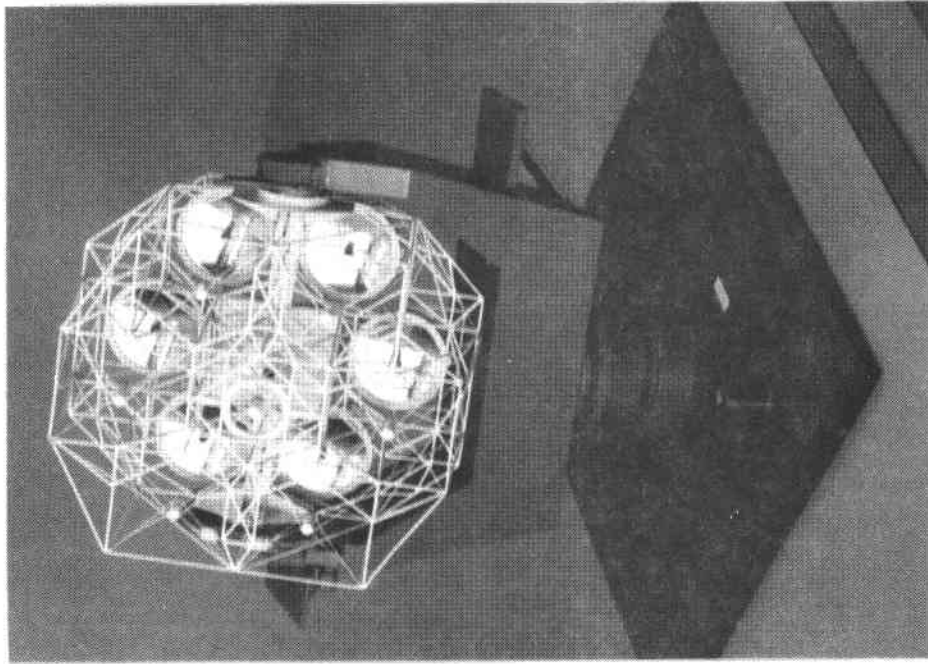
**Technical Report 19**  
**The MMT Upgrade:**  
**A Workshop to Consider**  
**Scientific and Technical Issues**

April 8, 1986

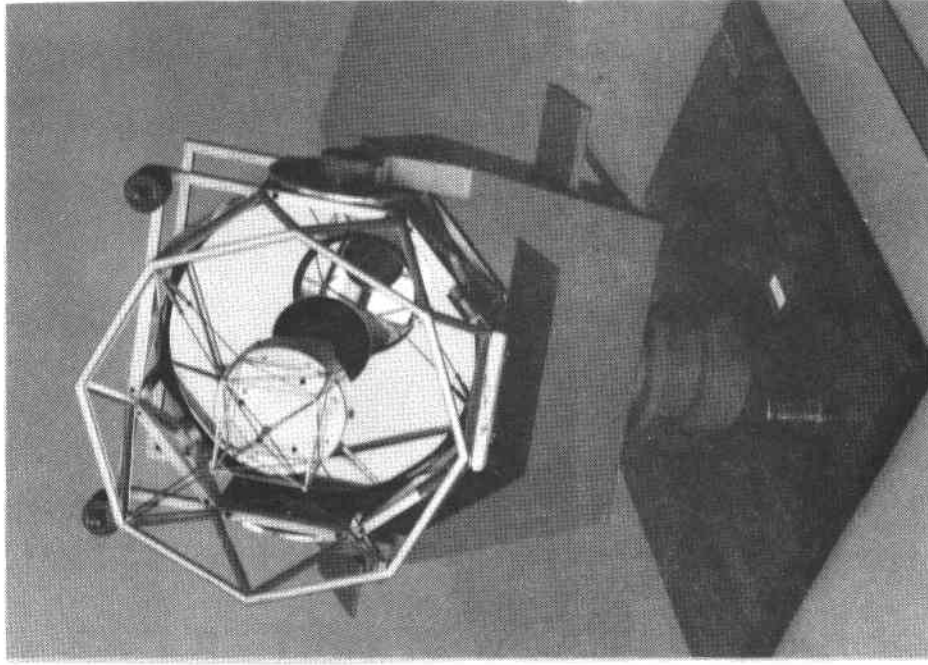
Cambridge, Massachusetts



## The MMT Upgrade



Model of the Multiple Mirror Telescope showing its yoke and the Optics Support Structure holding the six 1.8 meter telescopes.



Model of a possible upgraded version of the Multiple Mirror Telescope in which the original Optics Support Structure has been replaced by one holding a 6.5 meter primary and a 1.8 meter secondary mirror. The yoke remains unchanged.

