**REPORT DOCUMENTATION PAGE**

Public reporting burden for this collection of information is estimated to average 1 hour per response, inclu

gathering and maintaining the data needed, and completing and reviewing the collection of information, inclu

collection of information, including suggestions for reducing this burden, to Washington Headquarters 5e

d Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, 1

1. AGENCY USE ONLY (Leave blank)  
2. REPORT DATE  
01 June 1995 - 31 May 1999

3. REPORT TYPE  
5. FUNDING NUMBERS  
F49620-95-1-0368

4. TITLE AND SUBTITLE  
Infrared Studies of Solar Convection

6. AUTHOR(S)  
Philip Goode

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION REPORT NUMBER

AFOSR  
801 N. Randolph Street, Room 732  
Arlington, VA 22203-1977

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

F49620-95-1-0368

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT  
Approved for Public Release.

12b. DISTRIBUTION CODE

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR)  
NOTICE OF TRANSMITTAL DTIC. THIS TECHNICAL REPORT  
HAS BEEN REVIEWED AND IS APPROVED FOR PUBLIC RELEASE  
LAW AFR 132-42 DISTRIBUTION IS UNLIMITED.

13. ABSTRACT (Maximum 200 words)

This ASSERT grant was to support the Ph.D. work of Tom Spiro so who is a native of New Jersey. Tom will finish his  
Ph.D. this year, thanks in large part to ASSERT support. His work was to build an infrared magnetograph and use it for  
scientific work.

Solar magnetic fields are concentrated in flux tubes, and appear on different scales: sunspots, pores (small sunspots without  
penumbra) and magnetic network flux elements. The magnetic network elements are the detritus of decaying active regions  
and play an important part in the solar cycle. They are very long lived.

14. SUBJECT TERMS

15. NUMBER OF PAGES  
2

16. PRICE CODE

17. SECURITY CLASSIFICATION  
OF REPORT

18. SECURITY CLASSIFICATION  
OF THIS PAGE

19. SECURITY CLASSIFICATION  
OF ABSTRACT

20. LIMITATION OF ABSTRACT

Standard Form 298 (Rev. 2-89) (EG)  
Prescribed by ANSI Std. Z39.18  
Designed using Perform Pro, WHS/DISR, Oct 94
October 19, 2000

AFOSR/NM
801 North Randolph Street
Room 732
Arlington, VA 22203-1977

Subject: AASRT final report (AFOSR-95-0368)

This AASRT grant was to support the Ph.D. work of Tom Spirock who is a native of New Jersey. Tom will finish his Ph.D. this year, thanks in large part to AASRT support. His work was to build an infrared magnetograph and use it for scientific work.

The Science:
Solar magnetic fields are concentrated in flux tubes, and appear on different scales: sunspots, pores (small sunspots without penumbra) and magnetic network flux elements. The magnetic network elements are the detritus of decaying active regions and play an important part in the solar cycle. They are very long lived.

Study of the physical mechanism underlying small scale magnetic flux tubes and their associated bright faculae in the magnetic network has attracted increased attention, since it is now clear that faculae seem to provide the main contribution to the observed changes in the solar irradiance over the 11 year solar activity cycle. The center-to-limb variation of the contrast of faculae provides tests of competing flux-tube models. The hot wall flux-tube model treated a facula as a tiny sunspot with kilogauss field strength and 100 km diameter (which is under the resolution of all ground-based observations). At disk center, it is darker inside a flux tube than the surrounding photosphere at the same physical height because the magnetic field suppresses convection. However, because the opacity inside the tube is lower, effectively a deeper layer (higher temperature) is observed. Those two effects cancel each other and make faculae have no net contrast at disk center. When the target is close to the limb, a large section of the "hot wall" is seen which increases the contrast. Finally, at the extreme limb the hot wall is no longer visible due to the fact that one side of the wall blocks the other side. On the other hand, the "hot cloud" model just assumes that the faculae are due to magnetic heating at or above the photosphere. It predicts
that facular contrasts increase monotonically towards the limb, due to increased opacity. The "hillock" model assumes faculae are emission of heat which are flowing around sunspots. According to this model, the curve of facular contrast variation is between that of hot wall and hot cloud model--contrasts fall off only at very extreme limb.

Observations of facular contrasts in the near infrared (IR) are particularly interesting, because the opacity minimum is at 1.6 microns, so that we can probe deepest into the photosphere at that wavelength--adding additional constraints to the above models. Foukal and his colleagues have published a series of papers based on observations at that wavelength, and reported that many faculae are dark at disk center. This discovery would exclude the "hot clouds" and "hillock" models, since they would not explain the dark contrasts.

Tom Spirock set up NJIT's PtSi/Si camera at BBSO to observe contrasts of faculae at 1.6 microns. Our observations had several important advantages over those of Foukal et al.: (1) high quality of IR images because the camera has 320 by 240 pixels, and was carefully "home-made" by experts at NJIT. (2) We have near-simultaneous high resolution observations of CaK, magnetogram and white-light with IR observations. (3) We followed an active region from east to west limb. (4) BBSO has better seeing conditions than Kitt Peak. We confirm several of Foukal et al.'s earlier results but could not confirm one of their results with respect to the comparison between IR and visible facular contrasts. We argue their conclusions about eliminating certain models is incorrect.

Philip Goode, PI
Director, Big Bear Solar Observatory
40386 N. Shore Lane
Big Bear City, CA 92314