Abstract

Delta Scorpii is an interesting binary system, whose primary companion created a circumstellar disk after the passage of the secondary at periastron, being since then classified as Be. Since the disk polarizes the light from the star, this work has a observational focus to monitor the polarization variation, as well as the consequences of recent 2011 July periastron. The observational data collected since 2006 in Observatório Pico dos Dias were partially reduced, and show a polarization not only variable, but also in correlates with the light curve. We conclude that the disk density varies by different epochs and furthermore there was no total destruction of the disk in recent periastron.

Introduction

Delta Scorpii is a binary system, whose primary companion is classified as Be type. During a large period was classified as simple Be type, without any sign of presence of circumstellar material. After the 1990 passage of the secondary companion at the periastron, it began to exhibit emission lines, which became more intense in next passage, in 2000, indicating the presence of circumstellar material. Since then the Hα flux stays strong, although highly variable [*]. The secondary's orbit is highly eccentric, e = 0.94 ± 0.01 (Miroshnichenko et al., 2001). Even the orbital period is of 10.817 ± 0.005 years (Tycer et al., 2011), the newest passage occurred in 2011 July 6th (±2) (JD 2455749 ± 2), according predictions of Tycer.

Table 1: Delta Scorpii properties calculated by Miroshnichenko et al. (2001) from spectroscopic observations.

<table>
<thead>
<tr>
<th>T (K)</th>
<th>m (m -)</th>
<th>(deg)</th>
<th>d (pc)</th>
<th>V rad (Km s⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21500</td>
<td>14</td>
<td>5</td>
<td>153</td>
<td>6.20</td>
</tr>
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</table>

A Be stars have an intrinsic linear polarization, which arises due to scattering of the free electrons of disk – and its direction is perpendicular to the envelope. In 2006, Carciofi has begun a long-term project in Observatório Pico dos Dias – Pico dos Dias Observatory, at Minas Gerais, Brazil – to monitor the polarimetric and spectroscopic variability of several Be star, including δ Scorpii.

Observational Data

All the polarimetric data presents in this work were obtained in BVRI filter, in a 0.6m telescope, by the project mentioned above (in Observatório Pico dos Dias). In an exceptional night, we can obtain P values with 0.006% of accuracy (but typically the data have an uncertainty of 0.01%). To subtract the interstellar polarization we used the field star HD 142705, of spectral type A0V. We are still investigating whether the interstellar polarization, as estimated by HD 142705, is indeed a good estimate.

Results

For companions, the graphs of polarization on figures 1 and 3 were combined with light curve of δ Scorpii. These photometric data were obtained by S. Otero (visual photometry), B. Fraser, D. West (PEP photometry), and T. Moon (CCD photometry); average error of about 0.05 mag.

In figure 4 the polarized spectrum is plotted for seven different subsets of our data, to illustrate the temporal evolution of the polarization slope.

Conclusions

One of the main findings of the work is that at times the polarization seems to be correlated with the photometry, whereas at others it is anti-correlated. This behavior can be understood if one considers the fact that these observables trace the disk density at different disk locations: visual photometry is sensitive to the inner disk structure while polarization tracks the structure of the disk over larger volumes. The observed trends are indications of a complex evolution of disk surface density over time. This is further illustrated by the observed changes in the slopes of different data groups in polarized spectrum, that suggests that the density of disk is variable. We expect, therefore, that the combination of both data sets will impose quite stringent constraints on any model that try to explain the disk evolution.

Finally, our results indicate that there are no signs of total destruction of the disk during the recent periastron passage.

References


Acknowledgments