

# Analysis of Emission Lines in Select RV Tauri Stars

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## Abstract

Nine RV Tauri stars were selected for observation between June 2003 and October 2006 at Kitt Peak National Observatory, using the Coudé Feed Telescope. This poster includes the analysis of the six stars which had emission spectra, including AC Hercules and R Scutum. The Image Reduction and Analysis Facility (IRAF) plot function was used to apply a gaussian fit to the emission lines and to determine equivalent width, central wavelength and the flux of these lines. We found that the emission spectra of these stars at various wavelengths have changed over the years. Support for this research was by the National Science Foundation (NSF) to South Carolina State University (SCSU) through Historically Black Colleges and Universities-Undergraduate Program/ Research Infused STEM Curriculum (HRD-0506062) and through the Partnerships in Astronomy & Astrophysics Research and Education (PAARE)/ Partnership in Observational and Computational Astronomy (POCA) (AST-0750814).



Patrick Durant at work using IRAF

## RV Tauri Stars

### Pulsating Variables

#### Radial Pulsations

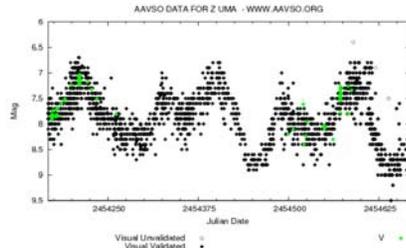
Produce changes in luminosity (resultantly brightness), temperature (resultantly color), and radial velocity (the rate of change of the radius).

#### Light Curves

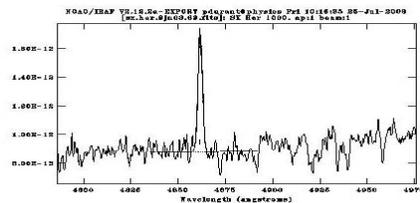
RV Tauri stars light curves contain alternating deep and shallow minimum, with periods ranging between 30 to 150 days.

#### Classification

RV Tauri spectral classifications range from types F to G at maximum light, and K to M at minimum light.



## Gaussian Fitting



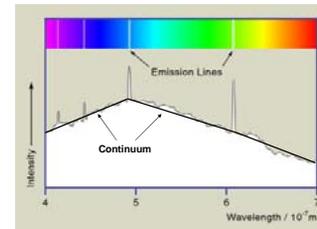
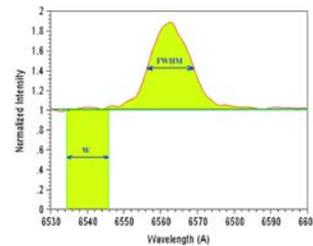
The Image Reduction and Analysis Facility (IRAF) plot function was used to apply a Gaussian fit to the emission lines and to determine equivalent width, central wavelength and the flux of these lines.



The data used for this report was collected at Kitt Peak, Arizona using the Coudé Feed Telescope. The data was collected by Dr. Steven Howell.

## Measuring Emission Lines

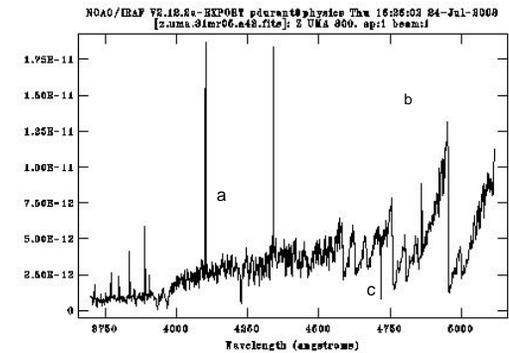
The strength of the line is proportional to its area measured from the continuum. The area can be displayed as a rectangle with one dimension being equivalent to the height of continuum and the other being the equivalent width. If the center reaches zero intensity then the line is saturated and any other increase comes from the wings. The equivalent width of a spectral line depends on the number of atoms in the atmosphere of the star at the energy level from which the transition occurs.



## Results

Star	Observed Emission Features
R Scu	Pollard mentions the presence of Blamer Hydrogen, but ten years later the H alpha emission lines have disappeared. Through future efforts is South Carolina State University we hope to figure out how this came to be.
SU Gem	Not enough data was collected to deduct anything from our study of SU Gem.
V Vul	Different atomic lines appeared and disappeared, but no types of trends were found. The line 6562 was present in June and was absent by September.
Z Uma	There was an emission line at 7618 Å on June 10, 2003 and had increased 10% by June 26, 2004. March 31, 2005- all Blamer series in the blue spectrum were present in these spectra. No red spectra were collected.
AC Her	The H Alpha emission line showed a 10% increase in equivalent width between October 2003 and June 2004.
SX Her	On June 9, 2003 H Delta was present at 4101, along with H Gamma at 4340, and H Beta at 4861. On June 10, 2003 H Alpha was present at 6563.

## Sample Spectrum



This blue spectrum, is on e of Z UMa it displays many common spectral features. The emission lines are a result of the stars hotter outer atmosphere, the corona, and the continuum is caused by the photosphere, what we see when we look at stars.

**Spectral Feature a (Balmer Series)** These emission lines come from an electron leaving the third or higher orbital, dropping to the second orbital in a Hydrogen atom. Shown are strong H Gamma (4340) and H Delta (4101) lines.

**Spectral Feature b (Molecular Bands)** These emission bands do not come from atoms, they come from molecules in the star's atmosphere.

**Spectral Feature c (Absorption Lines)** These lines are created when an atom absorbs a photon and the electron jumps to a higher level. We observed but did not measure these.



Patrick Durant (left), along with Graham and Josh Davis working on telescope assembly.

## Reference

Percy, John R. *Understanding Variable Stars*. New York, NY: Cambridge UP, 2007. 1-80, 136-144, 167-172.

Zeilik, Michael, and Stephen A. Gregory. *Introductory Astronomy and Astrophysics*. 4th ed. Thomson Learning, Inc., 1998. 160-169, 251-259.

Pollard, K. R., Cottrell, P. L., Lawson, W. A., Albrow, M. D., and Tobin, W. *Monthly Notices of the Royal Astronomical Society*, Volume 286, Issue 1, 1-22 1997.

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