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POLARIZED HYDROGEN EMISSION LINES IN MIRA STAR

Lèbre, A.[1], Gillet, D.[2] and Fabas, N.[1]

Abstract. We present the very first results of a full spectropolarimetric study (in the four Stokes parameters I, Q, U and V) performed with NARVAL at TBL, on the Mira star o Cet. We focus on the high level of time variable linear polarization detected in Hydrogen emission lines.

1 Introduction

Mira stars are cool, evolved and variable stars. They are radially pulsating stars with long period of luminosity. The prototype of the class, o Cet (or Mira), has a pulsation period of about 332 days and, from maximum to minimum light, its spectral type varies from M5 to M9. A cool and very extended stellar atmosphere is present, surrounded with a circumstellar envelope.
Among the peculiar features of Miras 'spectra, emission lines are detected. The series of Hydrogen Balmer lines are observed in emission during about 80% of the luminosity period. They are supposed to be formed in the radiative wake of a hypersonic shock wave propagating periodically throughout the stellar atmosphere.
From september 2007 to february 2008, we have performed spectropolarimetric observations of o Cet with NARVAL@TBL. We have observed the star around its mimimum light (on september 4, 2007) and around its consecutive maximum light (january 20 and february 10, 2008) with the aim to explore the magneto-electric nature of the shock wave propagating throughout the stellar atmosphere.

2 Spectropolarimetric study

Spectropolarimetric signatures are well detected in the 4 Stokes parameters (IQUV) associated to Balmer Hydrogen lines (from Hα to Hδ). In figure 1, we present our NARVAL observations focussing on Hβ and Hδ lines. Those signatures appear to be time variable, being much more visible and structured at the maximum light, when the shock is emerging from the photosphere and is propagating with a high intensity.
From the Q and U Stokes parameters, linear polarization in the Balmer lines has been estimated. We confirm, in the Hβ line, the high level of linear polarization already reported by McLean & Coyne (1978) for o Cet at its 1977 maximum of luminosity. Moreover in figure 2, we present - in Hβ - the time variable nature of this linear polarization. Indeed, our NARVAL observations show that the linear polarization rate, in all the Balmer lines, appears to be time variable, and non-existent at the minimum light.
We suggest that the origin of this polarization phenomenon associated to Balmer emission lines lies in the shock wave structure itself. More precisely it would be due to a magneto-electric field located just behind the shock front, i.e, in the region where emissions are formed.

References

McLean I.S, Coyne G.V., 1978, ApJ, 226, L145

[1] GRAAL, Université Montpellier II, CNRS, Place E. Bataillon, 34095 Montpellier
[2] Observatoire de Haute Provence, CNRS, OAMP, 04870 Saint Michel l'Observatoire

