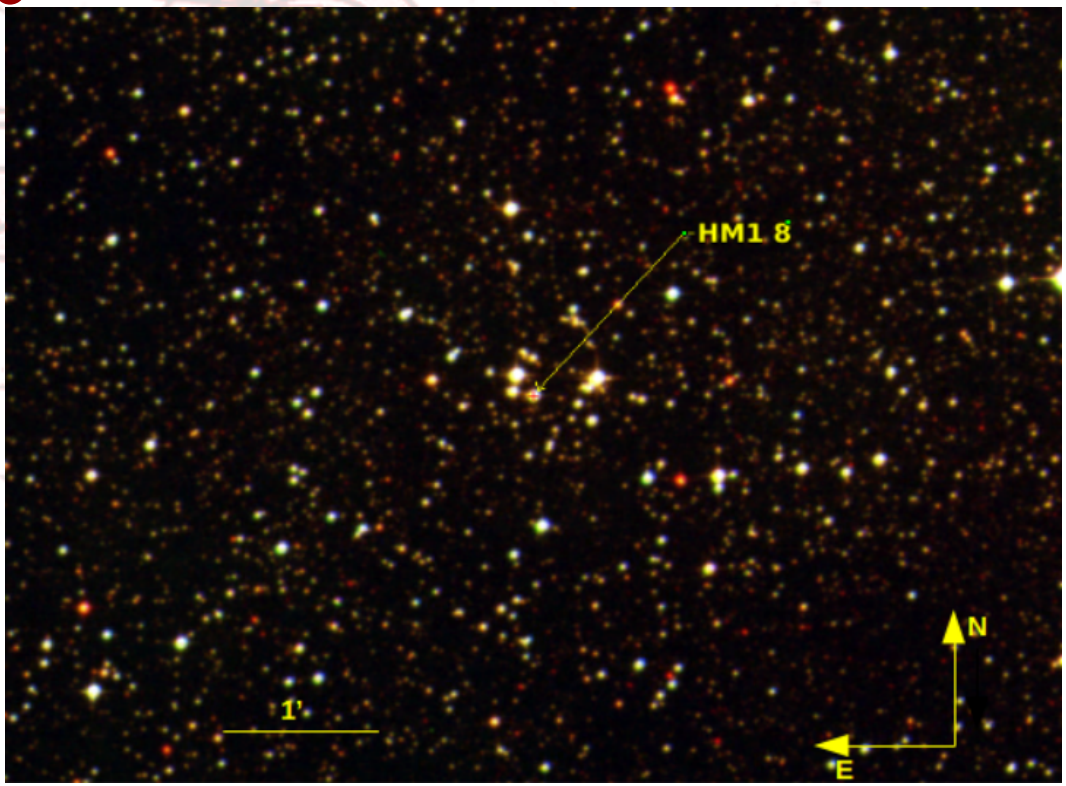
The Massive Binary System HM1 8

Cinthya Nazarena Rodríguez (IALP)

Gabriel Ferrero (FCAG-UNLP-IALP)
Roberto Gamen (FCAG-UNLP-IALP)
Nidia Morrell (Las Campanas Observatory)
Rodolfo Barbá (Dto. de Física y Astronomía, Universidad de La Serena)
Omar Benvenuto (FCAG-UNLP-IALP)
Philip Massey (Lowell Observatory)
Jorge Combi (FCAG-UNLP-IAR)

INTRODUCTION
The binary system HM1 8

- Located in the open cluster HM1. (Havlen & Moffat, 1977)
- Primary component: **O5 III**. Secondary component: **OB**. P$\sim$5.9 days. (Gamen et. al., 2008)
- d=3.01 ± 0.46 kpc (GAIA DR2, 2018)
- Age of HM1: 2-4 Myr. (Vázquez & Baume, 2001)



Composite image of the cluster in B, V and I bands.
$(\alpha, \delta) = (17^h 19^m 04.43^s, -38^\circ 49' 04.87'')$

INTRODUCTION
Observations

Three different data sets:

- Echelle spectra from the OWN Survey database:
  - FEROS - MPG/ESO (ESO-La Silla)
  - echelle spectrograph - Irénée du Pont (LCO)
  - MIKE - Clay-Magellan (LCO)
- Photometric data obtained with:
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  - SMARTS Yale (CTIO)
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Barbá et. al., 2017, IAU Symposium, 329, 89-96

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Massey et. al., 2012, ApJ, 748, 96

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ANALYSIS
Optical spectroscopy - Orbital solution

- To obtain the orbital solution:
  - Radial velocity measurements.
  - Parameters estimation.
  - Orbital fit with `FOTEL` code[1].

- Separation of the spectrum of each component.

[1] Hadrava. P, 2004, Publications of the Astronomical Institute of the Czechoslovak Academy of Sciences, 92, 1

