NIR interferometric observations of massive hierarchical triple systems: Tr16-104 and HD150136

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Abstract:

Aims: We report on an observational astrometric study of the outer RV-orbit of the tertiary in the case of the long period. We also report on the radial velocity of the tertiary in the case of the short period.

Methods: We carried out interferometric and spectroscopic astrometric and RV measurements of the binaries of the two massive hierarchical triple systems HD104 and HD150136.

Results: We report on an observational astrometric study of HD104 and HD150136. The interest of the interferometric and spectroscopic observations is to verify the presence of a tertiary companion and to derive co-planar orbits for the inner and outer systems. In the case of the long period, the tertiary is astrometrically separated from the P+S system and we are able to derive a direct measurement of the radial velocity of the tertiary. The combined interferometric and spectroscopic data are well compatible with a periodicity of P=1335.0 days.

Discussion:

We have demonstrated here that the relative orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes. This is the first work is complemented by radial velocity data with the aim of deriving the full 3D orbit and constraints on the orbital planes. This is the first such study involving two massive triple systems. The results are very promising and we are now studying the other massive triple systems under study: HD150136 and another hierarchical triple system under study: HD152246.

Acknowledgements:

The interferometric observations of Tr16-104 were obtained on 29-12-2013 and on 24-02-2014 using the PIONIER four beam combiner at the ESO/MPG 2.2m telescope at La Silla. The spectroscopic observations were performed at the Subaru telescope equipped with NIRC2 and at the Keck I telescope equipped with HIJADE. The work was supported by the French National Research Agency (ANR-09-BLAN-0019-01). Additional support is by the National Science Foundation for Research in Astronomy (Grant No. AST-0909600) and the National Science Foundation for Research in Astronomy (Grant No. AST-1109854). The work was performed at the Astrophysics Group of Keele University, Staffordshire, United Kingdom.

Table 1: Derived spectroscopic parameters for HD104.

<table>
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<tr>
<th>Date</th>
<th>JD</th>
<th>Slit (mas)</th>
<th>Δν (mas)</th>
<th>Δθ (mas)</th>
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<th>f (mas)</th>
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<td>29-12-2013</td>
<td>56655.839</td>
<td>2.12E+10</td>
<td>-1.30E+11</td>
<td>3.68</td>
<td>144.8</td>
<td>0.26</td>
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<tr>
<td>24-02-2014</td>
<td>56712.745</td>
<td>2.44E+10</td>
<td>-2.41E+10</td>
<td>3.45</td>
<td>134.7</td>
<td>0.26</td>
</tr>
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Table 2: Results of the PIONIER observations obtained at the ESO/MPG 2.2m telescope at La Silla.

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Figure 1: The normalized spectrum of Tr16-104 in the neighborhood of the He I 10830 line. We present here spectra in absorption and emission in 2003 (bottom to top). The emission lines are identified by the authors. The presence of these components is clear. The spectra are from the Primary. Secondary or Tertiary object are included.

Figure 2: Plot of the RV curve of the Tertiary in a function of phase as computed according to the period P=1335.0 days. Phase corresponds to the base of passage at periastron. The bottom line shows the prediction of the model for the parameters given in Table 1.

Figure 3: The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 4: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The right panel exhibits the chi-square map in the vicinity of the best fit solution giving the relative position of the Tertiary around the P+S inner system. The solution is very well constrained by the data. The left panel shows the relative positions for Sep2014, Feb2015, Jun2015 and Aug2016, labelled with the date of the observations (filled black or white circles). The existing position of the tertiary star is represented by the solid ellipse. The existing position of the tertiary star is represented by the solid ellipse. The existing position of the tertiary star is represented by the solid ellipse. The existing position of the tertiary star is represented by the solid ellipse. The existing position of the tertiary star is represented by the solid ellipse.

Figure 5: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 6: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 7: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 8: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 9: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 10: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 11: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 12: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 13: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 14: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.

Figure 15: The relative positions of the Tertiary (triangles) with respect to the P+S inner system (circles). The predicted orientation of the two orbital planes, with the ultimate aim of understanding the related star formation processes.