NASA-CR-193611

FINAL report for NAG5-1214 Task 1: 8/15/90 -- 8/14/93
(under no cost extension since 8/15/92)

CRITICALLY EVALUATED/DISTRIBUTED DATABASE OF IRAS LRS SPECTRA

R.E.Stencel, CASA, U of Colorado at Boulder

ACCOMPLISHMENTS UNDER THIS GRANT EFFORT--

1. Successful scientific utilization of the IRAS Low Resolution Spectrometer [LRS] database of over 150,000 scans of 7-23 micron spectra for over 50,000 celestial sources. Data originally imported from Dutch instrument P.I. and installed and maintained at Colorado computing cluster for this project.

2. Publication in refereed journal of an additional 486 critically evaluated spectra of sources brighter than 20 Jy, completing the LRS ATLAS (Olnon and Raimond 1986 A&A) uniformly to that level. Also, production of an additional 1,830 critically evaluated spectra of sources brighter than 10 Jy. This latter was printed only as a preprint due to the excessive page charges that would have been involved in publication. Both set were included in the on-line database made available on the internet. Availability was announced both in an AAS Newsletter (10/91) and at the IR Spectroscopy Workshop organized by this P.I. for the ASP meeting in Laramie, 6/91 (Proceedings).

3. Creation and maintenance of on-line, remotely accessible LRS spectra of over 7500 sources. Advertising led to fairly widespread use (see attached user list), but apparently the interest was not widespread enough to persuade reviewers to continue funding the service for a third year.

4. Cooperation with Astrophysics Data System personnel for transitioning this LRS database to the ADS access system after funding for this project expires.

5. Research higlights: several interesting results and leads have developed as a result of working with the LRS data, with the most useful being the increased interest in new observations in this spectral region with IR array devices. Among the published highlights are: "The Formation and Annealing of Circumstellar Dust based on Mira LRS Spectra and the Microwave Maser Chronology" and ""Does the 10 micron Dust Feature Vary in Miras? A Survey of LRS Spectra". In the first case, we found a systematic variation of the shapes of LRS silicate features among stars of differing IRAS broad-band colors, maser characteristics and light curve asymmetries, all correlated with the chemical and physical development and processing of solid phase material, perhaps as a function of evolutionary state or time since helium shell flash event. In the second case, we found preliminary evidence for silicate profile variations in individual stars as a function of visual light curve phase. Both results can be served with new observations. However, U of Colorado has not proven itself worthy and so much of this followup research will be pursued elsewhere. Among the observational devices working in this spectral region are the CGS3 at UKIRT, the GLADYS instrument at WIRO and the HIFOGS instrument at Mt.Lemmon (see paper 'd' below for details).

PUBLICATIONS AND REPORTS CITING SUPPORT OF NAG5-1214:

a. "The Formation and Annealing of Circumstellar Dust based on Mira LRS Spectra and the Microwave Maser Chronology"
R. Stencel, J. Nuth, I. Little-Marenin and S. Little

1990 Astrophys. Journal (Letters) vol. 350, pages L45-L49.

b. "Supplementary IRAS LRS Spectra for 842 Sources Brighter than 20 Jy, Not included in the LRS ATLAS"
K.Volk, R.Stencel and E.Brugel and S.Kwok
1989 C.U. Astrophysics Preprint, 187 pages (available on request).
also 1991 Astronophys. Journal Supplements Vol.77, pp 607-645.

c. "Supplementary IRAS LRS Spectra of 1,810 Sources Brighter than 10 Jy, Not included in the LRS ATLAS"
K.Volk, R.Stencel, E.Brugel and S.Kwok
1990 C.U. Astrophysics Preprint, 306 pages (available on request).

d. Proceedings of the ASP Workhop on Infrared Spectroscopy
ed. R.Stencel
1991 Colorado Astrophysics Reprint 107 (100 pages).

