



## UvA-DARE (Digital Academic Repository)

### Optical Spectral Evolution of the Gamma-Ray Binary PSR J2032+4127/MT91 213 Toward Its 2017 Periastron Passage

Rouco Escorial, A.; Hernández Santisteban, J.V.; Echevarría, J.; Wijnands, R.; Page, D.; Degenaar, N.

**DOI**

[10.3847/2515-5172/ab04f6](https://doi.org/10.3847/2515-5172/ab04f6)

**Publication date**

2019

**Document Version**

Final published version

**Published in**

Research Notes of the American Astronomical Society

[Link to publication](#)

**Citation for published version (APA):**

Rouco Escorial, A., Hernández Santisteban, J. V., Echevarría, J., Wijnands, R., Page, D., & Degenaar, N. (2019). Optical Spectral Evolution of the Gamma-Ray Binary PSR J2032+4127/MT91 213 Toward Its 2017 Periastron Passage. *Research Notes of the American Astronomical Society*, 3(2), [31]. <https://doi.org/10.3847/2515-5172/ab04f6>

**General rights**

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

**Disclaimer/Complaints regulations**

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

*UvA-DARE is a service provided by the library of the University of Amsterdam (<https://dare.uva.nl>)*

☐ **NOTICE:** Access in China: Some users in China are being blocked by IOP's security software. Please contact [china@iopublishing.org](mailto:china@iopublishing.org)



## RNAAS RESEARCH NOTES OF THE AAS

# Optical Spectral Evolution of the Gamma-Ray Binary PSR J2032+4127/MT91 213 Toward Its 2017 Periastron Passage

Alicia Rouco Escorial<sup>1</sup>, Juan V. Hernández Santisteban<sup>1</sup>, Juan Echevarría<sup>2</sup>, Rudy Wijnands<sup>1</sup>, Dany Page<sup>2</sup>, and Nathalie Degenaar<sup>1</sup>

Published 2019 February 13 • © 2019. The American Astronomical Society. All rights reserved.

[Research Notes of the AAS](#), [Volume 3](#), [Number 2](#)

4023 Total downloads

[Get permission to re-use this article](#)

Share this article



### ☐ [Article information](#)

#### Author e-mails

[A.RoucoEscorial@uva.nl](mailto:A.RoucoEscorial@uva.nl)

#### Author affiliations

<sup>1</sup> Anton Pannekoek Institute for Astronomy, University of Amsterdam, Science Park 904, 1098 XH, Amsterdam, The Netherlands

<sup>2</sup> Instituto de Astronomía, Universidad Nacional Autónoma de México, CDMX, 04510, Mexico

#### ORCID iDs

Alicia Rouco Escorial <https://orcid.org/0000-0003-3937-0618>

Juan V. Hernández Santisteban <https://orcid.org/0000-0002-6733-5556>

Dany Page <https://orcid.org/0000-0003-2498-4326>

## Dates

Received 2019 January 31

Accepted 2019 February 7

Published 2019 February 13

## Citation

Alicia Rouco Escorial *et al* 2019 *Res. Notes AAS* **3** 31

[Create citation alert](#)

## DOI

<https://doi.org/10.3847/2515-5172/ab04f6>

## Keywords

[accretion](#), [accretion disks](#); [pulsars: individual \(PSR J2032+4127\)](#); [stars: individual \(MT91 213\)](#); [techniques: spectroscopic](#); [X-rays: binaries](#)

[Journal RSS feed](#)

