Why Galaxies Care About AGB Stars: A Continuing Challenge through Cosmic Time
Proceedings IAU Symposium No. 343, 2019
F. Kerschbaum, M. Groenewegen & H. Olofsson, eds.

doi:10.1017/S1743921318005872

The Impact of Dust/Gas Ratios on Chromospheric Activity in Red Giant and Supergiant Stars

Kenneth G. Carpenter[1] **and Gioia Rau**[1,2]

[1]NASA Goddard Space Flight Center, Code 667, Greenbelt, MD, 20771, USA
email: Kenneth.G.Carpenter@nasa.gov

[2]Dept. of Physics, Catholic University of America, USA
email: gioia.rau@nasa.gov

Abstract. Stencel *et al.* (1986) analyzed IUE spectra of a modest set of cool stars and found that they continue to produce chromospheres even in the presence of high dust levels in their outer atmospheres. This reversed the previous results of Jennings (1973) and Jennings & Dyck (1972). We describe an on-going extension of these studies to a sample of stars representing a broader range in dust/gas ratios, using archival IUE and archival and new HST data on both RGB and AGB stars. Surface fluxes in emission lines will be analyzed to assess the chromospheric activity and obscuration by dust in each star, as those fluxes will follow a different pattern for reduced activity (temperature/density dependent) vs. dust obscuration (wavelength dependent). Wind characteristics will be measured by modeling of wind-reversed chromospheric emission lines.

Keywords. stars: chromospheres, stars: winds, outflows, stars: late-type

1. Introduction

Stencel *et al.* (1986) examined UV chromospheric diagnostics in cool stars with a range of outer atmospheric dust levels. They found, as shown in Fig. 1a, that such objects continue to produce chromospheres even in the presence of high dust level in their outer atmospheres, although the surface fluxes were lower in the dustier stars (see Fig. 1b). This reversed the previous results of Jennings (1973) (cf. Jennings & Dyck (1972)).

2. HST Extension of IUE Studies

The goals of this new study are to: 1) verify the claim that cool stars still produce chromospheres even in highly dusty atmospheric environments, by studying a larger, more diverse (dust/gas content) sample of stars and 2) examine the characteristics of the winds, and how they change with outer atmospheric dust levels.

In this on-going study, we aim to resolve the discrepancy between the Stencel *et al.* (1986) and Jennings (1973) findings by examining the strength of the UV emission features in IUE and HST spectra. An overview of a subset of archival data are shown in Fig. 2a and a sample of wind diagnostic lines in Fig. 2b.

3. Conclusions and Future Work

Figures 1 and 2 show the feasibility of further observations of chromospheric lines using HST/STIS. By measuring their surface fluxes and studying the overlying wind absorptions (Fig. 2b) to map their winds, we will be able to assess the strength of their chromospheres and the characteristics of their winds and mass-loss rates.

