Gaia18aen

First symbiotic star discovered by Gaia

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Symbiotic binaries
Introduction

- strongly **interacting binaries**
  - among the **widest** interacting systems
  - **open** binaries
- consist of a **cool giant** and **hot compact star**, mostly a white dwarf
  - circumbinary envelope
  - mass transfer via stellar wind or Roche lobe overflow

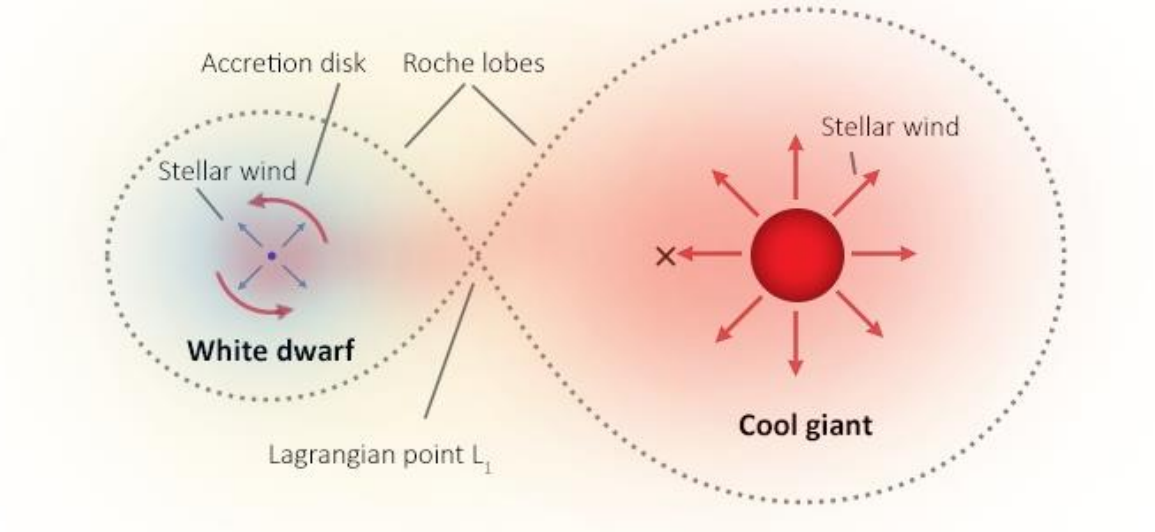

Figure: Simplified model of a symbiotic binary.

References:
Kenyon, 1986, The Symbiotic Stars
ISBN: 978-0521093316
Mikołajewska, 2012, Baltic Astronomy
doi: 10.1515/astro-2017-0352
Munari, 2019, Review in The Impact of Binary Stars on Stellar Evolution
arXiv:1909.01389
Merc et al., 2019, Astronomische Nachrichten
doi: 10.1002/asna.201913662

Symbiotic binaries
Importance

- unique **astrophysical laboratories**
  - **stellar interaction** – mass transfer, accretion processes
  - stellar **winds** and their collision
  - formation and collimation of **jets**
  - **dust formation** and destruction
  - thermonuclear **outbursts**

- important in study of **stellar evolution**
  - **evolution** of binaries
  - possible **supernovae Ia** progenitors

References:
Kenyon, 1986, The Symbiotic Stars
ISBN: 978-0521093316
Mikołajewska, 2013, Proceedings of the International Astronomical Union
doi: 10.1017/S1743921312014925
Iłkiewicz et al., 2019, Monthly Notices of the Royal Astronomical Society
doi: 10.1093/mnras/stz760

Gaia18aen
Introduction

- at the beginning of 2018, *Gaia* detected the **brightening of Gaia18aen**
  - announced by the **Gaia Science Alert** on January 17, 2018 (Delgado et al., 2018)
  - referred to as a „**bright emission-line star** in Galactic plane which brightened by 1 magnitude“
  - previously classified as an emission line star (Wray, 1966)
- soon classified as a **‘nova?’** (Kruszyńska et al., 2018)
  - spectrum obtained by VLT/X-Shooter

References:
Merc, Mikołajewska, Gromadzki et al., 2020, Astronomy & Astrophysics
doi: 10.1051/0004-6361/202039132
Delgado et al., 2018,
Transient Name Server Discovery Report 84
Kruszyńska et al., 2018,
The Astronomer’s Telegram 11634
Wray, 1966, PhD thesis

Gaia18aen
Observational data

- low-resolution spectroscopic observation using the **Liverpool Telescope** at La Palma (PI: Hodgkin)
- medium-resolution spectrum from **VLT/Xshooter** (PI: Wyrzykowski)
- photometry from ***Gaia***, and the **follow-up network**
  - LCO 0.4-m, PROMPT 0.6-m, Terskol 0.6-m, and PIRATE robotic telescope
  - calibrated using the **Cambridge Photometric Calibration Server**
- ASAS-SN, OGLE IV, ATLAS, Bochum Survey of the Southern Galactic Disk

References:
Merc, Mikołajewska, Gromadzki et al., 2020, Astronomy & Astrophysics
doi: 10.1051/0004-6361/202039132

Gaia18aen
Symbiotic classification

- spectra satisfy the conditions for the symbiotic classification
  - presence of the **late-type giant**
  - **emission lines** of ions with an ionization potential of **at least 35 eV**
  - emission lines of **Raman-scattered OVI**

