Department of Astronomy
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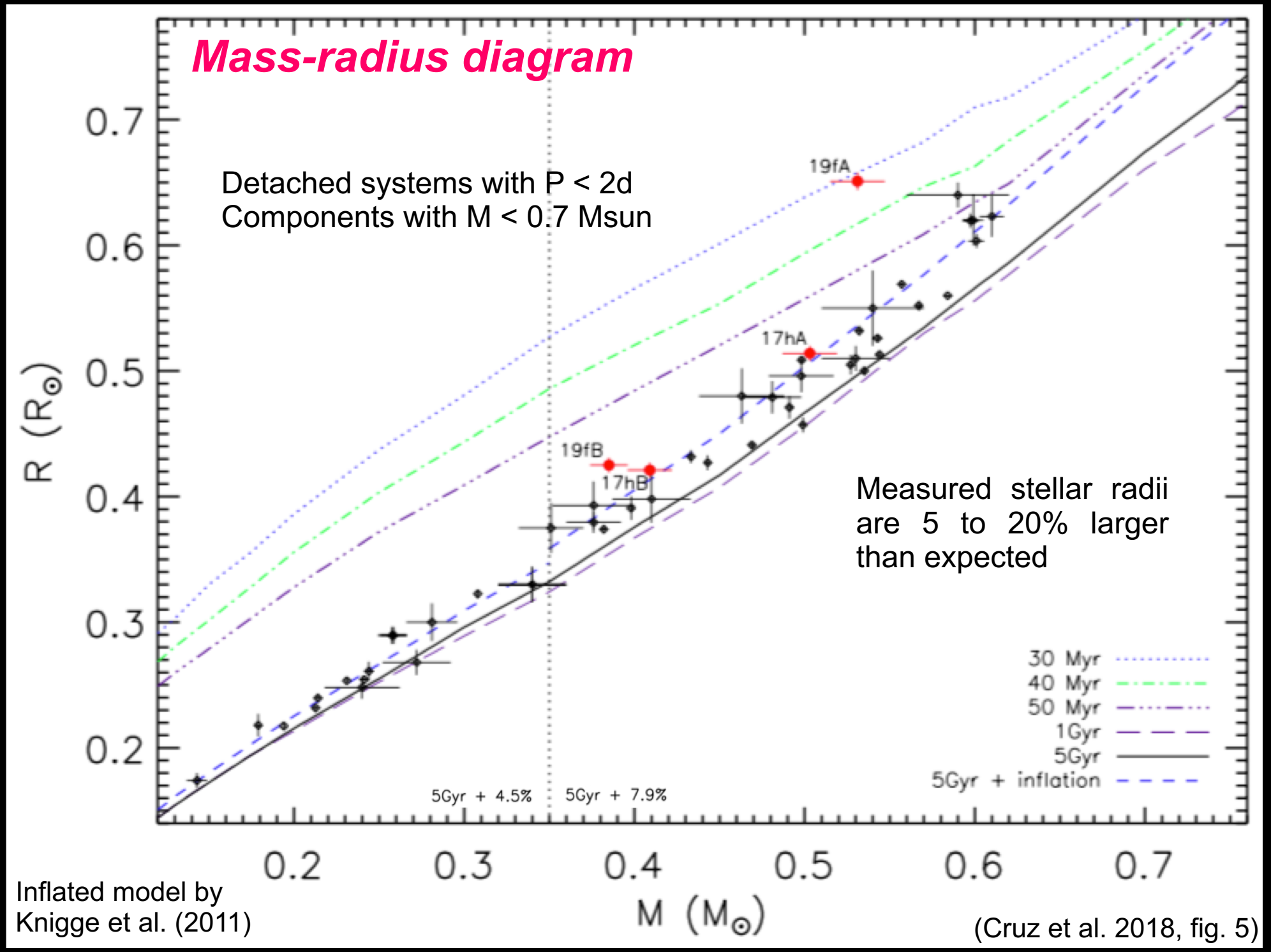
# *A large-sample analysis of the radius anomaly problem in short-period eclipsing binaries*

