

## LOWMASS MEMBRANE TELESCOPES

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Progress in observational astrophysics parallels the development of telescope technology and the associated instrumentation. The problem of constructing telescopes using polished metal mirrors has a long history tracing back to Gregory(1663), Newton(1672), and Cassegrain. The first successful mirrors with silver reflecting surfaces on a glass substrate were constructed in the late 1850's by von Steinheil and Foucault. Current state-of-the-art reflectors can trace their roots back to this technology.

The function of the substrate is to support the thin layer of high reflectivity material; the glass or metal substrate is formable into a shape that has useful optical properties. In current state-of-the-art telescopes the mass of the substrate is  $10^3 - 10^6$  times the mass of the reflecting layer. Clearly, new perspectives on telescope systems are necessary to reduce the cost and mass of the primary element.

The technology described achieves a significant reduction in mass by minimizing the thickness of the substrate. The telescope systems described use reflectors whose three dimensional shapes and curvatures are formed by the elastic bending or plastic stretching of a membrane over an appropriate boundary. The membrane is deformed by this process, with the result that the surface assumes a shape that concentrates electromagnetic radiation. If the field of view needs to be larger than can be afforded by a single primary reflector, subsequent optics can correct the aberrations intrinsic to the primary. In either case, a diffraction limited system will result. By using suitable materials for the membrane and other structures, systems with very low areal mass density ( $\sim 1\text{kg/m}^2$ ) that are scalable to large apertures ( $\sim 10$  to 20 meters) are constructable.

Almost all telescope systems are on-axis, where the secondary and tertiary optics obstruct the primary reflector. Scattering and diffraction of the incident electromagnetic radiation by the secondary optics and its support structure reduces the performance of the overall system. This is particularly problematic for observations of low-contrast objects, or in communications systems where cross-talk between nearby antennas is undesirable. The solution is to use an unobstructed, off-axis design. The systems described are naturally suited for off-axis construction.

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