A new classification scheme for intrinsic variability of close binary stars



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Close binaries: morphology & LCs

Detached / near contact binaries

Contact binaries



Close binaries: morphology & LCs





Light curve deformation: the O'Connell Effect









Phenomenological classification of the O'Connell Effect



No O'Connell Effect

Signal of transition between spots



Cycles of activity



Stable, non-changing O'Connell Effect



Regular variations







Separation of the brightness maxima



Separation of the brightness maxima



Separation of the brightness maxima

Simulated evolution of the maxima separation under the migration of a different kinds of star spots



KIC 6118779 – contact binary with a migrating polar spot



Measurement of the parameters variation magnitude



Epoch

Measurement of the variation magnitude - the big picture



The hidden variability

- Maxima separation evolution can serve as a signature of an activity not visible in the O'Connell Effect, such as:
 - Stationary, non-migrating, evolving polar spot (Candidates found, e.g. KIC 5535061)
 - No O`Connell Effect

- Small changes in the maxima separation
- Simultaneous changes in the maxima height
- (Thermal) pulsations of the <u>binary neck</u> (Candidates found, e.g. KIC 5376552)
 - No O`Connell Effect
 - Considerable changes in the maxima separation
 - Large variation of the primary minimum depth
- Global temperature changes of one of the binary components
 - Changes in the maxima separation
 - Changes in the minima depth
 - No changes in the O`Connell Effect

Activity signatures: starspot migration





primary maximum absolute height [flux]

Activity signatures: starspot migration



maxima separation [phase]

Activity signatures: neck pulsations

(neck in the contact binaries)

Maxima height relation

Maxima separation vs minima depth difference



Activity signatures: polar spot evolution

(stationary spot)

Maxima height relation

Maxima separation vs minima depth difference



Activity signatures: spot migration

Maxima height relation

Maxima separation

VS



Classification



Typical timescale of the activity



Typical timescale of the activity



Typical timescale of the activity

Summary

- The **O'Connell Effect** serves as a basic signature of a star spot presence, e.g.:
 - Stationary, non-migrating spots
 - Various cases of migrating spots
- Maxima separation can be used for detecting the activity `hidden' from the O'Connell Effect, such as:
 - Stationary (evolving) polar spots
 - Pulsations of the <u>binary neck</u>
 - Global temperature changes
- Activity can be classified by a fast analysis of the light curve. The leading indicators of a various types of the activity are:
 - the evolution of the O'Connell Effect (O'Connell IQR, O'Connell median)
 - the evolution of the maxima separation (maxima separation IQR, maxima separation median)
 - relation between maxima separation and the difference between minima depths

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