**Patricia Cruz**



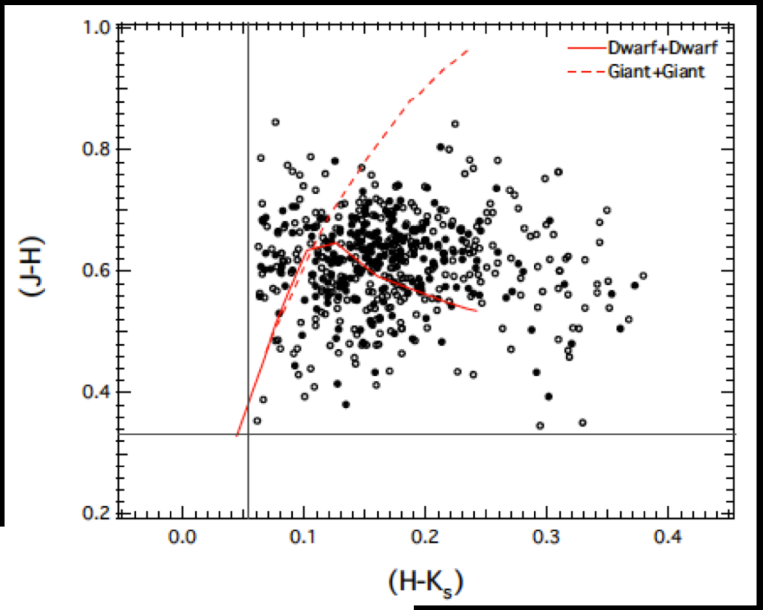

Inflated model by Knigge et al. (2011)

(Cruz et al. 2018, fig. 5)

# *The radius inflation problem in short-period low-mass binaries* *a large sample analysis*

Search for detached EBs (DEBs) in the Catalina Sky Survey (Drake et al. 2009).
→ CSDR1, CSDR2 (Drake et al. 2012, 2014)

Criteria:
– Detached systems with periods shorter than 2 d.
– Low-mass main-sequence stars as components: later than G3 dwarf (Teff < 5720 K; M < 1 Msun)




(Garrido, Cruz et al. 2019, fig. 1)

MNRAS 482, 5379–5388 (2019)

**The radius inflation problem in short-period low-mass binaries: a large sample analysis**

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**230 DEBs** with LMMS (Low-Mass Main Sequence) stars: solving the systems with photometric data only.

# *Getting temperatures and masses from broadband photometry*

## *using clustering techniques*

→ The binary systems go under a supervised statistical analysis which uses clustering techniques to search for similarities between observed data and models, based on a multi-color dataset.

SDSS–2MASS ten-color calibration grid of synthetic composite colors.
(ugriz) (JHK)

990 models – based on 1 and 3 Gyr models from Bressan et al. (2012).

K-Nearest Neighbors classifiers method (Hartigan 1975) to assign Teff for each component of the system.

Masses from the semi-empirical values of stellar colors and effective temperature sequence by Pecaut & Mamajek (2013).

→ We used the JKTEBOP code (Southworth et al. 2004) modified with the Asexual Genetic Algorithm (Coughlin et al. 2011) for the light curve modeling.

# *Getting temperatures and masses from broad[illegible] photometry*

## *using*

→ Th[illegible]h uses
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SDSS
(ugriz)

990 m[illegible]