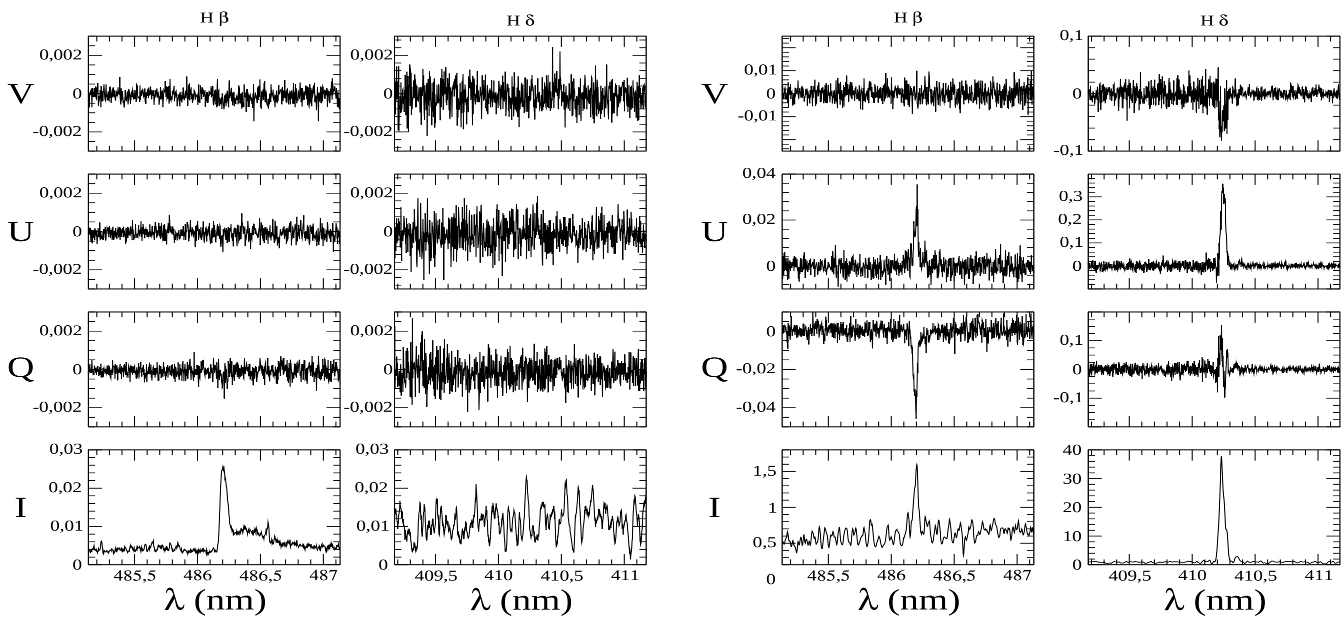

Fig. 1. Stokes parameters (IQUV) around Hβ and Hδ lines, for o Cet observed at its minimum light (left-side plots) and at its maximum light (right-side plots). At maximum light (february 2008), spectropolarimetric signatures are clearly detected in the 4 Stokes parameters and on both Balmer lines, while they are faint or absent in the observations around minimum light (september 2007).

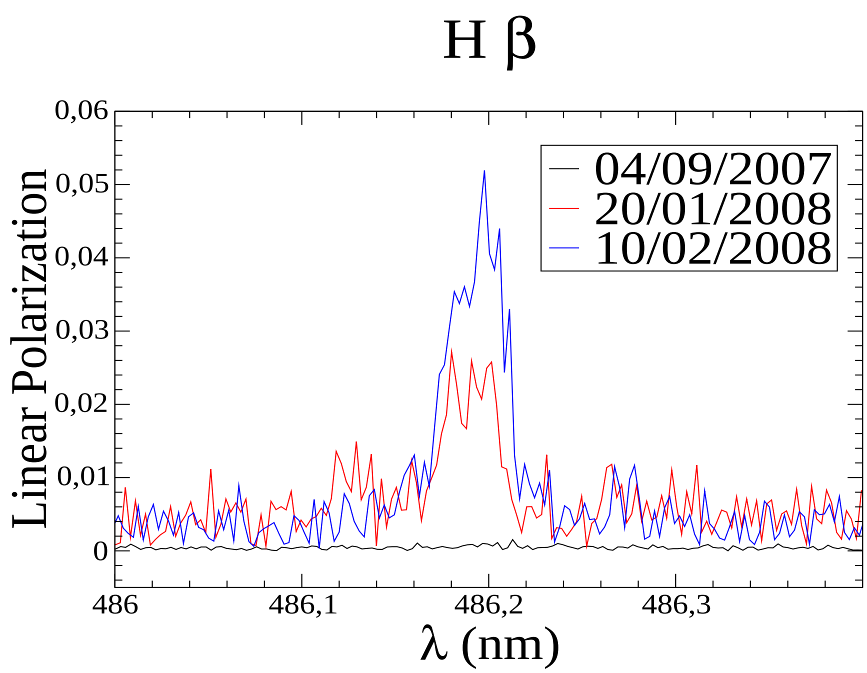

Fig. 2. Linear polarization rate in the Hβ line. From minimum to maximum light, it appears strongly variable suggesting a sharp link with the mechanism responsible of the emission line itself : the structure of the shock wave propagating throughout the stellar atmosphere.