The AstraLux Binary M Dwarfs Survey

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Abstract. Binary/multiple properties provide clues to the formation of stars. In the AstraLux binary survey, we use the Lucky Imaging technique to search for companions to a large sample of young, nearby M dwarfs. We present results from observations of the first sub-sample, consisting of 124 M dwarfs in the southern sky.

Keywords. techniques: high angular resolution – binaries: visual – stars: low-mass, brown dwarfs

1. Introduction

M dwarfs form a link between solar-type stars on one side and very-low-mass stars and brown dwarfs on the other, and may represent a transition between different formation modes. Multiplicity characteristics of M dwarfs, such as the binary fraction and distribution of mass-ratio and separations can, therefore, provide clues to the formation of very-low-mass stars and brown dwarfs.

While multiplicity characteristics are well known for solar-type stars, they are less well constrained for M dwarfs. The binary fraction, $f_{bin} = N_{bin}/N_{total}$, decreases with decreasing mass from ≈57% for Sun-like stars (Duquennoy & Mayor 1991) to only 10-30% for very-low-mass stars and brown dwarfs (e.g., Burgasser *et al.* 2007). The distributions of mass-ratio, $q = M_2/M_1$, and binary separation also appear different for very-low-mass stars and brown dwarfs, compared to those of solar-type stars. These differences may indicate different formation scenarios (Thies & Kroupa 2007).

2. The survey

The AstraLux M dwarfs survey is the largest survey for binary/multiple M dwarfs to date. We observed ~ 800 young, nearby, early- to mid-M type stars using the two Lucky Imaging instruments *AstraLux Norte* at the 2.2 m telescope at Calar Alto, Spain, and *AstraLux Sur* at the 3.5 m New Technology Telescope (NTT) at La Silla, Chile (Hormuth *et al.* 2008; Hippler *et al.* 2009).

The aim of the survey is to investigate multiplicity properties of M dwarfs from a statistically large sample, and to find and characterize young, close binaries containing very-low-mass stars and brown dwarfs. Follow-up orbital monitoring with AstraLux combined with near-infrared spectra of selected systems discovered in the survey will provide observational calibration of the mass-luminosity relation and evolutionary models for very-low-mass stars and brown dwarfs.
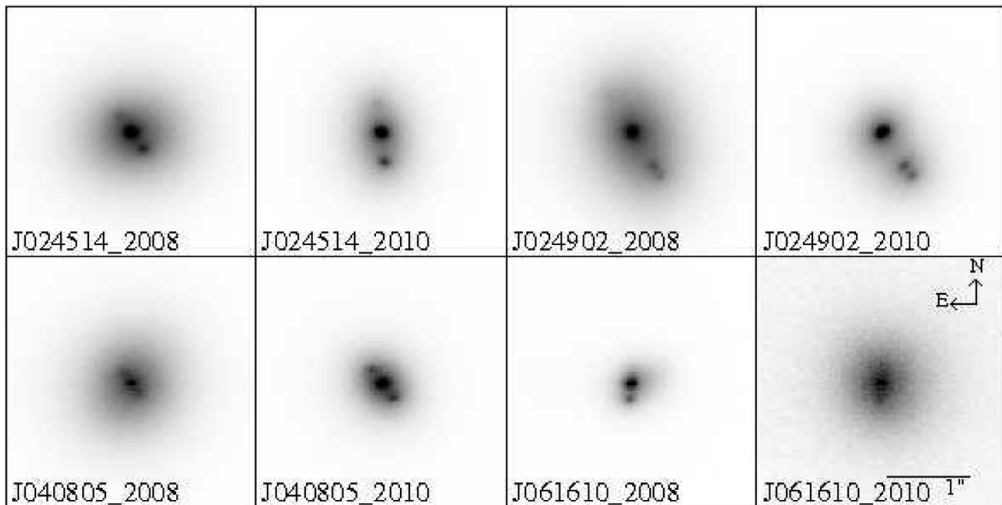
Figure 1. Three of the close binaries and one triple system discovered in the AstraLux M dwarfs survey. The figure shows SDSS z'-band observations obtained with *AstraLux Sur* in November 2008 and January 2010. The separation between the two close companions of (2MASS) J02490228-1029220 is $\rho \approx 0.15$ arcsec. These systems are being continuously monitored with *AstraLux Sur*, and near-infrared spectra have been obtained with SINFONI at the VLT.

3. The first results

In the first part of the southern sky survey, 124 young, nearby M dwarfs were observed with *AstraLux Sur* at NTT in November 2008 (Bergfors *et al.* 2010). This subsample is in itself the largest M dwarf multiplicity survey to date.

• 34 new and 17 previously known companions were identified in this sample. Most of these were separated by less than 1 arcsec, and would thus have been missed in a seeing-limited survey.

• We found a multiplicity fraction of $32 \pm 6\%$ for a set of 108 M0–M6 dwarfs within 52 pc from the Sun and with angular separations 0.1–6 arcsec, which corresponds to projected separations of 3–180 AU at the median distance of 30 pc.

• Late-type M dwarfs ($\geqslant$ M3.5) seem to prefer more equal-mass binaries than early-type M dwarfs. They are also mainly found in closer binaries, with the projected separation being closer than 20 AU for more than half of the sample.

References

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