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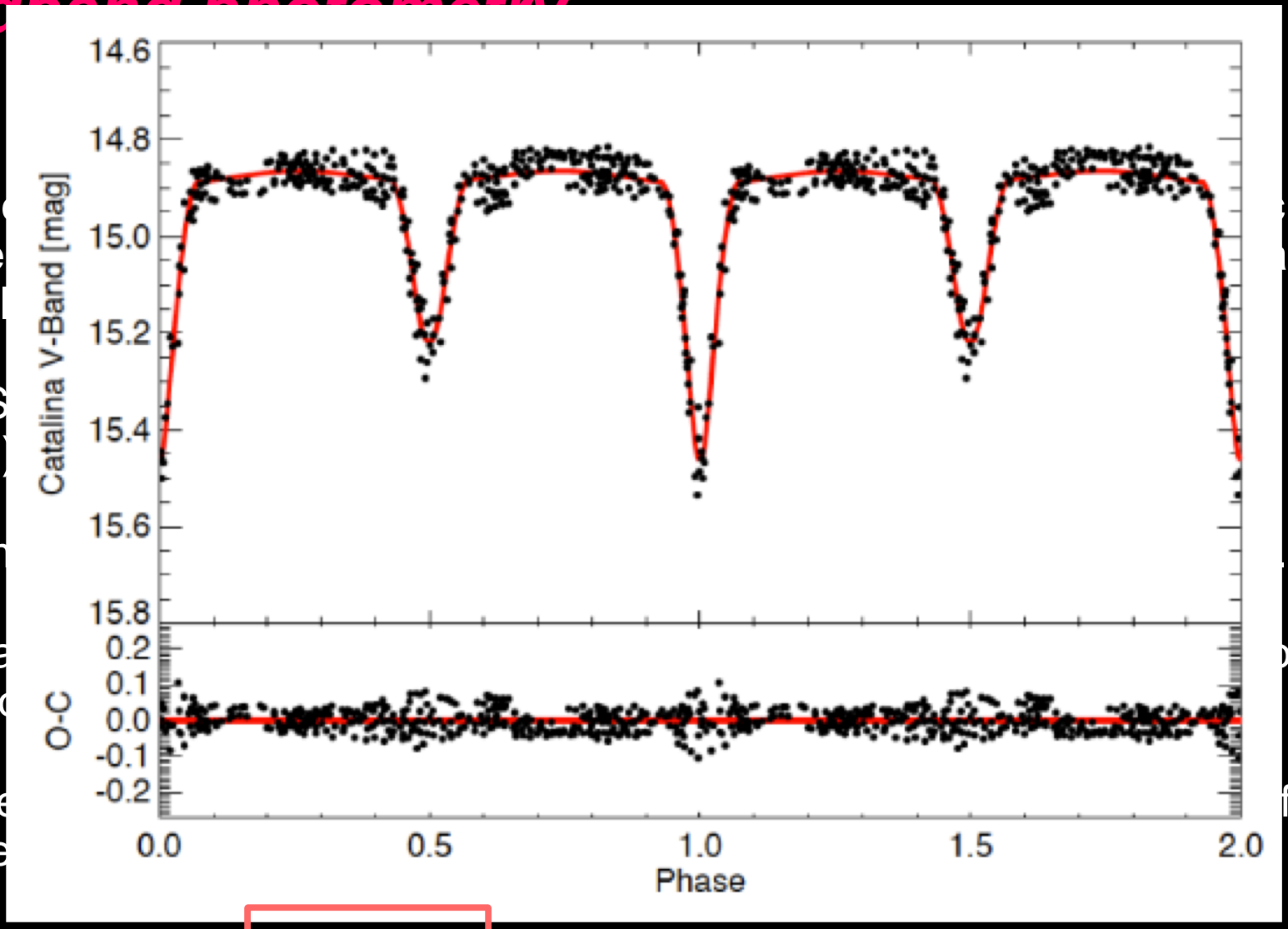


