ISO KEY PROJECT:
EXPLORING THE FULL RANGE OF QUASAR/AGN PROPERTIES

NASA Grant No. NAG5-8847

Annual Report
For Period 01 January 2002 through 31 December 2002

Principal Investigator
Dr. Belinda Wilkes

October 2002

Prepared for:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts 02138

The Smithsonian Astrophysical Observatory is a member of the Harvard-Smithsonian Center for Astrophysics

The NASA Technical Officer for this Grant is Donald K. West, 681.0, Goddard Space Flight Center, Greenbelt, MD 20771
TABLE OF CONTENTS

I. Program Summary

II. Progress Report
   A. Workshops and Conferences:
   B. Research Results:
   C. Advising Students and Postdocs:
   D. Other publications
   E. E&PO Activities

III Program Plans
I. Program Objectives

While most of the work on this program has been completed, as previously reported, the portion of the program dealing with the sub topic of ISO LWS data analysis and reduction for the LWS Extragalactic Science Team and its leader, Dr. Howard Smith, is still active. This program in fact continues to generate results, and newly available computer modeling has extended the value of the datasets. As a result the team has requested and been granted an obtained a no-cost extension to this program, through December 31, 2003.

The essence of the proposal is to perform ISO spectroscopic studies, including data analysis and modeling, of star formation regions using an ensemble of archival space-based data from the Infrared Space Observatory's Long Wavelength Spectrometer and Short Wavelength Spectrometer, but including as well some other spectroscopic data bases. Four kinds of regions are considered in the studies: (1) disks around more evolved objects; (2) young, low or high mass pre-main sequence stars in star formation regions; (3) star formation in external, bright IR galaxies; and (4) the galactic center. One prime focus of the program is the OH lines in the far infrared.

The program has the following goals:

(1) refine the data analysis of ISO observations, to obtain deeper and better SNR results on selected sources. The ISO data itself underwent “pipeline 10” reductions in early 2001, and additional “hands-on data reduction packages” were supplied by the ISO teams in 2001. The Fabry-Perot database in particularly sensitive to noise can slight calibration errors.

(2) model the atomic and molecular line shapes, in particular the OH lines, using revised Monte-Carlo techniques developed by the SWAS team at the Center for Astrophysics;

(3) attend scientific meetings and workshops;

(4) do E&PO activities related to infrared astrophysics and/or spectroscopy.

II. Progress Report

Work proceeded fully on track and on time this past year. We review our accomplishments in the items below.

A. Workshops and Conferences:
One major item of the year program was organization of an ISO LWS workshop at Cambridge, CfA on “ISO/LWS results on Extragalactic Astronomy from the Central Programme.” This meeting was held from December 6-7, 2001. It was very successful, and it appears likely that a follow-up workshop will beheld again.
B. Research Results:

During this period we successfully extended the SWAS (Submillimeter Wave Satellite) montecarlo radiative transfer code to include: (1) OH; (2) the far IR lines of H$_2$O; (3) [OI]; and are in processes of adding (4) the far infrared lines of CO. As a result we are able to model theoretically the emission and absorption from these species in molecular clouds whose structures we can adjust to ascertain the physical parameters most suitable for the various data observed. A fuller description is included in the attached preprint presented at the $2^{nd}$ Maryland Conference on Far IR Astronomy, 2002.

Also during this period we began to use the “DUSTY” radiative transfer code to model the continuum emission from the same regions. The DUSTY code allows us to produce a fully thermodynamically self-consistent model of the cloud, from which we can then use the SWAS montecarlo code to calculate the line emission properties.

Also during this period we spend a considerable effort helping to prepare for SIRTF observations, including IRAC observations of extragalactic sources, and including the proposed Early Release Observations (EROs).


“ISO/LWS Observations of the Bright Rimmed Globule IC 1396 N,” Saraceno, P., Smith, H.A.,

Finally, as proposed, we spent time with our collaborator Dr. Glenn White, currently of the University of Kent, Canterbury, England, working on the Galactic Center data set. We gave an invited seminar to the Physics Department there.

C. Advising Students and Postdocs:

During this past year the project PI has helped to advise one postdoctoral researcher, Dr. Lisa Kewley, who is now at the CfA. Her specialty is the AGN-IRB connection, and one conference proceeding has so far been published: “Do Mergers Stop Monsters?,” Kewley, L., Dopita, M., and Smith, H.A., B.A.A.S., 199, 4304, 2001.

Also in this time period the PI advised the thesis research of two graduate students, who completed their theses: (1) Dr. Sarah Leeks, of Queen Mary and Westfield College, who’s thesis was, “The Long Wavelength Spectrometer: Reduction and interpretation of Data on W28 A2, a high-Mass Star-Forming Region”; and (2) Dr. Matt Bradford, of Cornell University, whose thesis was on Far Infrared Spectroscopy.
D. Other publications: In addition to the publications listed above, we were co-author of the following:


We acknowledge that some additional support for these research activities has come from other NASA grants.

E. E&PO Activities:
During this period HAS gave several talks to elementary school groups. He also helped to prepare the E&PO program for NGST based-instruments. He spoke at the Boston Museum of Science to a assembly of museum staff on the upcoming, cosmological, “Cosmic Questions” exhibition.

III. Program Plans

During the next year of this program we intend to continue apace with the proposal, as originally presented. We anticipate no particular difficulties.