e. "Stars and the Network Accessible Database of LRS Spectra" (review)
R.Stencel
1991 in Proceedings of the ASP Workshop on Infrared Spectroscopy
ed. R.Stencel, Colorado Astrophysics Reprint 107, p.9-15

f. "Time Variability of Dust Grain Signatures" (poster abstract)
I. Little-Marenin and R. Stencel
"Circumstellar Shell Sizes based on LRS Spectra" (poster abstract)
R.Stencel, I.Little-Marenin and C.Harris
1991 in Proceedings of the ASP Workshop on Infrared Spectroscopy
ed. R.Stencel, Colorado Astrophysics Reprint 107, p.88, p.92.

g. "Do Dust Grain Signatures Vary During Light Cycle of a Mira?"
I. Little-Marenin and R.Stencel
"A Stellar Evolution Paradigm Based on Specific Mass Loss/Feedback Modes"
M. Cuntz and R. Stencel
"Wind-Driven Dust: The Interaction Between Dust and Gas in Late-type Stellar Atmospheres"
K.MacGregor and R.Stencel
1992 in Proceedings of Cool Stars VII, eds. Bookbinder and Giampapa, ASP Conference Series, Vol.26.

h. "S Persei: Optical and Water Maser Variations -- 1984 to 1990"
I. Little-Marenin, P. Benson, M. McConahay, R. Cadmus, R. Stencel and K. Eriksson
1991 Astron. Astrophys. 249, 465.

i. "On the Interaction of Dust and Gas in Late-type Stellar Atmospheres and Winds"
K. MacGregor and R.Stencel
1992 Astrophys. Journal, 397, 644.

j. "Does the 10 micron Dust Feature Vary in Miras? A Survey of LRS Spectra"
I. Little-Marenin, S.Staley and R.Stencel
1992 in Proceedings of the Astronimical Infrared Spectroscopy Conference, ed. S.Kwok, ASP Conf. Ser. -- in press.

k. "Additional Spectroscopic Discoveries Possible Among Late-type, Evolved Stars with ESA's Infrared Space Observatory"
R.Stencel
1992 in Proceedings of the Astronimical Infrared Spectroscopy Conference, ed. S.Kwok, ASP Conf. Ser. -- in press.

l. "To Vary or Not to Vary: SiC Dust Emission from Circumstellar Shells"
S.Little, I.Little-Marenin, S.Staley and R.Stencel
1992 Bull.Amer.Astron.Soc. 24 (Phoenix AAS meeting, paper 50.11).

m. "A Search for AL-O Masers from Circumstellar Envelopes."
in preparation.