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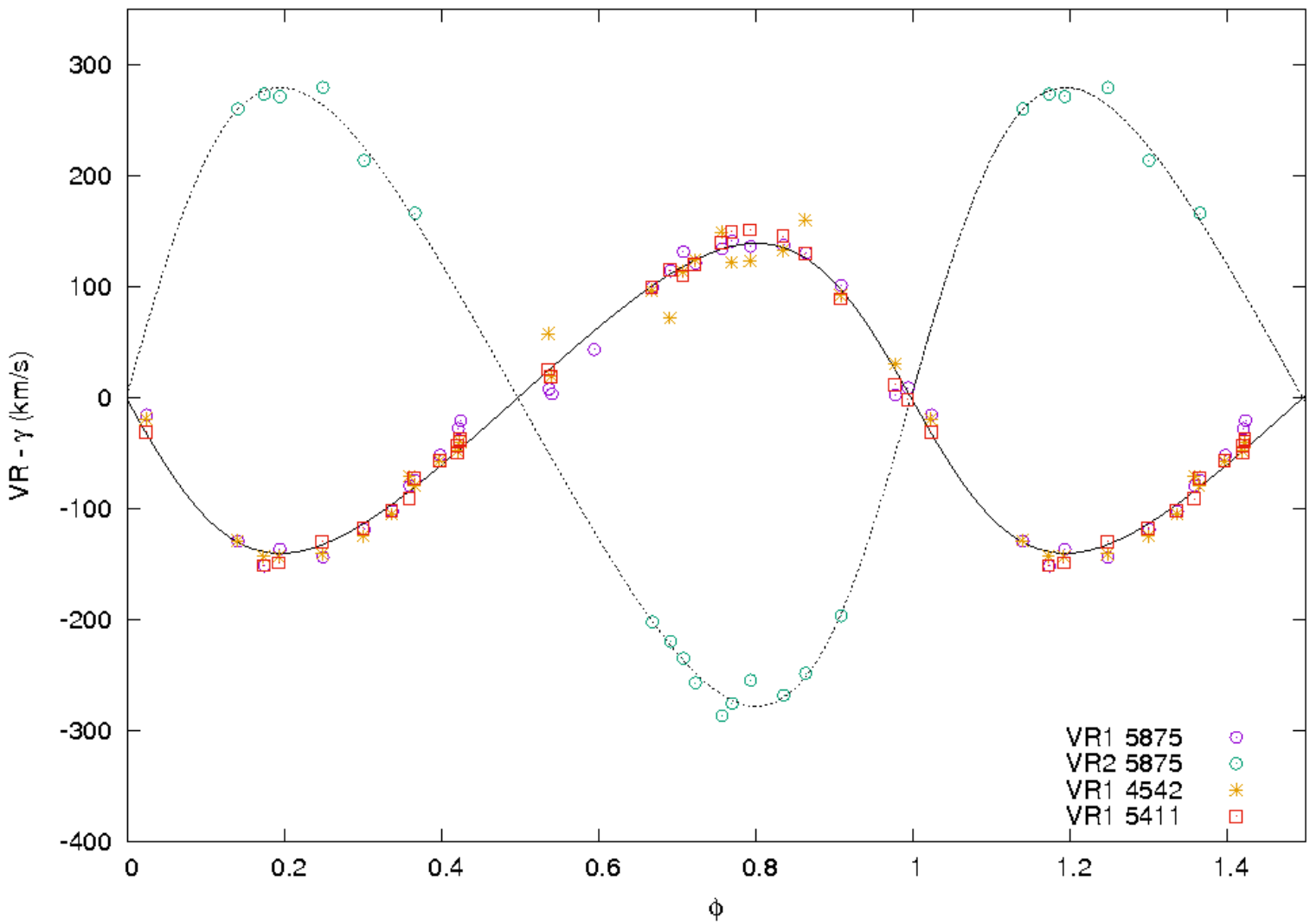
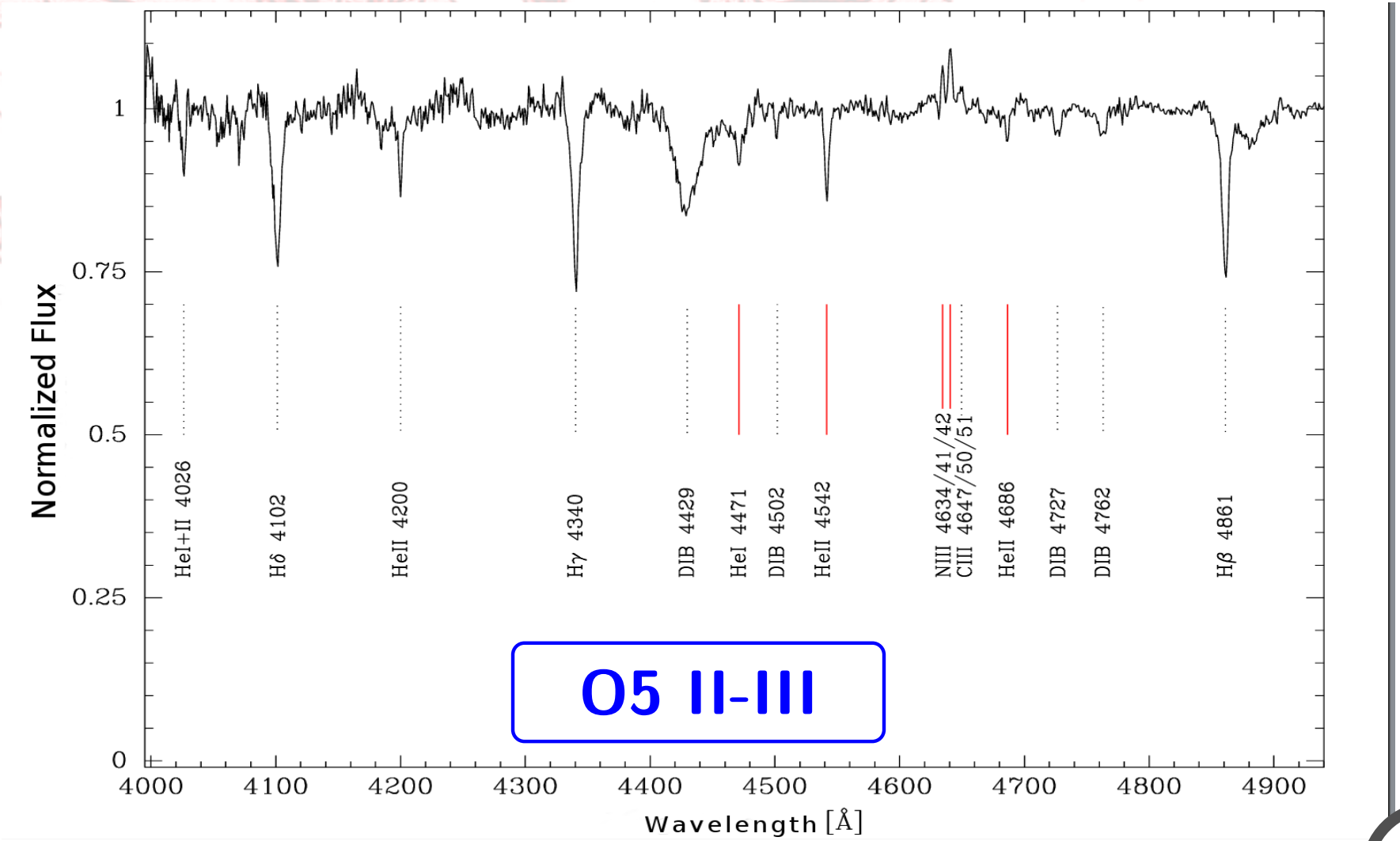
Optical spectroscopy - Orbital solution



