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Metallic Line Doubling in the Spectra of the Variable Star R Scuti

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Abstract. In this work, we present spectroscopic results of the variable star R Scuti, obtained during the campaign of measures led in 2016 at the Oukaimeden observatory in Morrocco. High resolution spectra (R ≈ 12 000) were obtained between 4289 Å and 7125 Å. This intensive observing campaign spanned over 26 nights from June to November 2016.

Keywords. stars: variables: R Sct - shock waves - line: profiles - stars: individual

1. Introduction

The RV Tauri stars are pulsating variables characterized by alternating deep and shallow minima in their light curves. They are Population II variables of high luminosity ($10\,000 > L/L_{\odot} > 1\,500$) and pulsation period (30–150 d), as reported by Wallerstein & Cox (1984). In this study, we present the observation of line doubling absorption in the spectra of R Sct on the metal lines of Fe I and Ti I. The doubling of metal lines was observed in 1952 for the first time by Sanford on W Virginis. This phenomenon was interpreted by Schwarzschild (1952) on the basis of a two-layer atmosphere: during compression all the layers of the atmosphere move inwards, the front of the shock wave penetrates the lower layer of the atmosphere and a reversal of direction of motion occurs which results in rapid movement of the atmospheric layers from the inside to the outside.

2. Materials & methods

The instrument set up includes two telescopes mounted on each other. It is mounted at Oukaimeden Observatory (J43), a research entity belonging to the Cadi Ayyad University in Morocco. The instrument set up has already been presented in Benhida *et al.* (2018).

3. Discussion and Results

The dynamic atmosphere of R Sct is characterized by two shock waves during one luminosity period. These two shock waves were clearly observed by Lèbre and Gillet (1991a). They observed also the double absorption line of TiI (λ5866.46 Å) around $\varphi = 1.33 - 1.36$, $\varphi = 1.6$ and $\varphi = 1.83$. The interpretation of these features assumes that the first double absorption means that a weak infalling shock must certainly exist within the "Titanium layer" and is the consequence of the terminal infalling phase of the ballistic motion produced by the previous secondary shock, the second line absorption is the signature of the new ballistic motion of the "Titanium layer", the third line absorption

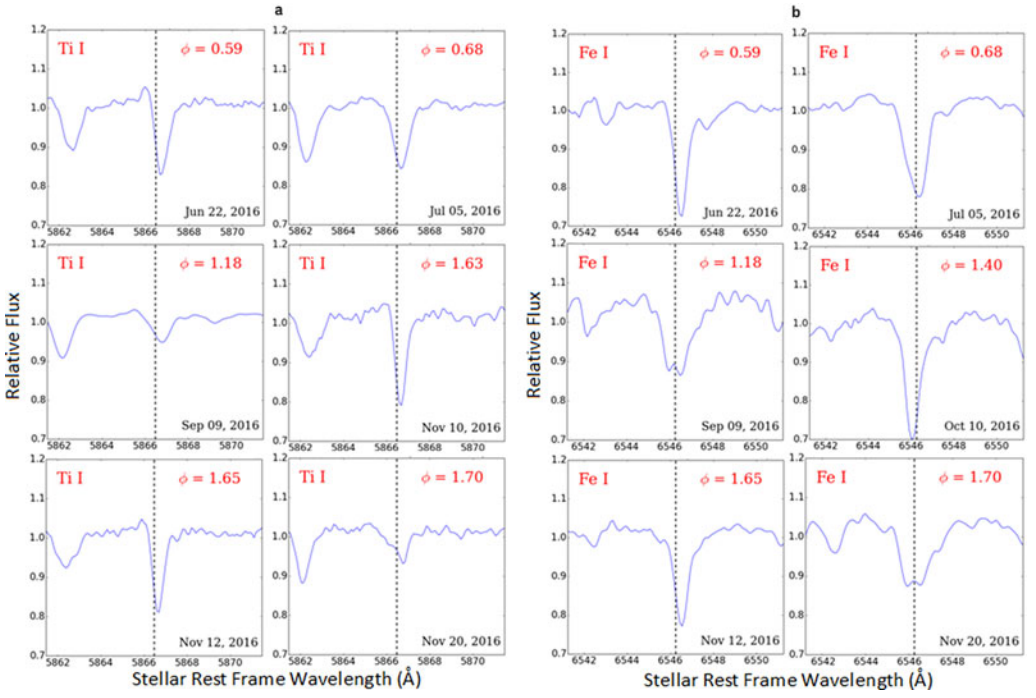

Figure 1. a) and b) The TiI λ5866.46 Å and FeI λ6546.245 Å profiles of R Sct in 2016 at Oukaimeden Observatory. The wavelengths are measured in the rest frame of R Sct (with systemic velocity equal to 43.8 km/s). The relative flux refers to the main level of the continuum. The vertical line represents the zero velocity in the stellar rest frame.

explains the existence of a weak infalling shock which would be the consequence of the acceleration of the external atmospheric layer caused by the stellar gravity. In this work, we present the observations of line doubling absorption in the spectra of R Sct on the metal lines of TiI(λ5866.46 Å) and FeI-TiI(λ6546.245 Å). In comparison with Lèbre and Gillet (1991a), we confirm the existence of two double absorption line of TiI(λ5866.46 Å). This double absorption, is well visible in Figure 1a, at phases φ= 1.18 and φ= 1.7, its blueshifted component weaker than its redshifted one. The third double line absorption is not observed in our results, supposedly the consequence of a low acceleration of the external atmospheric layers. Since 2016, the light curve in AAVSO observations of R Sct didn't show deep light minima. This disappearance may be the result of the decrease of the acceleration of the external atmospheric layers. On the other hand, for the first time, we observed a clear double absorption profile of the complex line FeI-TiI (λ6546.245 Å) in the same phases like TiI(λ5866.46 Å) profile at φ=1.18 and φ=1.70 (Fig. 1b).

4. Conclusion

Our work is based on R Sct spectroscopic observations in 2016. The light curve shape of the AAVSO data base does not allow us to distinguish the deep light minima in the 2016 cycle. For the first time, our spectroscopic results present two double absorption lines during one period for both titanium (λ5866.46 Å) and iron ($FeI\lambda$ 6546.245 Å). The third weak double absorption of the TiI (λ5866.46 Å) mentioned in the paper of Lèbre & Gillet doesn't appear in our results. These results allowed us to assume that the intensity of the main shock in R Sct has become low.

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