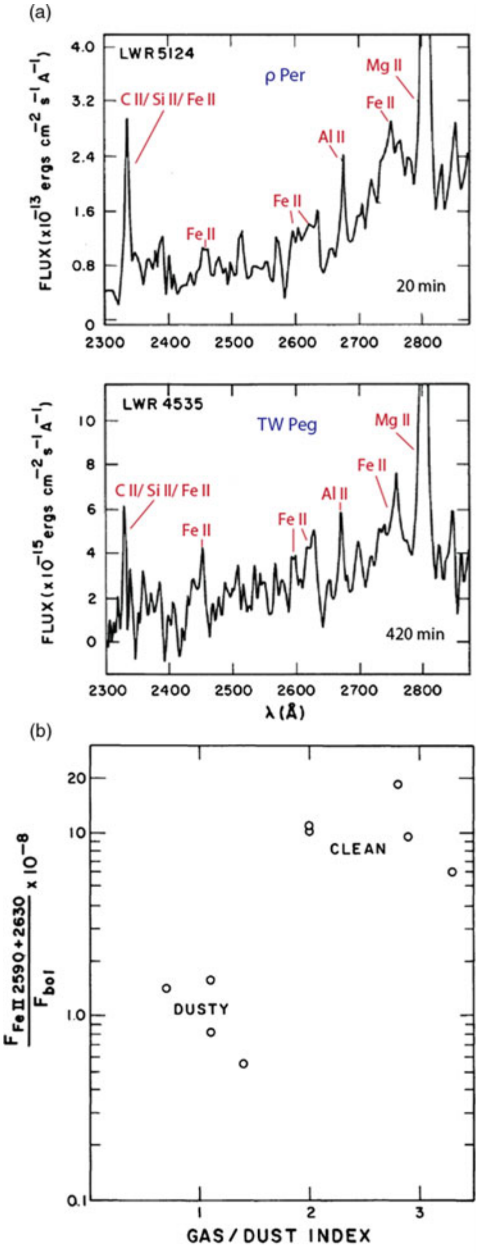

Figure 1. IUE Observations and Results: (a) IUE low-resolution spectra of two stars from the Stencel et al. study. Rho Per is a clean star (i.e. gas/dust>1) with strong optical Ca II emission, while TW Peg is a very dusty star (i.e. gas/dust<1) with no Ca II emission. All of the major UV chromospheric indicators in this region (Mg II, Al II, Fe II, and C II) are visible in both spectra. This demonstrates that the chromospheres in dusty stars are not fully quenched by high levels of dust. (b) total flux in two blends of Fe II lines near 2590 Å & 2630 Å, normalized by the stellar bolometric flux, vs. the gas/dust index of Hagen *et al.* (1983). The Fe II fluxes are substantially reduced in the dusty stars, but still measureable and significant.

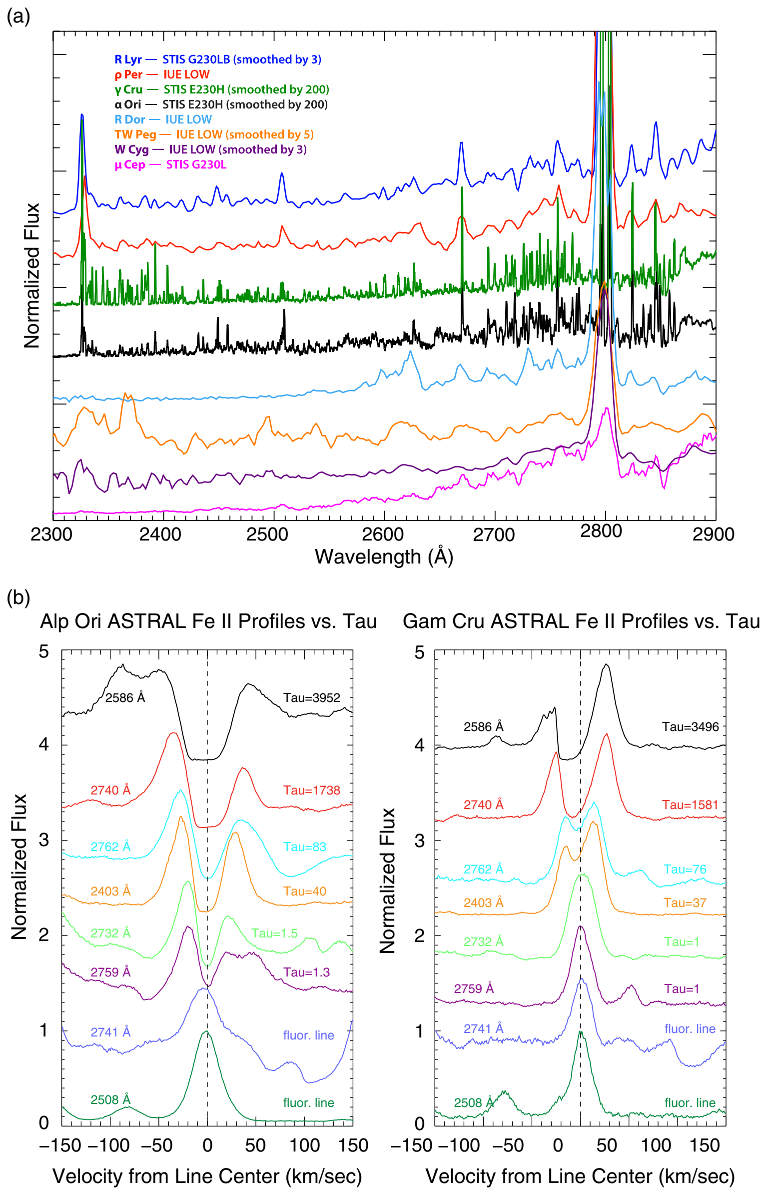

Figure 2. HST/IUE archival data and example wind lines: (a) Spectra of the overall UV region 2300-2900 Å for a subset of our stars. The spectra in this figure confirm that chromospheres persist in dusty stars, albeit at lower activity levels. We show IUE low resolution observations in this figure for clarity, when the IUE high resolution spectra are very noisy at shorter wavelengths. (b) For stars with sufficient S/N, we will also examine Fe II lines of various opacities (α Ori (left), γ Cru (right)), to map the wind acceleration and mass-loss, and characterize the impact of dust and chromosphere on these parameters.

References

Jennings, M.C. 1973, *ApJ*, 185, 197

Jennings, M.C. and Dyck, H.M. *ApJ*, 177, 427

Hagen, W., Stencel, R.E., & Dickenson, D. 1983, *ApJ*, 274, 286

Stencel, R.E., Carpenter, K.G., & Hagen, W. 1986, *ApJ*, 308, 859

https://doi.org/10.1017/S1743921318005872 Published online by Cambridge University Press