ANALYSIS

Optical spectroscopy - Spectral classification (preliminary)

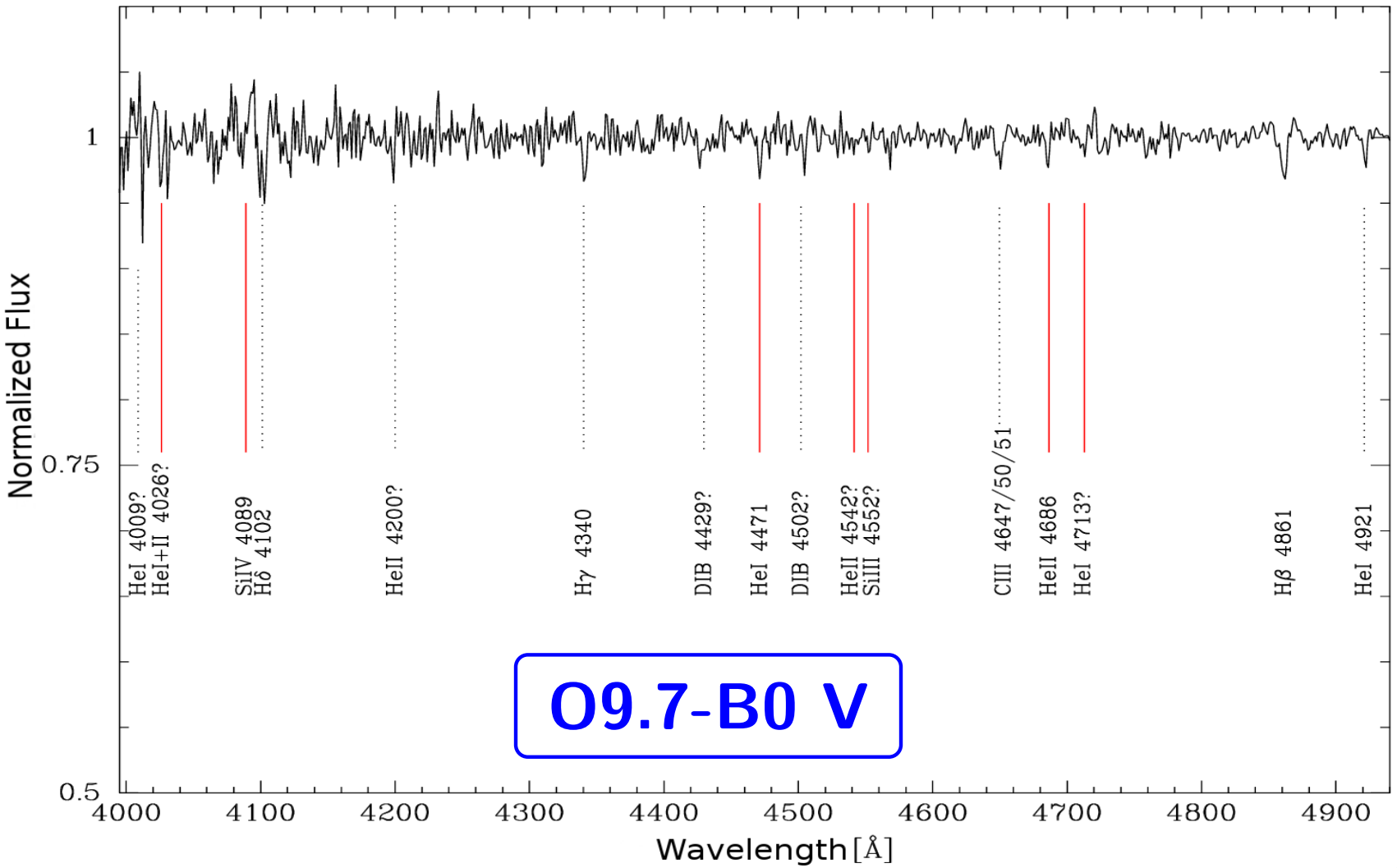
Primary



ANALYSIS

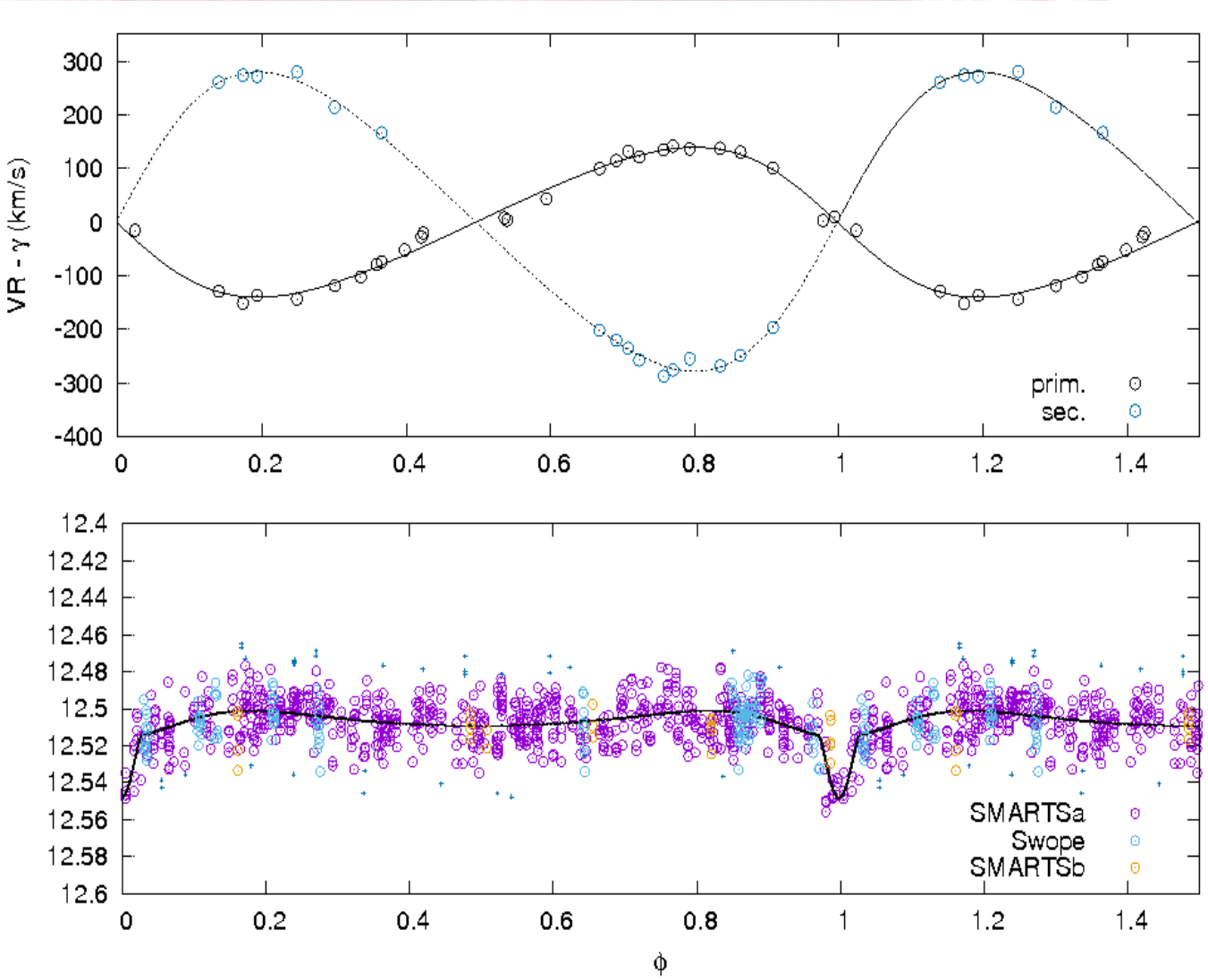
Optical spectroscopy - Spectral classification (preliminary)