## **Preface**

On April 8, 1986, members of the staffs of the Multiple Mirror Telescope Observatory, the Harvard-Smithsonian Center for Astrophysics, and the Steward Observatory of the University of Arizona held an informal workshop to discuss ideas for a possible upgrade of the Multiple Mirror Telescope. This technical report provides an edited transcript of those proceedings.

**Introduction by**  
**Frederic H. Chaffee, Jr.**  
**Director**  
**Multiple Mirror Telescope Observatory**

I want to welcome you all to the MMT upgrade workshop. A number of us—myself, Clint Janes, J.T. Williams, Dan Blanco, Roger Angel and Peter Strittmatter—have for some time been discussing the question of how to build a large telescope for the lowest cost. In light of Roger Angel's early success in producing fast, lightweight mirrors and the promise it holds for producing mirrors up to 8 meters in diameter, the idea of upgrading the MMT to a large single-primary mirror telescope seemed to us an appealing possibility. Our U of A colleagues, because of our geographical proximity to them, tend to be more aware of our discussions than our colleagues at SAO, so I have taken the opportunity to bring key members of the MMT staff to Cambridge so that we can discuss our thoughts with as many interested potential users as possible during our visit here.

Initially we asked whether such an upgrade is a realistic thing to consider and what it would take to do it. In our discussions I set several guidelines that I think such an upgrade should follow: It should be designed in such a way that no significant modifications should be required to 1. the existing yoke or 2. the existing building. 3. At least one of its optical configurations should produce a Cassegrain focal ratio of  $f/9$  so that the fine existing MMT instrumentation could be used on the upgraded telescope with minimal modifications.

Guideline #1 dictates the size of the mirror that can be put into the new optics support structure (OSS), and upon close examination, we determined that any mirror larger than about 6.5 meters in diameter would require significant modifications to the yoke. Therefore we set 6.5 m as the target size of the new telescope.

Guideline #2 dictates that the focal ratio of the 6.5 m primary mirror must be very nearly  $f/1$ . Anything slower puts the secondary outside the existing building doors.

Guideline #3 sets limits on the back focal distance, since a significant increase in that distance would prevent the MMT spectrograph from clearing the floor.

Thus, in its simplest form the upgrade would involve removing the existing OSS that holds the six 72" telescopes and replacing it with one that holds a single 6.5 meter telescope.

We approached Harland Epps of UCLA, who has made major contributions to the design of both the Keck telescope and the NNTT, with these guidelines and asked him to investigate possible optical designs for the 6.5 meter. One of the main limitations of multiple-telescope telescopes is the narrow field over which they produce good, unvignetted images. Therefore, in addition to the "standard" configurations at f/9 and at f/45 (for infrared work), we asked Harland to explore a design for a wide field, faster focal ratio Cassegrain system. He has produced these designs in a report to myself and Roger Angel (of which copies are available today and will be issued as MMT Technical Report #18), and although there are some rather tight mechanical constraints for maintaining proper optical alignment, there seem to be no fundamental limitations to producing excellent images in all configurations. Especially encouraging is the wide field design that produces excellent images over a wide wavelength range and over a field of 20 arcminute radius.

Our preliminary estimate of the cost of such an upgrade is of the order of \$10<sup>7</sup>, and if such funding could begin today, it could be implemented by about 1992. We further estimate that we would have to take the telescope out of operation for between 3 and 6 months to install and check-out the new OSS. In the meantime, we have an excellent 4.5 meter telescope for our research.

I'm going to Washington on Thursday to speak to the management council of the Smithsonian - perhaps including Secretary Adams, we don't know yet whether he'll be there - to fill them in on the upgrade and the response it has received in various places. I have been, personally, very encouraged by that response both at the U of A and here. I think it is evident to all users of large telescopes that a 6.5 m telescope has a tremendous appeal and that an MMT upgrade may be a practical way to get us on the air quickly and at reasonable cost.

It is, as I say, very early in the process, but I thought it would be useful to get as many scientific and engineering minds involved as we can from the start. A lot of things have to fall in place. Obviously, there are a lot of unanswered questions. Nonetheless we are encouraged by what we've seen so far and we are scheduled to discuss the engineering aspects of the problem this afternoon. We've asked a number of people who were involved in the MMT originally to join us. Joe Antebi just came in; he was involved in the design of the OSS. Tom Hoffman also was involved in the original OSS design. People who have retained an interest of the MMT over the years could be very helpful in the next era as well.

This morning's session will feature various scientific spokespersons from 3 divisions - Optical and Infrared, High Energy Astrophysics and Solar and Stellar Physics. The division associate directors have either gotten them to volunteer or twisted their arms to tell us a little bit about the kind of science they would like to do with such a telescope and what impact it would have on their research. I'd like

to lead off with Bob Kirshner from OIR. As you all know, Bob has been involved in a lot of the deliberations with the NNTT.