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!emailable list of known LRSUSER accesses       2/4/93 RES
!
!
!1991 list, following Laramie meeting "release":
smtp%"mjm@as.arizona.edu"                !Mark McCaughrean  Steward Obs, Uof Arizona
smtp%"rthompson@as.arizona.edu"          !Rodger Thompson  Univ of Arizona   rthomps
42215::cohen                             !m. cohen  UC Berkeley  42215::cohen
smtp%"hjk@wells.haystack.edu"            !Joel Kastner  Haystack  hjk@wells.haystack
        !sean casey  nasa/gsfc  sean@irastro.gsfc.nasa.gov, stars::casey
33832::STSCIC::STDADS::MBOBROWSKY        !Matt Bobrowsky  CTA INCORPORATED
!
!late 1991 user list, following AAS Newsletter notice:
!
6696::ALCOLEA                      !J. Alcolea, Center for Astrophysiscs, 11/91
smtp%"jvrtilek@cfa.harvard.edu"          !J. Vrtilek, Center for Astrophysics
6960::WCHEN                        !WEN PING CHEN, CARNEGIE INSTITUTION OF WASHINGTON
jnet%"CHAVEZ@ITSSISSA"             !.BITNET,Miguel Chavez Dagostino, SISSA ITALY
15437::CHAMP::KUMAR                !C.KRISHNA KUMAR, HOWARD UNIVERSITY, WASHINGTON, D.
smtp%"cadwell@astro.psu.edu"       !Brian Cadwell, Penn State
15437::iuesoc::loomis              !charles g loomis, csc/iue observatory
smtp%"sean@irastro.gsfc.nasa.gov"        !s. casey, nasa/gsfc
smtp%"wolfire@cfacxl.harvard.edu"              !wolfire, CfA
smtp%"shure@hubble.ifa.hawaii.edu"       !Mark Shure, Institute for Astronomy
smtp%"steve@surya.caltech.edu"           !steve thorsett, caltech
smtp%"zb4ms@ipac.caltech.edu"                  !Marion Schmitz,NED/IPAC
smtp%"eap@gauss.pha.jhu.edu"                   !Edward Pier, Johns Hopkins
smtp%"fgiovane@helena.hq.nasa.gov"       !fgiovane,nasahq
!
!1992 userlist--
!
smtp%"m.albrow@csc.canterbury.ac.nz"     !michael Albrow, university of canterbury
smtp%"kwc@astro.umd.edu"                 !Kin Wing Chan, University of Maryland
smtp%"greenhill@bkyast.berkeley.edu"     !Lincoln J. Greenhill,Department of Astronc
38028::pesce                             !Joe Pesce,SISSA/Trieste
smtp%"aes@heasfs.gsfc.nasa.gov"          !Andrew Szymkowiak,NASA/GSFC
smtp%"library@stsci.edu"                 !sarah stevens-rayburn,ST ScI
smtp%"roberts@uhifa.ifa.hawaii.edu"      !Kathleen Robertson,Institute for Astronomy
smtp%"sloan@afglsc.dnet.nasa.gov"
!TAURUS::ILITTLE
!TAURUS::STALEY
smtp%"kuchar@plh.af.mil"
smtp%"wcd@isi7.ssl.berkeley.edu"         !bill danchi
!ferguson@yonder
!
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IRAS LOW RESOLUTION SPECTROMETER DATABASE ACCESS
[~8,000 astronomical spectra, 8-23 micron region]
(Boulder database)

Release 1.2, Updated Apr 1993
R.E.Stencel and ADP grant NAG5-1214

The IRAS-LRS data have been processed using the LRSVAX analysis system developed by the Laboratory for Space Research at Groningen, The Netherlands. This development was partly funded by the University of Groningen, the Space Science Department of ESTeC, and the Air Force Geophysics Laboratory (USA).

This service will be ported into the Astrophysical Data System [ADS] by summer 1993.
Contact allison@puppis.colorado.edu for ADS details.

Select "PREPRINTS" menu item to see titles and citations to papers in print and in press that have made use of LRS data (sev. dozen!)

1. Welcome to the LRS database access. Access is available as follows:

LRS_SEARCH
queries by RADEC, IRASNAME or LRS CLASSIFICATION; this procedure will EXTRACT the header info and spectrum vectors for one of the ~8,000 re-calibrated LRS spectra for sources brighter than ~10 Jy at 12um, sorted by RA/DEC (1950), IRAS Name, or LRS Classification.

The original automatic classification of LRS spectra was given with two digits, with the first defined in terms of overall shape or continuum slope, and the second refering to contrast of some feature:

10-19 "Blue and featureless"
20-29 "Blue, with silicate emission"
30-39 "Blue, with silicate absorption"
40-49 "Blue, with SiC emission" (e.g. carbon-rich stars)
50-59 "Red and featureless"
60-69 "Red, silicate em"
70-79 "Red, sil abs"
80-89 "line spectra with UIR emission"
90-99 "line spectra with no UIR em"

See Chapter IX of the IRAS Explanatory Supplement for details, along with the following -- KEY REFERENCES --

"Chapter IX" of the IRAS Explanatory Supplement (US GPO)
"Atlas of IRAS LRS Spectra" Olnon and Raimond
1986 Astron.Astrophys. Suppl. 65: 607-1065.
"New LRS Spectra for 356 Bright IRAS Sources" Volk and Cohen
1989 Astron.Journal vol. 98: 931-975.
"New LRS Spectra for 482 Additional IRAS Sources" Volk, Kwok, Stencel, and Brugel 1991 Ap.J. Suppl. 77: 607-645.
"Proceedings of the North American Workshop on Infrared Spectroscopy
ed. R.Stencel, (ASP/Laramie, 6/91) U of Colorado
Astrophysics Reprint 102. Mailed to participants and
major IR astronomy libraries.
"Proceedings of the Infrared Astronomical Spectroscopy Conference"
ed. S.Kwok, (Calgary 6/92) ASP Conf. Ser. in press.