Secondary



ANALYSIS

Simultaneous analysis of the radial velocity and photometric variations

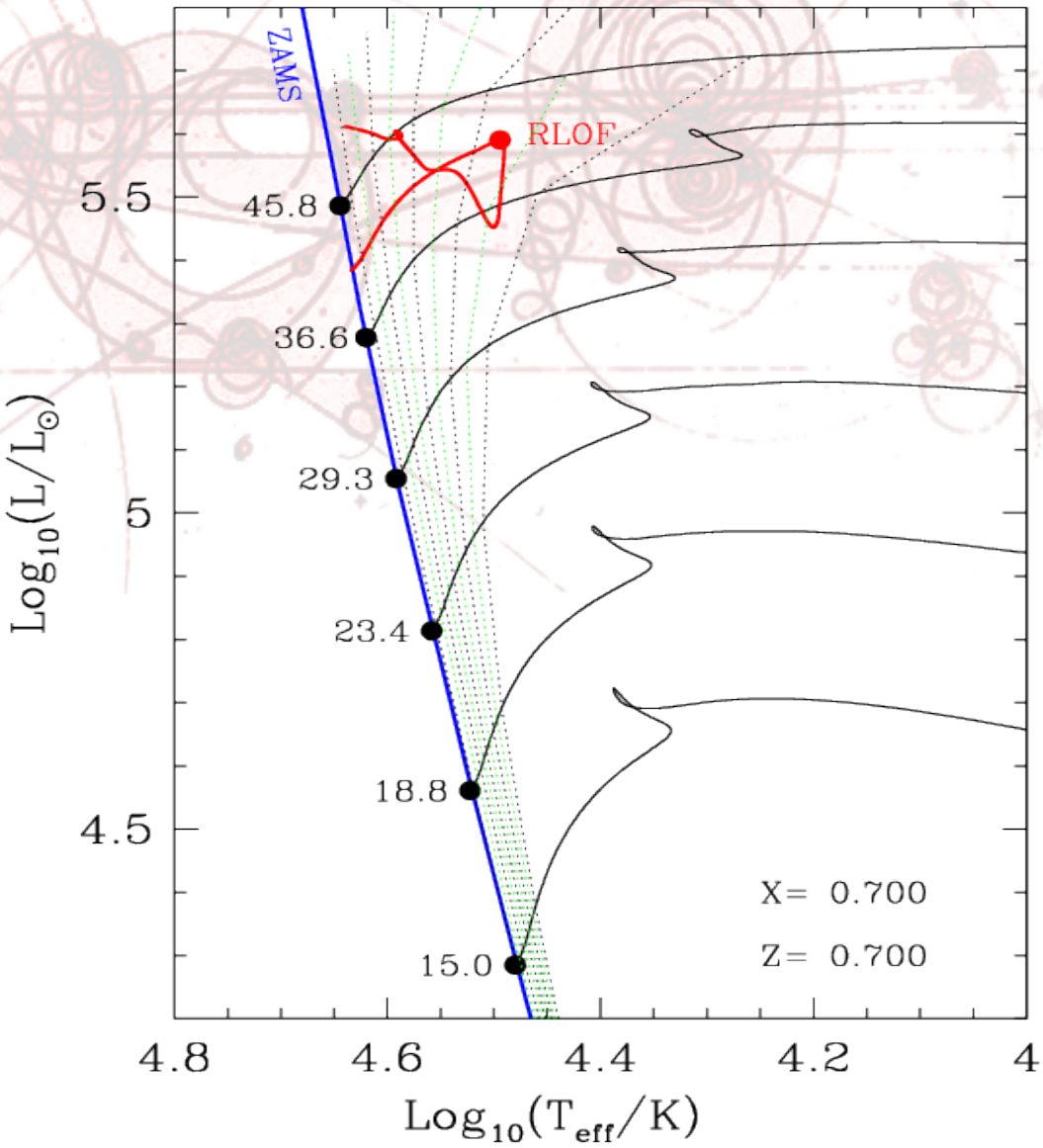


ANALYSIS

Simultaneous analysis of the radial velocity and photometric variations

- $P = 5.87864 \pm 0.00012$ [days]
- $K_1 = 139.8 \pm 3.7$ [kms^{-1}]
- $K_2 = 279.0 \pm 7.2$ [kms^{-1}]
- $e = 0.168 \pm 0.013$
- $i = 66.037 \pm 0.095$ [°]
- $M_1 = 37.5 \pm 3.1$ [M$_\odot$]
- $M_2 = 18.8 \pm 1.6$ [M$_\odot$]
- $V_1 = 12.75 \pm 0.76$ [mag]
- $V_2 = 14.7 \pm 1.1$ [mag]
- $R_1 = 12.66^{+0.33}_{-0.99}$ [R$_\odot$]
- $R_2 = 7.99^{+0.18}_{-0.68}$ [R$_\odot$]

