Monthly Notices
of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS 482, 4697–4712 (2019)
Advance Access publication 2018 November 13

doi:10.1093/mnras/sty3076

Ultraviolet and optical spectroscopy of AGB stars showing UV excess

Roberto Ortiz [1]★ Martín A. Guerrero[2] and Roberto D.D. Costa[3]

[1]*Escola de Artes, Ciências e Humanidades, USP, Av. Arlindo Bettio 1000, 03828-000 São Paulo, Brazil*
[2]*Instituto de Astrofísica de Andalucía (IAA-CSIC), Glorieta de la Astronomía s/n, E-18008 Granada, Spain*
[3]*Departamento de Astronomia, IAG/USP, Rua do Matão, 1226, Cidade Universitária, 05508-900, São Paulo, SP, Brazil*

Accepted 2018 November 8. Received 2018 November 8; in original form 2018 August 23

ABSTRACT

We have examined ultraviolet (UV) and optical *UB* spectra of 20 UV-emitting Asymptotic Giant Branch (AGB) stars of various variability classes to study the intensity of the continuum and emission lines as a function of stellar visual magnitude to shed light on the origin of their UV emission. A significant fraction (60 per cent) of these stars show Fe I and Fe II emission lines and ∼1/4 show Balmer lines in emission. The emission in the *GALEX* [FUV] and [NUV] bands is dominated by continuum emission, with a limited (≤36 per cent) contribution from emission lines. The UV spectra of sources with multiple *GALEX* or *IUE* observations reveal short-term (of a few days or less) variability, which does not follow the pulsation cycle. The intensity of the Mg II λ2800 doublet, a classical diagnostic of chromospheric activity, is anticorrelated with the spectral slope in the near-UV that could be partially attributed to temperature variations in a stellar chromosphere. We observed that the intensity of Mg II λ2800 in *o* Cet has a sharp maximum at the phase $\phi \simeq 0.35$ after the light curve maximum. Other LPV stars (T Cet and R Com) show strong UV Fe II emission lines near this same phase and, like the Mg II doublet, their excitation can be driven by pulsation. Our results suggest that far-UV emission from AGB stars might be external (hot companion, accretion disc), but contemporary photometric and spectral UV observations covering the whole pulsation period are required to ascertain its true origin.

Key words: binaries: general – stars: chromospheres – circumstellar matter – ultraviolet: stars – stars: AGB and post-AGB .

1 INTRODUCTION

Since the low effective temperature of late-type stars and the high opacity of their atmospheres make their continuum to decline steeply in the ultraviolet (UV), the origin of the UV emission detected in some late-type stars remains enigmatic (Schrijver 1995; Peréz-Martínez et al. 2011). The origin of this emission may be intrinsic (chromospheric emission, shock waves caused by stellar pulsation) or external (photospheric emission from a hot companion, emission from a hot accretion disc around a companion). The detection of UV emission in late-type dwarfes (Redfield et al. 2002) favours the first hypothesis because the vast majority of sources with UV emission do not show any evidence of a hot companion. This explanation was reinforced by Smith & Redenbaugh (2010), who found that the intensity of the far-UV emission correlates with the strength of the Ca II H&K lines, a common indicator of chromospheric activity.

In luminous late-type stars, such as Red Giant Branch (RGB) or Asymptotic Giant Branch (AGB) stars, UV emission originating from a hot companion could not be discarded because the detection of a relatively small radius companion, such as a white dwarf or even a normal main-sequence star, is hampered by the primary high luminosity. To estimate this effect, Parsons & Ake (1998) studied a sample of over 100 confirmed binaries of various spectral types and luminosities detected by the *IUE* satellite (Sonneborn et al. 1987), including late-type giants and supergiants. After fitting models of stellar atmosphere to the data, they found the crossover point, i.e. the wavelength where the UV flux density of the secondary begins to dominate over the combined spectrum for various values of luminosity and temperature. The crossover point varies roughly between 2800 and 5200 Å, depending on the relative luminosity and temperature of the components of the binary system.

Sahai et al. (2008, 2011) investigated *GALEX* (Martin et al. 2005) observations of UV bright AGB stars and concluded that their flux in the two *GALEX* bands, [*FUV*] and [*NUV*], can be generally attributed to the presence of a secondary with $T_{\rm eff} >$ 5500–6000 K. Similar conclusion was derived from the study of a volume-limited sample of AGB stars, of which ∼60 per cent of them show UV excess, even though this explanation does not exclude the possibility that some might be chromospherically active (Ortiz & Guerrero 2016). UV excess as a symptom of binarity has been

★ E-mail: rortiz@usp.br