COMING SOON: LRS ACCESS VIA THE ASTROPHYSICAL DATA SYSTEM [ADS]

Problem report:
When this database was re-built in the past year, an interpolation error introduced a "glitch" in selected bright-source spectra near ~9.5 microns. We are trying to determine the source of this error, but narrow features near 9.5 in bright sources MIGHT be spurious.

Caveat emptor. The data being ported to ADS will be corrected.

2. Further details:

----------Attn: SUN WORKSTATION USERS:
Note for Sun Workstation users, per Joel Kastner (Haystack Observatory): there is a way past the problem of garbled output on a Sun Workstation: use Xwindows. It isn't sufficient to use Sun's own 'openwindows'; rather, open an 'xterm' from 'openwindows', and then could control the output by toggling back and forth between 'vtmode' and 'tekmode' -- using the latter for plots of spectra.

----------Furtherance:
To improve upon and continue this service, we need your comments and citations in any papers that may use this data. An opportunity for comment will occur when you logoff from this session. Thanks!

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Updated: 1993Apr28
Last export: 1993Apr28

Greetings LRS User. We'd like to begin compiling titles and abstracts of relevant papers which use LRS data. If you have a title and abstract to add, please email a copy to 33832::STENCEL for addition to this listing, OR if you have comments on these papers, leave a note when you logoff LRSUSER.

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***** LRSUSER *****

LRS [P]REPRINT LIST -- MOST RECENT ADDED TO THE TOP OF FILE

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"ON THE INFRARED PROPERTIES OF S-STARS WITH AND WITHOUT TECHNICIUM"
Groenewegen
1993 A&A 271: 180

"EVOLUTION OF THE 8 - 13 MICRON SPECTRUM OF SUPERNOVA 1987A"
Roche, Aitken and Smith
1993 MNRAS 261: 522.
Companion paper on 1-4 micron spectrum of SN87A follows on p.535 (Meikle et al

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"CHARACTERIZATION AND PROPORTION OF VERY COLD C-RICH CIRCUMSTELLAR ENVELOPES USING IRAS LRS SPECTRA"
Omont, Loup, Forveille, teLintel-Hekkert and Habing
1993 A\&A 267: 515

"CO OBSERVATIONS OF LRS-SELECTED CANDIDATES FOR CARBON-RICH AGB AND POST AGBS"
Volk, Kwok and Woodsworth
1993 ApJ 402: 292

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"THE CIRCUMSTELLAR SILICATE DUST AS SEEN BY IRAS. II. CIRCUMSTELLAR EVOLUTION"
P.David and R.Papoular
1992 A&A 265:195

"SPECTRAL IRRADIANCE CALIBRATION IN THE INFRARED: (3 papers)
I. GROUND-BASED AND IRAS CALIBRATIONS
II. ALPHA TAU AND RECALIBRATION OF LRS
III. THE INFLUENCE OF CO AND SIO

Martin Cohen & friends*
Univ Califronia at Berkeley

1992 Astron. J. 104: 1653;
104: 2030;
104: 2045.

*incl. Walker, Barlow, Deacon, Witteborn, Carbon, Augason, Wooden, Bregman and Goorvitch.

8/21/92

LRS related papers appearing in ASP Conf. Proc. Vol. 26
THE SIXTH COOL STARS WORKSHOP (Tucson 10/91),
eds. M. Giampapa and J.Bookbinder 1992

p.474 Anandarao et al. CIRCUMSTELLAR DUST IN MIRAS AND PULSATION
p.478 Bauer & Stencel EXTENDED 60 MICRON EMISSION FROM MIRAS
p.591 Little & Stencel VARYING DUST GRAIN SIGNATURES IN MIRAS

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8/10/92 Submitted to ApJ(?)