EVOLUTIVE MODELS



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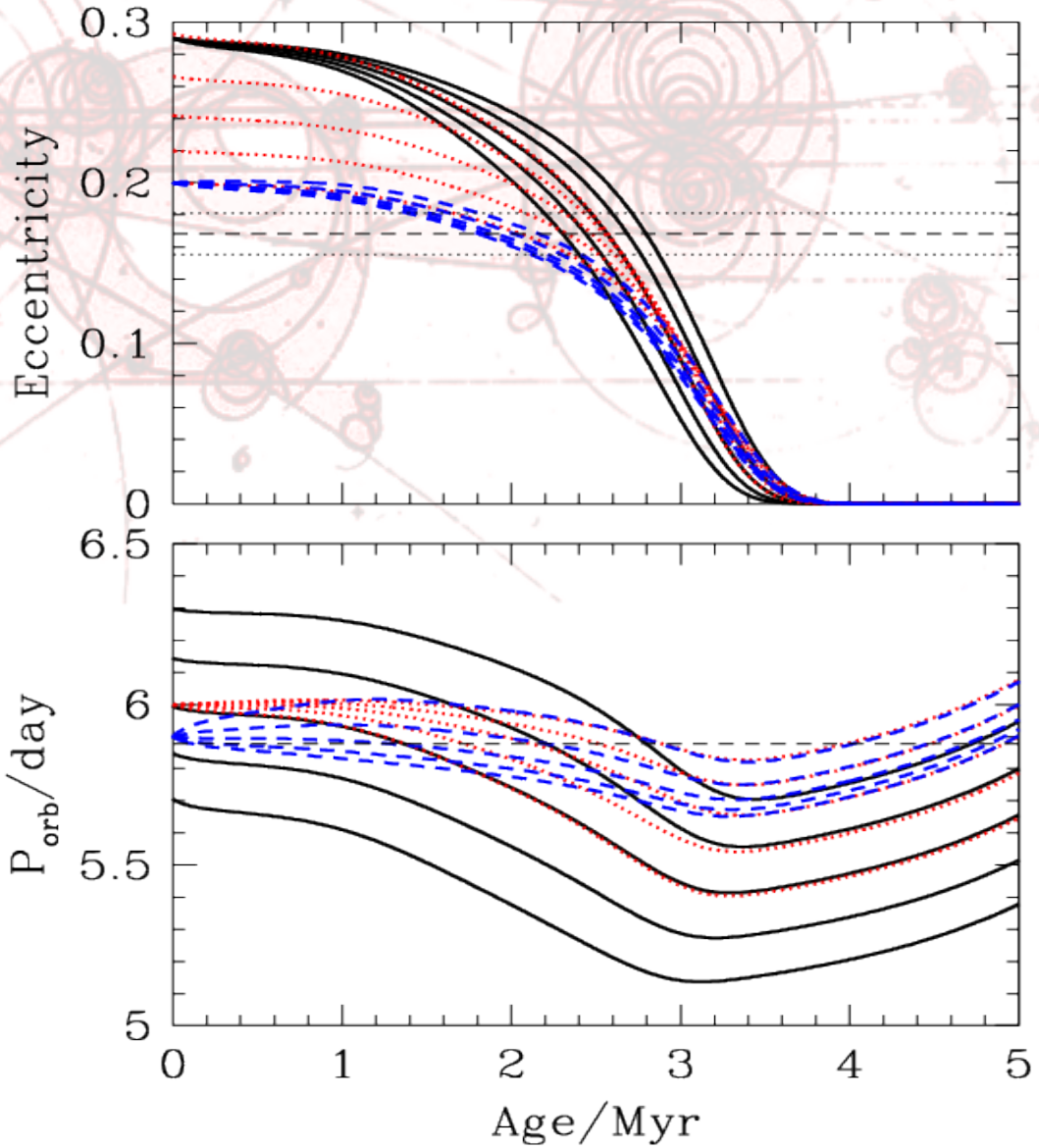
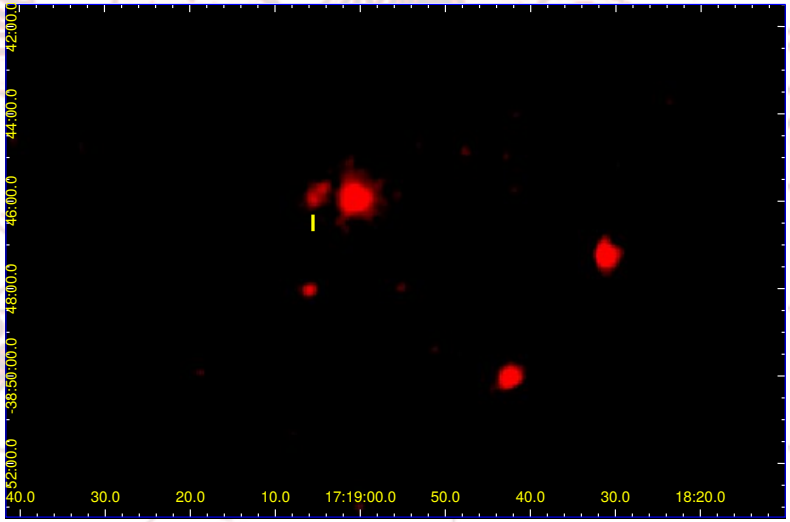
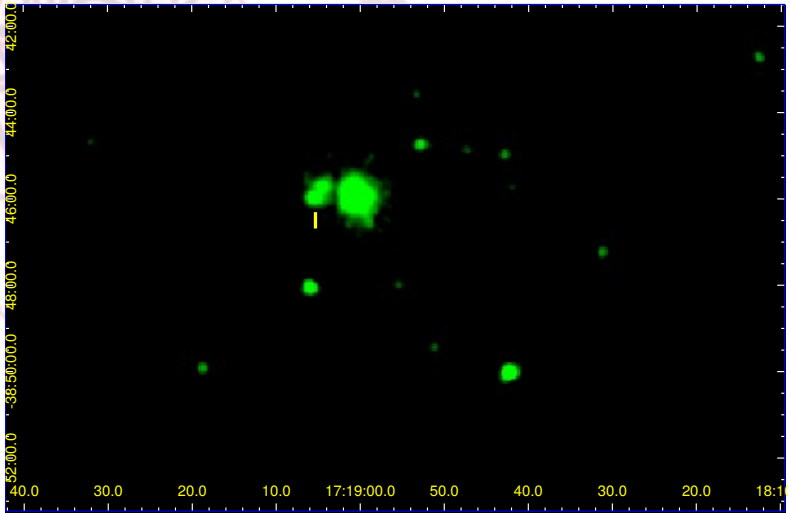
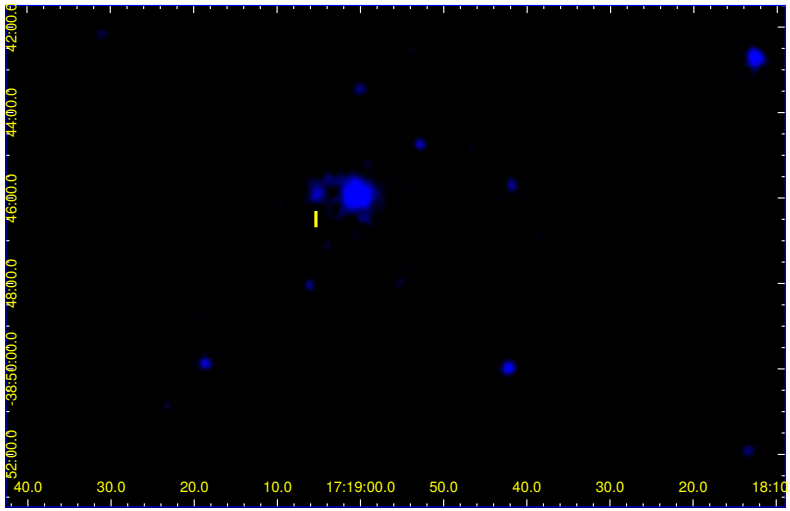


