Solar Rejection Filter for Large Telescopes

Filters help avoid thermal loading of the receiver by incident sunlight.

NASA's Jet Propulsion Laboratory, Pasadena, California

To reject solar radiation photons at the front aperture for large telescopes, a mosaic of large transmission mode filters is placed in front of the telescope or at the aperture of the dome. Filtering options for effective rejection of sunlight include a smaller filter down-path near the focus of the telescope, and a large-diameter filter located in the front of the main aperture. Two types of large filters are viable: reflectance mode and transmittance mode.

In the case of reflectance mode, a dielectric coating on a suitable substrate (e.g. a low-thermal-expansion glass) is arranged to reflect only a single, narrow wavelength and to efficiently transmit all other wavelengths. These coatings are commonly referred to as notch filter. In this case, the large mirror located in front of the telescope aperture reflects the received (signal and background) light into the telescope. In the case of transmittance mode, a dielectric coating on a suitable substrate (glass, sapphire, clear plastic, membrane, and the like) is arranged to transmit only a single wavelength and to reject all other wavelengths (visible and near IR) of light. The substrate of the large filter will determine its mass. At first glance, a large optical filter with a diameter of up to 10 m, located in front of the main aperture, would require a significant thickness to avoid sagging. However, a segmented filter supported by a structurally rugged grid can support smaller filters.

The obscuration introduced by the grid is minimal because the total area can be made insignificant. This configuration can be detrimental to a diffraction-limited telescope due to diffraction effects at the edges of each sub-panel. However, no discernable degradation would result for a 20× diffraction-limit telescope (a photon bucket). Even the small amount of sagging in each subpanel should have minimal effect in the performance of a non-diffraction limited telescope because the part has no appreciable optical power.

If the front aperture filter is integrated with the telescope dome, it will reject heat from the dome and will significantly reduce dome temperature regulation requirements and costs. Also, the filter will protect the telescope optics from dust and other contaminants in the atmosphere. It will be simpler to clean or replace this filter than the telescope primary mirror. It may be necessary to paint the support grid with a highly reflective material to avoid overheating.

This work was done by Hamid Hemmati and James Lesh of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). ***NPO-40421***