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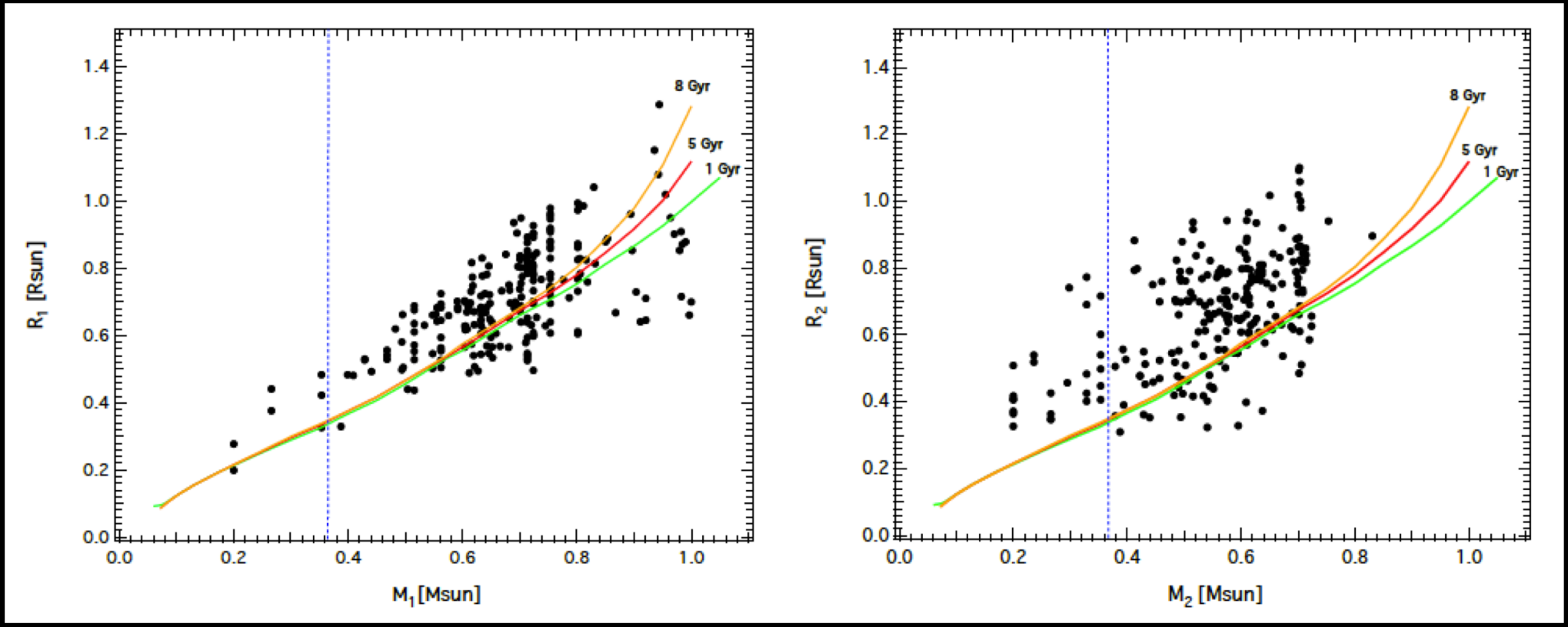
# The mass-radius diagram

## A large sample analysis

(Garrido, Cruz et al. 2019, fig. 4)