ANALYSIS
X-rays - Image analysis

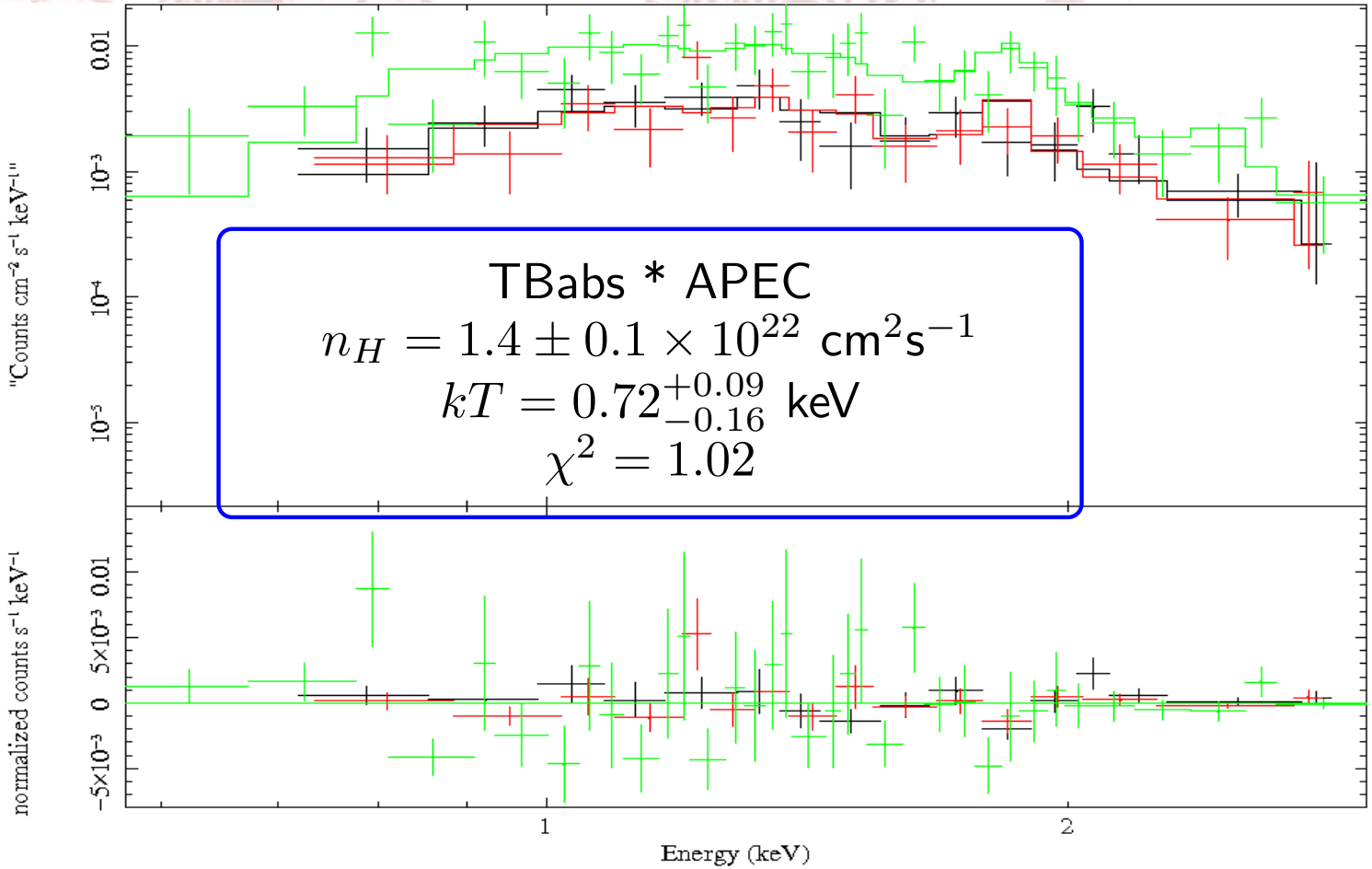






- Soft: 0.5-1.2 keV
- Medium: 1.2-2.5 keV
- Hard: 2.5-10 keV

ANALYSIS
X-rays - Spectral analysis



TBabs * APEC

$n_H = 1.4 \pm 0.1 \times 10^{22}$ cm^{2}s^{-1}

$kT = 0.72^{+0.09}_{-0.16}$ keV

$\chi^2 = 1.02$

Nazé et. al., 2013, A&A, 555, A83

ANALYSIS
X-rays - Spectral analysis

Radiation from stellar winds or colliding-wind region?

- Temperature analysis $\Rightarrow$ $T \approx 8.3 \times 10^6$ K
- $\frac{L_X}{L_{BOL}}$ $\Rightarrow$ $L_X = 0.15 \times 10^{-7} L_{BOL}$

Lucy & White, 1980, ApJ, 241, 300
Stevens et. al., 1992, ApJ, 386, 265
Chlebowski, 1989, ApJ, 342, 1091
Sana et. al., 2006, MNRAS, 372, 661