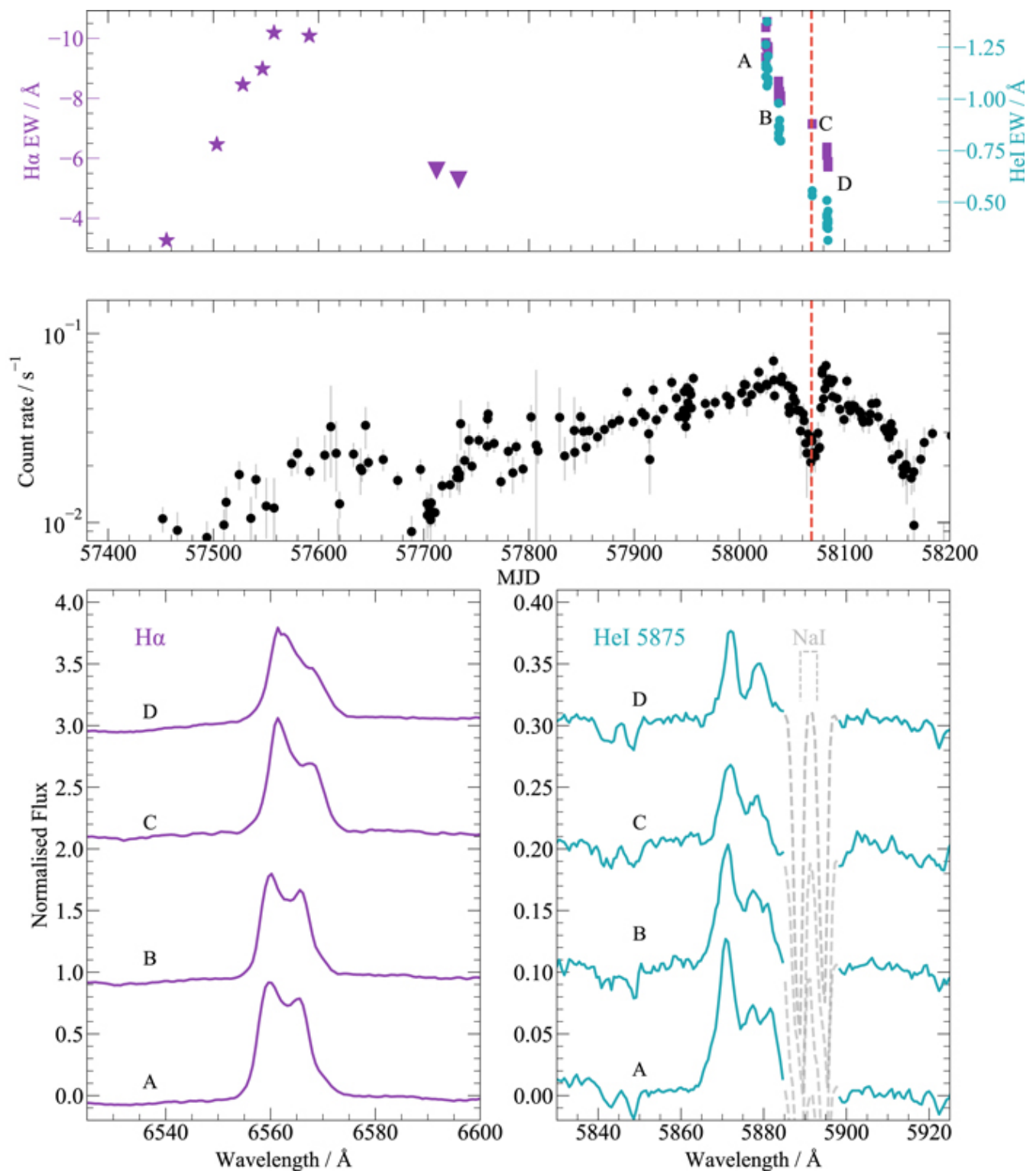
[Sign up for new issue notifications](#)

Export citation and abstract

[BibTeX](#)

[RIS](#)

The gamma-ray binary PSR J2032+4127/MT91 213 (hereafter J2032) harbours a radio and gamma-ray pulsar (Abdo et al. [2009](#); Camilo et al. [2009](#)), which orbits around its BoVe companion (Lyne et al. [2015](#)) at  $\sim 1.33$  kpc, every 45–50 yr. Ho et al. ([2017](#)) reported on a significant increase of the X-ray emission one year before the pulsar approached its periastron passage on 2017 November. This X-ray enhancement was explained by the interaction between the stellar and the pulsar winds (Ho et al. [2017](#); Li et al. [2017](#)). By the time of periastron passage, the source showed a deep X-ray decrease for  $\sim 26$  days that was followed by a post-periastron rebrightening (Figure [1](#), middle panel; Li et al. [2018](#)). Similar behavior has also been observed in the gamma-ray binary PSR B1259-63 (hereafter B1259, Chernyakova et al. [2015](#)). In addition, a continued increase in TeV gamma-ray emission of J2032 was detected during this period (Mirzoyan & Mukherjee [2017](#)).



Zoom In  Zoom Out

Reset image size

**Figure 1.** Top: H $\alpha$  (purple squares) and He I 5875 Å (blue circles) EWs evolution during our campaign. Stars and triangles show the H $\alpha$  EWs reported by Ho et al. (2017) and Li et al. (2017), respectively. Middle: *Swift*/XRT light-curve. Bottom left: H $\alpha$  line-profile evolution. Labels show the different campaign stages indicated in the top panel. Bottom right: He I 5875 Å line-profile evolution with previous labels (Na I D doublet is plotted in gray). Vertical red lines indicate periastron passage.

Download figure:

 Standard image High-resolution image Export PowerPoint slide

The aim of our campaign was to study the J2032 optical behavior toward periastron. We used the 2.1 m telescope at Observatorio Astronómico Nacional, Sierra San Pedro Mártir (OAN-SPM, Mexico), with the Boller & Chivens spectrograph (resolution of  $R \sim 1200$ ) in the 5400–6600 Å range. Our monitoring spanned from 2017 September to November, and consisted of four epochs with a length of three nights each run. The cadence corresponded to one run every month, except in November where two epochs were obtained to get better coverage of the periastron and post-periastron activity. Standard spectroscopic data reduction was performed using IRAF<sup>3</sup> tasks and flux calibration was carried out using the BD+28 4211 standard star (Oke 1990).

