University of Virginia
Department of Astronomy

BOX 3818, UNIVERSITY STATION
CHARLOTTESVILLE, VIRGINIA 22903

ROBERT W. O'CONNELL
Tel. [804] 924-7494
Bitnet: RWO@VIRGINIA

p. 2

10 September, 1990

2 P

To: Yoji Kondo, IUE Project Scientist, Code 684, NASA-GSFC

From: R. W. O'Connell, P.I., Grant NAG 5-1035 RWO

Re: Final Technical Report on "Spectra of Late Type Dwarf Stars of Known Abundance for Stellar Population Models"

This research was a continuation of a multi-year program to obtain high quality ultraviolet spectra of stars that can be used for the interpretation of the composite light of star clusters and galaxies. This was a collaboration with D. Burstein (ASU) and C.-C. Wu (CSC Corp.). The award period on this grant was 2/01/88 to 5/31/90, although funds were not allocated until 26 August 1988.

The project consisted of two parts. The first was to obtain new low-dispersion, long-wavelength, high S/N IUE spectra of F-G-K dwarf stars with previously determined abundances, temperatures, and gravities. To insure high quality, the spectra are either trailed, or multiple exposures are taken within the large aperture. A more complete description of this phase of the project has been submitted by D. Burstein, who is the overall P.I. on the project.

Second, the spectra are assembled into a *library* which combines the new data with existing IUE Archive data to yield mean spectral energy distributions for each important type of star. My principal responsibility is the construction and maintenance of this UV spectral library. It covers the spectral range 1200-3200Å and is maintained in two parts: (i) a version including complete wavelength coverage at the full spectral resolution of the Low Resolution cameras; and (ii) a selected bandpass version, consisting of the mean flux in pre-selected 20Å bands. These bands are centered on spectral features or continuum regions of special utility—*e.g.* the C IV λ1550 or Mg II λ2800 feature. In the middle-UV region, special emphasis is given to those features (including continuum "breaks") which are most useful in the study of F-G-K star spectra in the integrated light of old stellar populations.

The present library contains older short and long wavelength spectra for 172 stars of all spectral types from the *IUE Spectral Atlas* and new, long-wavelength spectra for 60 cool stars (types F5 through K4) obtained during the course of this program. During the first six months of the project, we completed development of a standardized, "universal", VAX/VMS storage format for spectral libraries. This contains all necessary spectral information for any kind of spectral synthesis library, plus all auxiliary information of interest (*e.g.* physical parameters such as [Fe/H], reddening parameters, quality vectors) as well as complete internal documentation on the processing history of each record (*e.g.* raw IUE spectrum, averaged spectrum, reddening-corrected, *etc.*).

The cool star data base was put in the universal library format in August 1988, and the *Spectral Atlas* spectra were added in February 1989. We have developed a large suite of new IDL-based routines to access universal libraries, plot spectra, normalize and average spectra, compute spectral indices, and so forth.

In late 1989, we undertook an analysis of the dependence of UV continuum and spectral features on the physical properties of the stars in the library. A paper describing the mid-UV spectral morphologies of our stars is sceduled for publication in *Astrophysical Journal* in November. It discusses the selection of 25 wavebands for a standard mid-UV spectral synthesis sequence as well as the behavior of 13 spectral indices (mainly Fe I, Fe II, Mg I, and Mg II) in the mid-UV as a function of stellar temperature, gravity, and abundance.

Several important results emerged from this study. First, the Mid-UV provides excellent temperature discrimination, implying that this spectral region will be the most sensitive to the properties of the main sequence turnoff as observed in the integrated light of galaxies or distant star clusters. Second, the total line-blanketing in the UV (as measured in UV–V colors, for instance) is very sensitive to [Fe/H]. A "UV-excess" measure based on the 2600 Å flux is about *ten times more sensitive* to abundance than is the quantity δ(U–B), defined in the optical region.

Third, Mg II 2800 exhibits unusual behavior such that metal-poor stars have stronger Mg II features than metal rich stars. We attribute this to chromospheric emission in Mg II, which depends on the age of the star. The fact that such age indicators can be measured in low resolution IUE spectra promises an important new approach to the age dating of stellar populations. A paper describing the potential of this method and comparing Mg II emission to Ca II emission is in press. We anticipate this discovery will lead to new IUE and HST proposals to calibrate the age-Mg II relation in a wide variety of stellar populations.

Results from this project have been incorporated in the PhD thesis of Michael N. Fanelli (scheduled for completion this fall), which discusses their application to interpretation of composite UV galaxy spectra through spectral synthesis.

Publications:

"Spectral Synthesis in the Ultraviolet. III. The Spectral Morphology of Normal Stars in the Mid-Ultraviolet", M. N. Fanelli, R. W. O'Connell, D. Burstein, and C.-C. Wu, *Astrophys. J.*, in press, 1990.

"Low Resolution IUE Spectroscopy of the 2800 ÅMg II Lines: A Possible Age Diagnostic for Stellar Populations", G. H. Smith, D. Burstein, M. N. Fanelli, R. W. O'Connell, and C.-C. Wu, *Astron. J.*, in press, 1990.

There were no inventions derived from this research project.