CIRCUMSTELLAR SHELLS RESOLVED IN THE IRAS SURVEY DATA

K.Young, T.G.Phillips & G.R.Knapp
CalTech-Physics and Princeton-Astro.

IRAS survey data for 512 red giants and young PN were examined...
76 stars found to be resolved at 60 microns...

(please contact the authors for a complete version)

1992 Astron. J. 104:377

VARIATIONS IN THE 8-13 micron VISIBILITY FUNCTIONS OF O-RICH STARS

H.M.Dyck and J.A.Benson

(IRMA results...)

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6/15/92 ApJ in press

SPATIALLY RESOLVED SILICATE FEATURES AROUND ALPHA ORIONIS

Sloan, G.C., Grasdalen, G.L., & LeVan, P.D.,
(U.Wyo & AFGL Phillips Lab)
1993, ApJ in press. (20Jan1993 issue)

Paraphrased abstract...
GLADYS observations show the CS shell of alpha Ori to be spatially resolved at the few arcsec level, in the 10 micron silicate feature...

(please contact the authors for a complete version)

1992 Ap.J. 392, pp.702-705
8-14 MICRON SPECTROSCOPY OF CARBON STARS ASSOCIATED WITH SILICON DUST
Levan, Sloan, Little-Marenin and Grasdalen

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Some additional previous papers of LRS interest --

"The Dutch Scientific Instrument on-board IRAS"
Wildeman, Beintema and Wesselius
1983 J.Brit.Interplan.Soc. 36:21-26.

"An Atlas of 5,425 Low Resolution IR Spectra"
Olnon and Raimond
1986 A&A Suppl. 65: 607-1065.

Chapter IX of the IRAS Explanatory Supplement (US GPO)

"New LRS Spectra for 356 Bright IRAS Sources (to 40Jy)"
Volk and Cohen
1989 Astron.Journal vol. 98: 931-975.

"Proceedings of the North American Workshop on Infrared Spectroscopy
ed. R.Stencel, (ASP/Laramie, June 1991)
1991 CASA/U of Colorado Astrophys. Reprint 103.
(mailed to participants and major astronomy libraries)

"New LRS Spectra for 482 Additional IRAS Sources (to 20Jy)"
Volk, Kwok, Stencel, and Brugel
1991 Ap.J. Suppl. 77: 607-645.

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1992 AJ 103:1734-1745; COHEN
IRAS LRS SPECTROSCOPY OF GALAXIES

1992 A&A 254, 133-148, LeSQUEREN et al.
COMPLETE SURVEY OF OH/IR OBJECTS FROM IRAS LRS WITHIN A DOMAIN OF THE COLOR-COLOR DIAGRAM

1992 A&A 254, L1-L4, SOURISSEAU ET AL.
ON THE 21 MICRON FEATURE OF PRE-PLANETARY NEBULAE

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1990A&AS...83..337J: JOURDAIN DE MUIZON M., COX P. and LEQUEUX J. <Astron. Astrophys., Suppl. Ser.,83,337-355,1990>
A survey of infrared features in HII regions, planetary nebulae and proto-planetary nebulae from the IRAS-LRS data base.

"THE 21 MICRON EMISSION BAND IN IRAS/LRS SPECTRA OF H II REGIONS"
P.Cox
1990 A\&A 236:L29

1990AJ....100..485V: VOLK K. and COHEN M. <Astron. J.,100,485,1990>
The IRAS low-resolution spectra of planetary nebulae.

1989ApJ...345..306L: LENZUNI P., NATTA A. and PANAGIA N. <Astrophys. J.,345,306-326,1989>
Properties and evolution of dust grains in planetary nebulae.

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ABSTRACT

4/20/92 Papers to appear in Proceedings of Conference on Astrophysical Masers
March 1992, Washington DC, eds. A.Clegg and G.Nedoluha
(Springer-Verlag) in press.

