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Final Report for NASA Grant NAG2-1056  
**Far Infrared Line Profiles from Photodissociation Regions  
and Warm Molecular Clouds**

Period: April 1, 1996 through December 31, 1998

R. T. Boreiko and A. L. Betz

Center for Astrophysics and Space Astronomy, University of Colorado, Boulder, CO 80309

**1. Introduction**

This report summarizes the work done under NASA Grant NAG2-1056 awarded to the University of Colorado. The aim of the project was to analyze data obtained over the past several years with the University of Colorado far-infrared heterodyne spectrometer (Betz & Boreiko 1993) aboard the Kuiper Airborne Observatory. Of particular interest were observations of CO and ionized carbon (C II) in photodissociation regions (PDRs) at the interface between UV-ionized H II regions and the neutral molecular clouds supporting star formation. These data, obtained with a heterodyne spectrometer having a resolution of 3.2 MHz, which is equivalent to a velocity resolution of  $0.2 \text{ km s}^{-1}$  at  $60 \mu\text{m}$  and  $1.0 \text{ km s}^{-1}$  at  $300 \mu\text{m}$ , were analyzed to obtain physical parameters such as density and temperature in the observed PDR. The publication resulting from the work reported here is appended. No inventions were made nor was any federally owned property acquired as a result of the activities under this grant.

**2. Science Results**

**2.1. Multitransition Study of High J CO in NGC 3576**

The CO molecule is uniquely suited as a probe of physical conditions in molecular clouds because it is abundant, durable, and has many transitions energetically accessible at temperatures typical of these regions. Since CO has a relatively low permanent dipole moment of 0.1 D, the small critical density for collisional excitation for the lower J levels

**Interim Report or Final Report Required by Patent Rights Clause**

Contract/Grantee/Subcontractor Name and Address:  
The Regents of the University of Colorado  
Boulder, Colorado 80309-0019

NASA Contract/Grant No. NAG2-1056  
Subcontract No:

Type of Report:  
( ) Interim (Complete Sections I and III)  
(xx) Final (Complete Sections II and III)  
Period Covered: April 1, 1996 To: Dec. 31, 1998

TITLE: "Far Infrared Line Profiles from Photodissociation Regions and Warm Molecular Clouds"

Section I: Interim reports should be submitted every 12 months from the date of the contract/grant. Please complete the following:

Descriptive title of all subject inventions during the period (if none, so state):  
NONE

Section II: A final report should be submitted within 3 months after completion of the contract/grant. Please complete the following:

Descriptive title of all subject inventions for the entire contract/grant period (if none, so state):

NONE

Section III: You should provide prompt notification of the award of any subcontract containing either the Patent Rights Clause or the New Technology Clause. For interim reports, please complete the following if subcontract information has not been previously reported to NASA. For final reports, list all subcontracts issued during the entire contract/grant period which contain either of the above clauses. In none, so state.

Subcontractor Name and Address:

NONE

Subcontract Number:

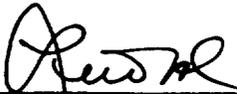
Applicable Clause:

Date of Award:

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Work to Be Performed:

I certify that all subject inventions have been disclosed to NASA or that there were none and that all subcontracts have been disclosed to NASA or that there were none.



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Laurence D. Nelson, Director  
Office of Contracts and Grants  
University of Colorado at Boulder

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