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Examining young stellar systems in birth by high angular resolution observations

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Abstract. We present a high angular resolution survey of young T Tauri binaries on the northern sky. The binaries were discovered in the early 1990s, using speckle interferometry or lucky imaging techniques. The aim of our survey is to reobserve about 30 T Tauri pairs using a fast Andor iXon EMCCD camera mounted on our 1 m RCC telescope at the Piszkéstető Mountain Station, Hungary, and determine whether the orbital motion of the companion could be revealed by speckle interferometry or lucky imaging.

Key words: lucky imaging – speckle interferometry – T Tauri stars – young binary systems

1. Introduction

Is has been known for over a decade that many low-mass stars located in star-forming regions are members of multiple systems. Observing young T Tauri binaries and measuring their orbital period offers a model-independent way of calculating their mass, which in turn lets us indirectly calculate other stellar parameters. The stellar parameters of the pre-main-sequence stars present a powerful approach to place stringent constraints on star formation theories. The binary fraction and the orbital properties of the binaries carry important information about the way binaries form and since all components of a multiple system share the same evolutionary history, we can compare the binary components without having to deal with a number of degeneracies. The models of the evolution of low-mass stars at young ages still have relatively large uncertainties, which can be mitigated by measuring the accurate properties of young stars.

At the distance of the closest star formation regions (≈140 pc, "Loinard et al., 2007) the size of such systems appears to be less than one arcsecond, and since the typical atmospheric turbulence is 1–3 arcsecond, the systems cannot be resolved via direct imaging. The close binary systems can only be observed by special high angular resolution techniques, such as lucky imaging or speckle interferometry. These methods utilize images with very short exposure times, when the atmosphere "freezes out" and the atmospheric turbulence is not present.

2. Sample and observations

This work covers a survey of young T Tauri binaries on the northern sky, which were discovered in the early 1990s by Leinert et al. (1993), using speckle interferometry. In 2006–07 we reobserved these systems using lucky imaging technique on the Calar Alto 2.2 m telescope (Hormuth, 2007).

We aim to reobserve the T Tauri binaries at a third epoch using lucky imaging with our fast Andor iXon EMCCD camera mounted on the 1 m RCC telescope at the Piszkéstető Mountain Station, Hungary. For this survey we selected a subsample of the Calar Alto binary sample, which have a separation of at least 0.25″ (due to diffraction limit) and where the primary is bright enough (V< 13 mag). In total we plan to reobserve about 30 systems in 2013 fall–winter.

3. Preliminary results

We have evaluated some of the second epoch observations, which are presented in Table 1 together with data from the first epoch for comparison. In most cases the separation of the binaries are within the tolerance of the first epoch, but we also observed cases (such as GI Tau or RW Aur) when the difference between the two epochs is significant compared to the formal uncertainties. The third epoch will determine if the changes are due to noises or systematic changes.

Table 1. Separations and position angles of some of the target systems. Based on data from the first two epochs, 1990–92 (Leinert, 1993) and 2006–07 (Hormuth, 2007).

Object	Position angle (1990–92, °)	Position angle (2006–07, °)	Separation (1990–92, ″)	Separation (2006-07, ″)
GG Tau Aa	9 ± 2	337	0.26 ± 0.01	0.25
GG Tau Bb	135 ± 5	135	1.4 ± 0.2	1.47
GK Tau/GI Tau	151 ± 1	147	12.2 ± 0.2	13.14
GK Tau Cc	not resolved	58	not resolved	2.53
HN Tau	215 ± 2	38	3.1 ± 0.1	3.16
HV Tau AB	45 ± 5	42	4.0 ± 0.40	4.14
RW Aur	258 ± 1	73	1.50 ± 0.01	1.44
UX Tau AB	269 ± 2	261	5.9 ± 0.1	5.95
UX Tau AC	181 ± 2	174	2.7 ± 0.1	2.67

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