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Winner...

Probably stellar wind of the primary component.

SUMMARY

- We performed a spectral classification of the binary system HM1 8: **O5 II-III** (primary) and **O9.7-B0 V** (secondary).
- We obtained the inclination and the astrophysical parameters of the system. In particular, **absolute masses** ($M_1 = 37.5 \pm 3.0$ M$_\odot$, $M_2 = 18.8 \pm 1.6$ M$_\odot$)
- From the X-ray spectra, we calculated the quotient $\frac{L_X}{L_{BOL}}$: $L_X < 10^{-7}\ L_{BOL}$. Proposal: **the X-ray emission comes from the primary wind.**

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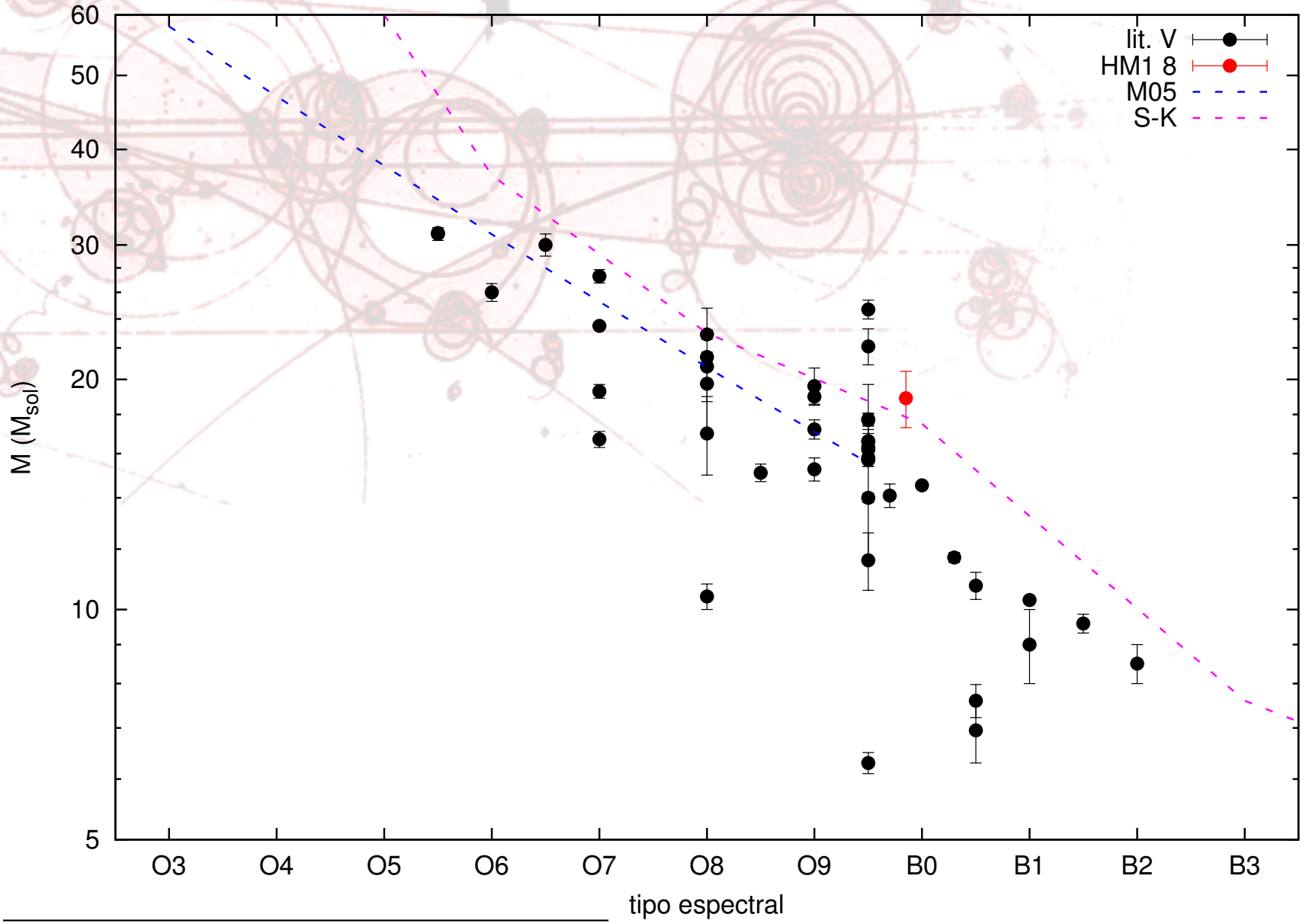

