A CRYOGENICALLY COOLED SECONDARY MIRROR FOR THE SOUTH POLE TELESCOPE

Joy, M. K.
National Space Science and Technology Center

An off axis ellipsoidal secondary mirror is being built for the *South Pole Telescope* (SPT), a large diameter (8 meter) telescope which will be used to perform deep, wide field astronomical survey observations at millimeter wavelengths. The telescope optics are of Gregorian design; to minimize spillover effects and noise the secondary mirror will be located at the exit pupil of the SPT optical system and the secondary will be cryogenically cooled to ~ 10 K, providing a highly effective cold stop. The ellipsoidal secondary is 1.02 by 1.05 meters in size, and the goal is to achieve a surface accuracy of ~ 10 microns RMS under cryogenic operating conditions.

A prototype SPT secondary mirror is being fabricated, and the following results will be discussed: (*i*) mirror fabrication techniques, including the use of indexing and alignment fixtures to permit fabrication of a large off axis ellipsoidal mirror on a standard CNC milling machine; (*ii*) metrology of a smaller scale optic, establishing that the desired $\sim 10\mu$m RMS surface accuracy can be achieved on a size scale of 35 cm using a standard CNC milling machine; (*iii*) lightweighting of the mirror to reduce the thermal mass that must be cryogenically cooled; (*iv*) metrology of the prototype ellipsoidal mirror, obtained using a Zeiss coordinate measuring machine which has a measurement accuracy of $\sim 1\mu$m; and (*v*) stress relief methods to minimize the distortion of the mirror when it is cooled from room temperature to ~ 10 K.

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1. (a)
Marshall Joy
NASA/MSFC
National Space Science and Tech
320 Sparkman Dr.
Huntsville, AL
35803 USA
marshall.joy@nasa.gov
   (b) 256-961-7689
   (c)
2. J - Radio Astronomy
3. (a)
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