A Brief Comment on the Future of Optical/Infrared Telescopes

Alan. M. Levine
aml@space.mit.edu
617-253-7525
M.I.T. Kavli Institute for Astrophysics and Space Research
March 31, 2009

Summary

Herein I try to bring attention to the need to understand the tradeoffs between building future generations of optical and infrared telescopes in space rather than on the ground. One should not assume that the conclusions of analyses done for earlier generations of telescopes will apply to future generations. I expect that as the size, complexity, and cost of telescopes grow, space-based telescopes will become relatively more cost-effective and will yield superior scientific performance. My recommendation is that it will be timely in the coming decade to set up a group to explore the future of optical and infrared telescopes and particularly the space/ground tradeoff from a high-level perspective, and that it will be important to reduce cultural barriers in terms of thinking about space- and ground-based observational facilities.

A Brief Comment on the Future of Optical/Infrared Telescopes

Explanation

The next generation of ground-based optical telescopes, e.g., the Giant Magellan Telescope, the Thirty Meter Telescope, and the European Extremely Large Telescope, are currently in the early stages of development. These projects aim to build instruments with effective apertures, in terms of collecting area, of 20 to 40 meters in diameter. I am not particularly knowledgeable about the details of these projects, but I understand that the projected costs involved in each are likely to be of order $1B. The cumulative costs of these three projects will approach the order of magnitude of putting a good-size optical/infrared telescope into space. Indeed, one can compare the total costs of those projects with the projected cost of JWST.

I believe it is time to understand in a rough way the size and cost of a telescope or telescopes in space that would provide the imaging, spectroscopic, astrometric, etc., performance equivalent to these 20 to 40 meter diameter ground-based telescopes and also, or even more importantly, of the even larger telescopes that could follow in the succeeding generation. In regard to imaging, the calculation is likely to be relatively straightforward, and the equivalent aperture will be much smaller, perhaps a 5 to 10 meter aperture in space yielding the performance of a 30 meter ground-based telescope. It may be more involved to make such a comparison for the kinds of spectroscopic measurements that are envisioned for these ground-based projects. The comparison between the performance of a ground-based telescope with a space-based one should take into account point-spread function size, background levels, spectral coverage, required or desired sensitivities, duty cycle for performing observations, observational flexibility, etc., as well as construction and operations costs, lifetime, risk, and so forth.

I can understand that the Decadal Survey panels may not want to open discussion of the status of the current three next-generation ground-based telescope projects, and it is not my intention to throw cold water on those projects. I submit that whether or not it would make sense from a technical perspective to review whether a space-based telescope or telescopes would make more sense than the generation of ground-based telescopes now under development, it is clearly imperative for the astronomical community to obtain answers to the questions about the relative merits of different technology paths, especially the space vs. ground dichotomy, that would apply to succeeding generations of telescopes.

In addition to comparing the possible technological paths of telescope development, I would hope that a cognizant group would also explore what kinds of technology development efforts would be useful for reducing the cost of the development of succeeding generations of telescopes and/or enhancing their performance. I believe it is not too early to be discussing these subjects.