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**FINAL TECHNICAL REPORT**

for

**Atmospheric and Spectroscopic Research in the Far Infrared**

(NAG-1-963)

Grant Period February 23, 1989 - February 22, 1992

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## 1. Introduction

The University of Oregon (UO) has been a major participant in the development of far infrared spectroscopic research of the stratosphere for the purpose of understanding the ozone layer processes. The UO has had a 15-year collaboration with the Italian group of B. Carli, and have participated in the 1978/79 Sub-millimeter Infrared Balloon Experiment (SIBEX, references 1-3), in the Balloon Intercomparison Campaign, (BIC, references 4-7), in the Infrared Balloon Experiment (IBEX), and in the recently concluded Far Infrared Experiment for UARS Correlative Measurements (FIREX). Both IBEX and FIREX programs were conducted in collaboration with NASA Langley, and were designed as validation flights in support of the Upper Atmosphere Research Satellite (UARS) Program.

The technique of atmospheric far infrared spectroscopy offers two important advantages. First, many chemically important species can be measured simultaneously and co-spatially in the atmosphere. Second, far infrared atmospheric spectra can be obtained in thermal emission without reference to the sun's position, enabling full diurnal and global coverage. Recent improvements in instrumentation, field measurements, and molecular concentration retrieval techniques are now making the far infrared a mature measurement technology. This work to date has largely focused on balloon-based studies, but the future efforts will focus also on satellite-based experiments.

We had proposed a program of research in the general areas of:

- Laboratory Pressure broadening coefficient studies;
- Specialized detector system assembly and testing;
- Consultation and assistance with instrument and field support.

The proposal was approved and a three-year research grant titled "Atmospheric and Spectroscopic Research in the Far Infrared" was awarded. This report presents a summary of technical accomplishments attained during the grant period.

## 2. Laboratory Spectroscopy Studies

The unique spectroscopy facility at the National Institute of Standards and Technology, Boulder (NIST-Boulder, formerly NBS-Boulder) was utilized to make pressure broadening measurements on chemical species of atmospheric interest. The NIST facility based on a tunable far infrared (TUFIR) source is particularly well suited for species whose line positions fall within the tunable ranges of the source. For such samples, pressure broadening coefficients can be readily measured with great precision and accuracy.

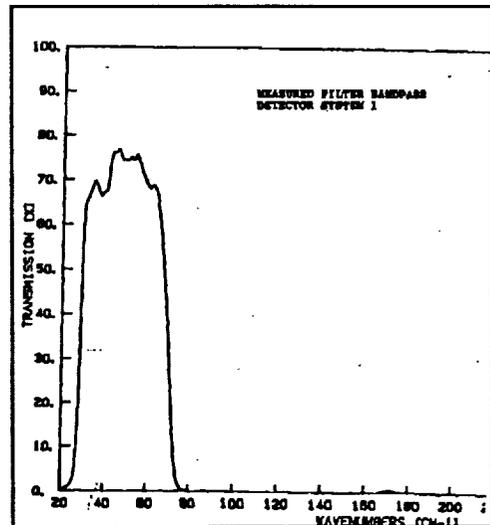
Laboratory measurements of line positions and pressure broadening coefficients of stratospheric trace gases were conducted in close collaboration with SAO and NIST. The references on *OH* and *HCl* (8,9) are examples of this type of work completed during the grant period (1988-1991, NAG-1-963). This work on *OH* and *HCl* pressure broadening measurements provided a key breakthrough for achieving high absolute accuracy in retrieving the atmospheric mixing concentrations of these gases from far infrared limb sensing data (reference 7). This ability to achieve high accuracy in pressure broadening parameters also is essential to the SAFIRE instrument concept for space-based atmospheric measurements.

A more recent example is the spectral studies of *HO<sub>2</sub>* (unpublished) which has prompted a major change in the design for SAFIRE. In this case the frequency measurements done at NIST with support by this grant established the precise frequencies of the lines (reference 7). This information was used by the SAFIRE Science Team to select much stronger transitions of *HO<sub>2</sub>* in May, 1991. This design change is expected to improve the SAFIRE sensitivity for *HO<sub>2</sub>*.

## 3. Infrared Detector Research

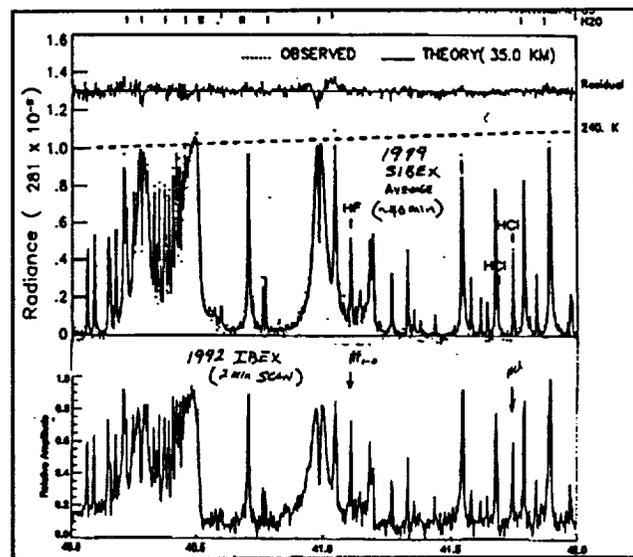
Research in far infrared detectors was carried out in collaboration with Professor Peter Ade of QMW, and with NASA LaRC. The UO-QMW collaboration over the past two and a half decades has been extremely productive. It continued to be a valuable resource for our research program.

Another area related to the detector research is advanced FIR filter technology. The work at the UO has had the objective of developing the test fixtures and procedures for evaluating filter grids and their optical properties. A major success of the recent work by the UO, QMW, and LaRC collaboration is the new technology for Thermal Blocking Filters. This technology is a breakthrough for achieving long-life space dewars where infrared signals are involved. As such, it will continue to have a significant impact on the SAFIRE program. Figure 1 shows the FIREX Detector System 1, which has incorporated such a filter.



Detector research has continued to improve systems for the spectroscopy using Tunable Far Infrared Radiation (TuFIR) techniques, and for the FIREX balloon experiment. The success of the spectroscopy for pressure broadening measurements at NIST (references 8,9) was due in part to detectors developed at UO.

The improvements in the detector performance over the past 12 years can be best illustrated by the latest FIREX data. Figure 2 compares two spectra, one from 1979 SIBEX and the other from 1992 FIREX. The SIBEX spectrum was obtained with a 40-minute scan, while the FIREX spectrum was obtained in 2 minutes. This twenty-fold improvement in the system performance is due largely to the improvement in the detector system.



## 4. Field Support

During the current grant period, the UO has provided the field support for two balloon launches, IBEX in October 1990 and FIREX in May 1992. The IBEX was a preparation flight, while the FIREX was a full validation flight for the UARS. The FIREX was a technically complex, because it was a simultaneous flight with a balloon by R. Zander of Belgium. The preliminary data analysis has shown that the FIREX was very successful.

The UO has not only provided support at launch times, but also participated in the balloon integration phase at JPL.

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