Here we report on the results of our J2032 monitoring. Our campaign epochs ("A" to "D" in Figure 1) showed an evolution in the H $\alpha$  and He I 5875 Å emission-line profiles. The double-peak H $\alpha$  profile became a single-peak line in the blue part of the line with a broader wing in the red part after the periastron (Figure 1, bottom left panel). While the full width half maximum (FWHM) of the blue part of the H $\alpha$  line slightly varied from  $\sim 200$  to  $\sim 225$  km s<sup>-1</sup>, the FWHM of the red part decreased from  $\sim 300$  to  $\sim 225$  km s<sup>-1</sup> in 3 months. In the case of He I 5875, the line's profile not only changed from three-peak to double-peak like, but also the normalized flux declined with the proximity of the periastron passage (Figure 1, bottom right panel). All these changes contributed to the evolution in the equivalent widths (EWs) of both H $\alpha$  and He I 5875 (Figure 1, top panel). The H $\alpha$  EWs decreased from  $\sim 10$  to  $\sim 6$  Å (consistent with the EW evolution reported by Kolka et al. 2017) while He I 5875 Å EWs from  $\sim 1.35$  to  $\sim 0.3$  Å. We calculated the change of the circumstellar decretion-disk size using Equation (1) in Ho et al. (2017), which relates the decretion disk and stellar radii ( $R_{\text{OB}}$ ) to the H $\alpha$  EW. The decretion disk shrank from  $\sim 90$  to  $\sim 60 R_{\text{OB}}$  during our monitoring.

The detection of the H $\alpha$  and He emission lines confirm the presence of a decretion disk around the companion star during our monitoring. The line-profile variations and EW values indicate that global changes were occurring in the disk. In particular, the decrease in EWs indicates a disk-size reduction while the neutron star was approaching its periastron. However, we cannot conclude that the shrinking of the disk was exclusively driven by the neutron-star influence as other factors (e.g., stellar activity or an asymmetric disk structure) may also play important roles in the system's evolution (Reig 2011). Additionally, the optical behavior of J2032 during periastron is completely opposite to that of B1259 (Chernyakova et al. 2015), despite their similar

X-ray behavior.

Observations obtained at OAN-SPM and using the Neil Gehrels *Swift* observatory. J.E. is indebted to DGAPA (UNAM) for financial support, PAPIIT project IN114917.

## Footnotes

- 3 Distributed by the National Optical Observatories, operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the NSF.

## References

- Abdo A. A., Ackermann M., Ajello M. *et al* 2009 *ApJS* **183** 46  
[IOPscience](#)   [ADS](#)   [Google Scholar](#)
- Camilo F., Ray P. S., Ransom S. M. *et al* 2009 *ApJ* **705** 1  
[IOPscience](#)   [ADS](#)   [Google Scholar](#)
- Chernyakova M., Neronov A., van Soelen B. *et al* 2015 *MNRAS* **454** 1358  
[Crossref](#)   [ADS](#)   [Google Scholar](#)
- Ho W. C. G., Ng C.-Y., Lyne A. G. *et al* 2017 *MNRAS* **464** 1211  
[Crossref](#)   [ADS](#)   [Google Scholar](#)
- Kolka I., Eenmäe T., Laur J. and Aret A. 2017 *RNAAS* **1** 37  
[ADS](#)   [Google Scholar](#)
- Li K. L., Kong A. K. H., Tam P. H. T. *et al* 2017 *ApJ* **843** 85  
[IOPscience](#)   [ADS](#)   [Google Scholar](#)
- Li K. L., Takata J., Ng C. W. *et al* 2018 *ApJ* **857** 123  
[IOPscience](#)   [ADS](#)   [Google Scholar](#)
- Lyne A. G., Stappers B. W., Keith M. J. *et al* 2015 *MNRAS* **451** 581  
[Crossref](#)   [ADS](#)   [Google Scholar](#)
- Mirzoyan R. and Mukherjee R. 2017 *ATel* **10971**  
[ADS](#)   [Google Scholar](#)
- Oke J. B. 1990 *AJ* **99** 1621  
[Crossref](#)   [ADS](#)   [Google Scholar](#)
- Reig P. 2011 *Ap&SS* **332** 1

[Crossref](#)

[ADS](#)

[Google Scholar](#)

Export references:

[BibTeX](#)

[RIS](#)

[Journals](#)

[Books](#)

[About IOPscience](#)

[Contact us](#)

[Developing countries access](#)

[IOP Publishing open access policy](#)

© Copyright 2020 IOP Publishing

[Terms & conditions](#)

[Disclaimer](#)

[Privacy & cookie policy](#)

This site uses cookies. By continuing to use this site you agree to our use of cookies.