

East Tennessee State University
Department of Physics and Astronomy
Johnson City, Tennessee 37614

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The following report covers the Department activities from July 1999 through July 2000.

1. PERSONNEL

The permanent teaching faculty that make up the astronomy group in the Department of Physics and Astronomy at East Tennessee State University include Drs. M. Castelaz, G. Henson, D. Luttermoser, and B. J. Smith. Dr. H. Powell retired from the full-time faculty in 1998; he is now a part-time faculty member. Our adjunct members include Dr. R. Gardner, a tenured professor in the Mathematics Department, and Dr. M. Giroux, who also holds a post-doctoral fellowship at the University of Colorado in Boulder.

2. FACILITIES AND INSTRUMENTATION

East Tennessee State University is part of the Southeastern Association for Research in Astronomy (SARA) consortium, which operates a 0.9 meter telescope on Kitt Peak in Arizona. This telescope can be operated remotely from Tennessee, and has two CCDs and a spectrometer.

On campus, there is a new observatory, the Harry D. Powell Observatory, which was completed in 1998. This observatory is used for teaching, research, and public outreach. It contains a 14" Celestron telescope under a 14-foot Ash-Dome. This telescope is operated from an adjacent control room. The observatory also has an outdoor area equipped with eight permanent pedestals for mounting telescopes. These pedestals have AC power and underground communication cables to link the telescope and CCD cameras to computers in the main room of the observatory building. The outdoor pedestals are used with eight 8" Meade LX-2000 telescopes. During the school year, public open houses are held at the observatory every two weeks. During these open houses, the telescopes are available for use, and one of the astronomers in the department gives a short presentation.

In addition to the observatory, the department operates a 50 seat planetarium under the direction of G. Henson and R. Gardner. The planetarium houses a Spitz A3P projector under a 24 foot dome. The planetarium has been in continuous operation since 1962 as both an instructional aid for classes and as a science education resource for the local community. Monthly evening programs for the general public are offered during the academic year and an average of 1000 school children each year attend special educational programs. The planetarium has recently had its projection capabilities upgraded with the addition of a data/video projector, internet access, and stereo sound system.

3. RESEARCH

East Tennessee State University has research strengths in both the study of the interstellar matter of galaxies and in the study of Mira variable stars.

3.1 Extragalactic Research

Using data from the NRAO 12 meter telescope and the Very Large Array, B. J. Smith has studied the interstellar matter in the unusual NGC 4410 galaxy group. NGC 4410A is a radio galaxy with a disturbed radio morphology. The distortions of this lobe were likely caused by an interaction of the lobe with interstellar matter, which was disturbed by the gravitational interactions in the group.

In collaboration with C. Struck (Iowa State), S. Jogee (Caltech), J. D. P. Kenney (Yale), B. J. Smith has made the first definitive detection of a large quantity of molecular gas in an extragalactic tail, via a detection of the 2.6mm line of carbon monoxide in the nearby peculiar galaxy NGC 2782. This study was part of a larger survey of molecular gas in tidal features made with the NRAO 12m telescope by B. J. Smith and C. Struck. A second successful detection was made of the extra-disk gas in the compact group Stephan's Quintet. Two distinct velocity components were found in this source, indicating that molecular gas was stripped from two different galaxies in the group, perhaps by a head-on collision between the galaxies. In order to better interpret these CO data, B. J. Smith has initiated a collaboration with J. Higdon (Kapteyn Institute, Holland) to measure chemical abundances in extragalactic tails and bridges using optical spectroscopy with the William Hershel 4.2 meter telescope.

With S. Jogee and J. D. P. Kenney, B. J. Smith has made a multi-wavelength study of the nuclear starburst and nuclear bar in NGC 2782. In addition, in collaboration with G. F. Benedict (Texas) and his group, B. J. Smith has studied the star forming ring of the barred spiral NGC 4314 using Hubble Space Telescope data. Also, along with P. M. Harvey (Texas) and additional collaborators, B. J. Smith has studied the far-infrared structure of the Galactic star formation region in AFGL 2136.

3.2 Research on Mira Variable Stars

D. Luttermoser has analyzed ultraviolet Hubble Space Telescope (HST) spectra of two Mira variable stars, R Leo and R Hya. These stars were observed under high-dispersion with the Goddard High Resolution Spectrograph (HRS) prior to this instrument being decommissioned. Two spectral regions were analyzed: 2320 Å – 2368 Å to record the C II] (UV0.01) multiplet and 2785 Å – 2835 Å to obtain the Mg II h & k lines. The R Hya spectrum was obtained at visual light phase 0.26 and shows a Mg II spectrum that is very clean, showing clear evidence for the overlying absorption from Fe I (UV3) and Mn I (UV1) over the k line. The fluoresced Fe I (UV44) feature at 2824 Å is plainly visible in this spectrum, whereas past IUE observations at high dispersion were unable to record this feature. Remarkably, the newly identified fluoresced Fe I (UV45) feature near 2807 Å is seen in this spectrum. Until now, this line has only been seen in cool carbon stars with HST/HRS. It is remarkable in

that it is pumped by the thin C II] (UV0.01) emission line at 2325.5 Å in the carbon stars. This line is the likely pump in the oxygen-rich Miras in our sample as well. Two of the strongest C II] (UV0.01) lines near 2325 Å are plainly seen in this spectrum. This region of the spectrum, however, is dominated by the Si II] (UV0.01) line near 2335 Å, opposite to what is observed in the carbon stars and the non-Mira oxygen-rich red giant stars. Very weak Mg II lines are seen in the R Leo spectrum at phase 0.12. At this phase, these lines are typically absent in IUE spectra. Velocity shifts of emission features in the UV spectra of Miras are consistent with previously published hydrodynamic models of these stars. These velocities indicate, however, that the C II] (UV0.01) emission lines are not formed in the same atmospheric layers as the Mg II emission. The electron density deduced from the C II] (UV0.01) multiplet is $\sim 10^9 \text{ cm}^{-3}$. Finally, the temperature-density structure of the semiregular variable carbon stars is similar to the oxygen-rich Mira variables — both are hydrodynamic in nature, however, the carbon stars macroscopic velocity fields are not identical to the Mira stars in the atmosphere layers between the Mg II emission region and the circumstellar shell. Luttermoser is currently analyzing spectra obtained with the Space Telescope Imaging Spectrograph of the Mira variable R Leo taken at phase 0.37 in its visual light curve.

D. Luttermoser, M.W. Castelaz, and REU student R.A. Piontek (now at the University of Maryland) analyzed TiO and VO in the optical spectra of Mira variables. From this work, it was realized that the molecular data for VO lines was not widely available to the scientific community. As a result of this, Castelaz, Luttermoser, & Piontek calculated oscillator strengths, lower energy levels, and wavelengths of the VO B-X (0,0) band and compared these calculations to the near-IR spectra obtained for a sample of Mira stars.

D. Luttermoser has begun work on the evolution of planetary atmospheres. He is in the early stages of development of a computer code that will follow changes in the atmospheric structure and composition of a planetary atmosphere (both terrestrial- and Jovian-types) as both the planet and a system's star evolves in time. An undergraduate laboratory in astronomy has been developed from the initial stages of this work.

B. J. Smith, M. Castelaz, and D. Luttermoser have initiated a study of infrared variability of Mira stars, using COBE data. A preliminary report on this work was presented at the Fourth Tetons Conference in May 2000.

PUBLICATIONS

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B. J. Smith