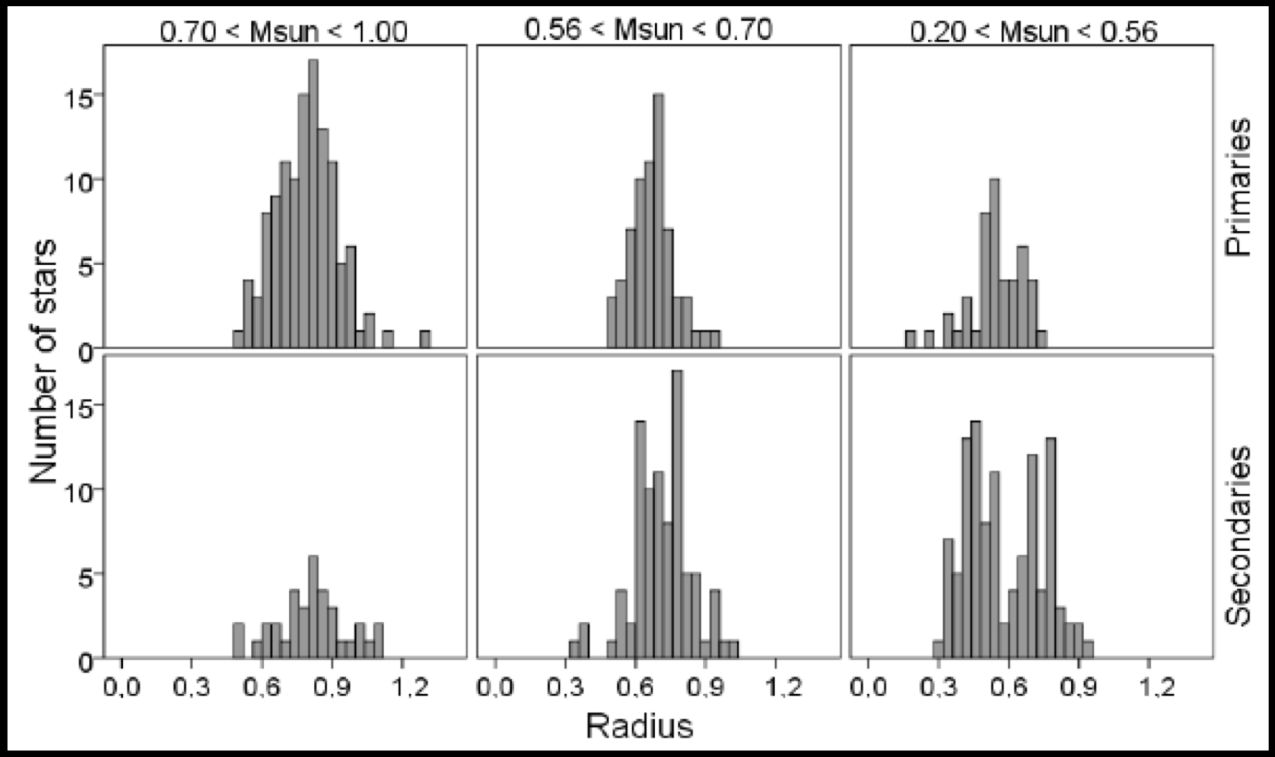



These results also suggest a global trend of inflation for low-mass stars.

Secondaries seem more inflated than primary components.

# *Are the secondaries more inflated?*

## *The Kolmogorov-Smirnov test*




(Garrido, Cruz et al. 2018, fig. 5)

For the less massive objects in our sample (Ms < 0.70 Msun), the significance of the KS test is only 0.005.

From the literature: 61% of the well-characterized short-period EBs present more inflated secondary components.

(Garrido, Cruz et al. 2019, table 2)

| | Mass range ($M_\odot$) | Number of Primaries | Number of Secondaries | Number of stars per bin | Percentage (%) | Statistical significance |
|---|---|---|---|---|---|---|
| BIN 1 | $0.70 < M < 1.00$ | 118 | 35 | 153 | 33.26 | 0.655 |
| BIN 2 | $0.56 < M < 0.70$ | 66 | 87 | 153 | 33.26 | 0.005 |
| BIN 3 | $0.20 < M < 0.56$ | 46 | 108 | 154 | 33.48 | 0.005 |

# *Ongoing project*

## *Photometric study of LMEBs – Garrido,Cruz et al. 2019*

The analysis of large samples is important and can reveal additional global trends.

– Are the secondary components more inflated than primaries? Why?

– Is the suggestion of a bimodal radii distribution a real trend?

## *More data are under analysis – Observational campaigns*

Granted telescope time in 2018:

– 13.1 hours at the 8.1m-GEMINI-North with GRACES for RV measurements
→ unfortunately, only 0.5h of acquired data

– 11 nights at the 0.6m-OPD/LNA for photometric follow up.

Last semester (2019):

– 5 nights at the 4.2m-WHT/ING with ISIS and ACAM for RVs and spectral typing;

– 26 hours at the 4.1m-SOAR with GOODMAN for RVs;

– 3 nights 1.6m-OPD/LNA for spectral typing;

– 10 nights at the 0.6m-OPD/LNA for photometric follow up.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