# FINAL REPORT NSG 5131

**TITLE:** The *Multi-Spectral Solar Telescope Array (MSSTA)*

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**Co-Investigators:** Troy W. Barbee, Jr., LNL, Richard B. Hoover, NASA MSFC,

In 1987, our consortium pioneered the application of normal incidence multilayer x-ray optics to solar physics by obtaining the first high resolution narrow band, "thermally differentiated" images of the corona[1], using the emissions of the Fe IX/Fe X complex at λλ ~ 171 Å to 175 Å, and He II Lyman β at 256 Å. Subsequently, we developed a rocket borne solar observatory, the *Multi Spectral Solar Telescope Array (MSSTA)* that pioneered multi-thermal imaging of the solar atmosphere, using high resolution narrow band x-ray, EUV and FUV optical systems. In 1991 and 1994, the *MSSTA* successfully obtained high quality solar images covering the chromosphere (λ ~ 1216 Å H Ly α), chromosphere/corona transition region (λ ~ 1550 Å C IV; λ ~ 304 Å He II), and corona (λ ~ 171-175 Å Fe IX/X; λ ~ 193 Å Fe XII; λ ~ 44 Å Si XII; λ ~ 211 Å Fe XIV, λ ~ 284 Å Fe XV)[2,3]. The resolution in the best image is ~1.0 arc seconds. Five completed Ph. D. Thesis (J.F. Lindblom, Max Allen, Ray O'Neal, Craig DeForrest, and Charles Kankelborg ) have resulted from the *MSSTA* program (Previously, five Ph. D thesis resulted from our pre-*MSSTA* rocket programs). Two current Stanford students (H. Oluseyi, D. Martinez-Galarce) are completing Ph.D. dissertations based on *MSSTA* observations. Analysis of *MSSTA* observations has resulted in four significant insights into the structure of the solar atmosphere:

- *The diameter of coronal loops is essentially constant along their length*[2,4].
- *models of the thermal and density structure of polar plumes based on MSSTA observations have been shown to be consistent with the thesis that they are the source of high speed solar wind streams*[5].
- *the magnetic structure of the footpoints of polar plumes is monopolar, and their thermal structure is consistent with the thesis that the chromosphere at their footpoints is heated by conduction from above*[3].
- *coronal bright points are small loops, typically 3,500 - 20,000 km long (5" - 30"); their footpoints are located at the poles of bipolar magnetic structures that are are distinguished from other network elements by having a brighter Lyman a signature. Loop models derived for 26 bright points are consistent with the thesis that the chromosphere at their footpoints is heated by conduction from the corana*[6,7].

The *MSSTA* images also suggest that thermal conduction from structures at coronal temperatures may play a significant role in heating the chromospheric network[8]; these structures may represent a population of transient loops, such as those recently discovered in SoHO EIT images, or some other phenomena such as coronal funnels. We are continuing the analysis of these observations.

There were no patents or inventions that resulted from the above grant.

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**The following scientific papers were published as a result of investigations carried out under the above grant.**

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- "The Solar Chromospheric and Coronal Explorer" A. B. C. Walker II *et al* to be publ. in *Proc SPIE*, **2804**, 1996
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- "Properties of Normal-Incidence Reflection Multilayer Coatings at Soft X-Ray Wavelengths" (J. Lindblom, A.B.C. Walker, Jr., T.W. Barbee, Jr.), 1986, *Proc. SPIE* **691**, 11.
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