(Ferrero, 2016, PhD thesis, UNLP)

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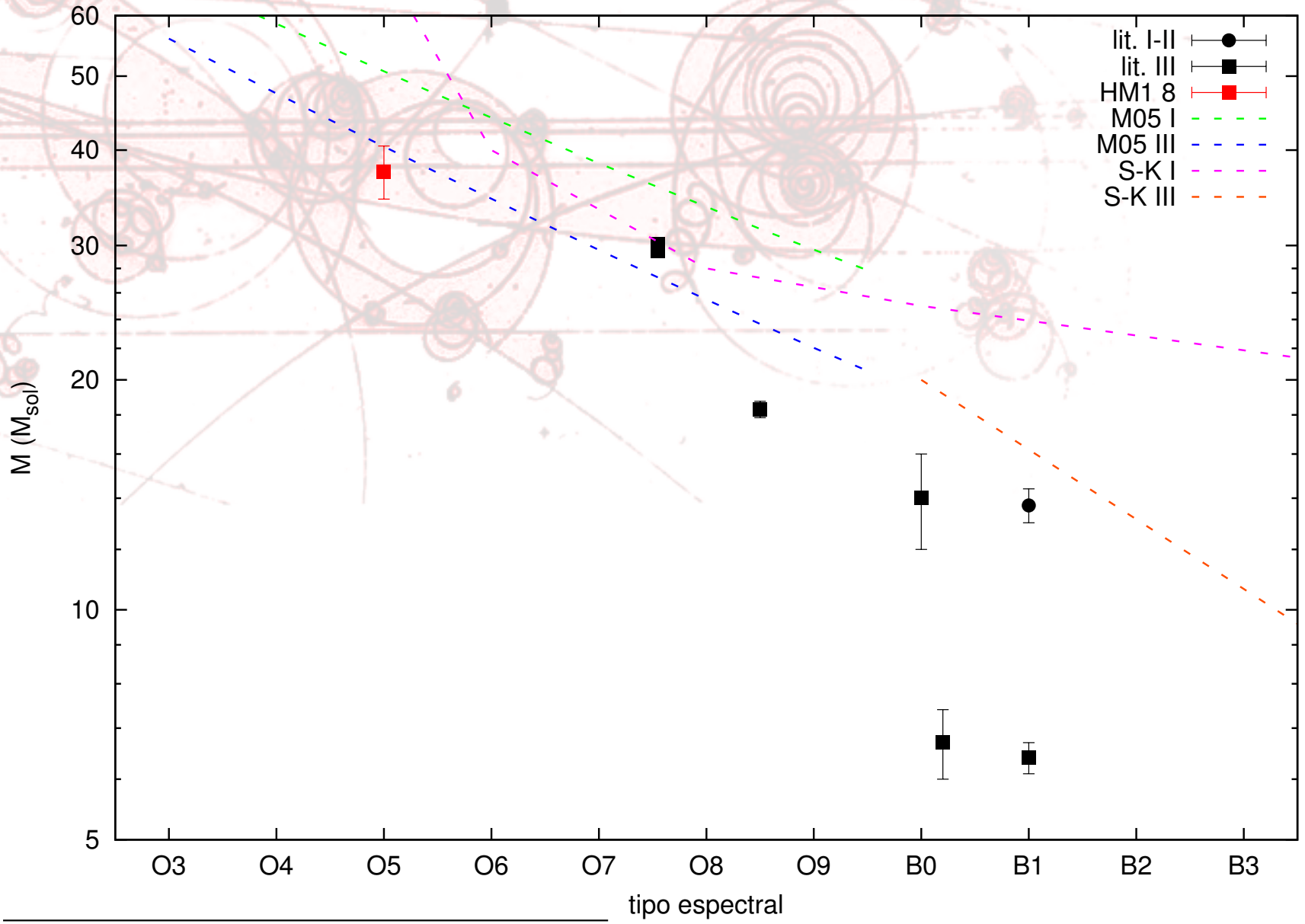

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Thank you!