MOLECULAR CATASTROPHES AND CIRCUMSTELLAR SiO MASERS

Robert E. Stencel, CASA and JILA \\ University of Colorado

Understanding the complex SiO maser regions of highly evolved stars can be improved through multiwavelength studies of ''pre-maser" stars, such as M0-M4 giants and semi-regular variables, which can be placed on normal H-R diagrams unlike most of the OH-IR stars.
I argue that SiO masers are a key part of the transformation of hot stellar plasma into cold circumstellar silicate dust, in the outflows from evolved, oxygen rich stars. Evidence for this statement rests on the following: (a) red giant mass loss originates in a stochastic, anisotropic manner; (b) SiO maser maps of Miras and red supergiants show numerous maser spots within a few stellar radii; (c) molecules and dust naturally form in a cooling outflow (e.g. SN1987A after 410 days showed strong shortwave infrared bands of CO and SiO molecular emission, and novae show dust production episodes after maximum light); (d) the IRAS Low Resolution Spectrometer provided evidence for diverse and variable 10 micron silicate features in Miras, and these shapes correlate well with the proposed maser chronology, suggesting a formation and annealing sequence. The theory for the occurence of SiO masers involves a thermal instability, plus potentially other ''new" physics. Some preliminary calculations and a prediction are discussed.

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ABSTRACT

5/1/92 Poster presented at Astronomical Infrared Spectroscopy meeting
June 1992 Calgary, eds. S.Kwok and R.Stencel
1993 ASP Conf. Ser. in press.

DOES THE TEN MICRON DUST FEATURE VARY IN MIRAS?
A SURVEY OF LRS SPECTRA

Irene R. Little-Marenin(1,2)
Stephanie B. Staley(1)
Robert E. Stencel(1,3)
(1)Center for Astrophysics and Space Astronomy, U. of Colorado
(2)Whitin Observatory, Wellesley College
(3) Joint Institute for Laboratory Astrophysics, U of Colorado

Given the extensive sample available in the IRAS Low Resolution Spectrometer (LRS) database, and the intrinsic variability of Miras, we have searched for time-dependent changes in the 10 micron dust feature, in order to place new constraints on the dynamics and chemistry of the dust-forming regions in such stars. Preliminary anlaysis has already shown that the IRAS broad-band 12 micron flux and the Contrast of the LRS ~10 micron silicate feature both vary roughly in phase with the visual light for selected Miras. Contrast is defined as maximum flux near 10 microns, divided by the flux of the underlying continuum.

This poster reports on a survey of a larger sample of Miras, wherein we are attempting to determine the relationship between the Contrast of the emission feature and the phase of the optical and 12 micron light variability.

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Additional abstracts are welcome: email to 33832::STENCEL
or rstencel@diana.du.edu

encl:
LRSUSER.DIS
LRSUSER.MEMO01

Final report for NAG5-1214 task 2: 8/15/90 -- 8/14/93

A SEARCH FOR RED SUPERGIANT STARS IN THE NORTHERN MILKY WAY

R.E.Stencel, CASA, U of Colorado at Boulder

The original funding for this task has expired. A renewal proposal was prepared to permit continuation, but not accepted. As time permitted during the associated no-cost extension, Co-I Garmany and the P.I. hoped to develop a follow-on report covering galactic longitudes 150 - 210 degrees.

Publications and reports citing support of NAG5-1214:

a. "Spatial Segregation of Red Supergiant Stars in Certified OB Associations"
R.Stencel, C.Garmany and E.Overgard
1990 in Proceedings of STScI Workshop: Massive Stars in Starbursts
ed. C. Leitherer.
Also, 1990 B.A.A.S. vol. 22, page 797 (Albuquerque; poster paper).

b. "Workstation-based Analysis of IRAS Views of OB Star Associations"
E.Overgard, R.Stencel and K.Mickus
1991 ASP Meeting (Laramie; poster paper).

c. "Galactic OB Associations in the Northern Milky Way. I. Longitudes 55 - 150"
C.D.Garmany and R.E.Stencel
1992 Astron.Astrophys. Supplements 94: 211-244.

(end)