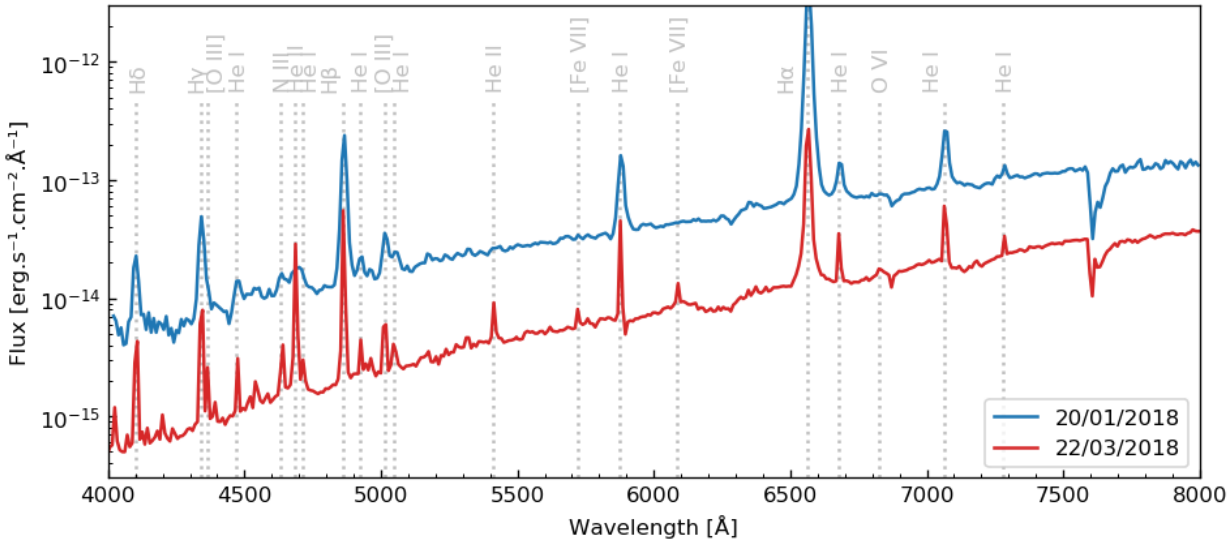

Figure: The optical spectra of Gaia18aen.

References:
Merc, Mikołajewska, Gromadzki et al., 2020, Astronomy & Astrophysics
doi: 10.1051/0004-6361/202039132

Gaia18aen
Photometric behavior

- **series** of outbursts in 2018
  - **0.5 – 3.3 mag**
  - amplitude and their duration resemble the behavior of typical **classical symbiotic stars**
  - **no brightening** detected before (2010 – 2018)
  - now in **quiescence**

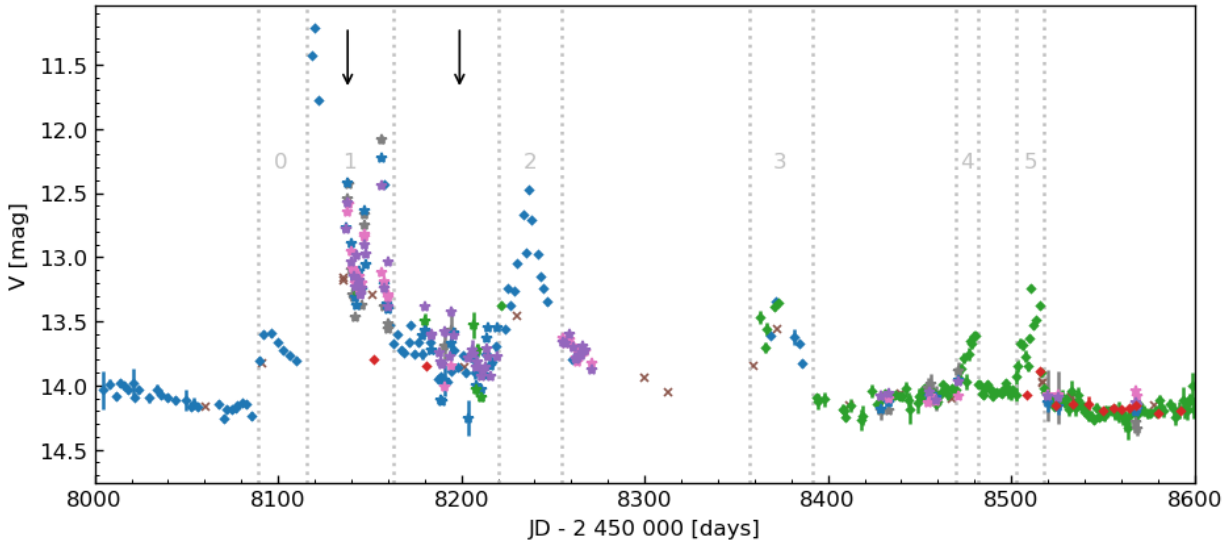

Figure: The light curve of Gaia18aen.

References:
Merc, Mikołajewska, Gromadzki et al., 2020, Astronomy & Astrophysics
doi: 10.1051/0004-6361/202039132

Gaia18aen
Photometric behavior

- **several minima** in quiescent light curves
- tentative **orbital period of 487 d**
- red giant might be **filling the Roche lobe**
- large scatter may be due to **short-term variations** (50 – 200 d)

References:
Merc, Mikołajewska, Gromadzki et al., 2020, Astronomy & Astrophysics
doi: 10.1051/0004-6361/202039132

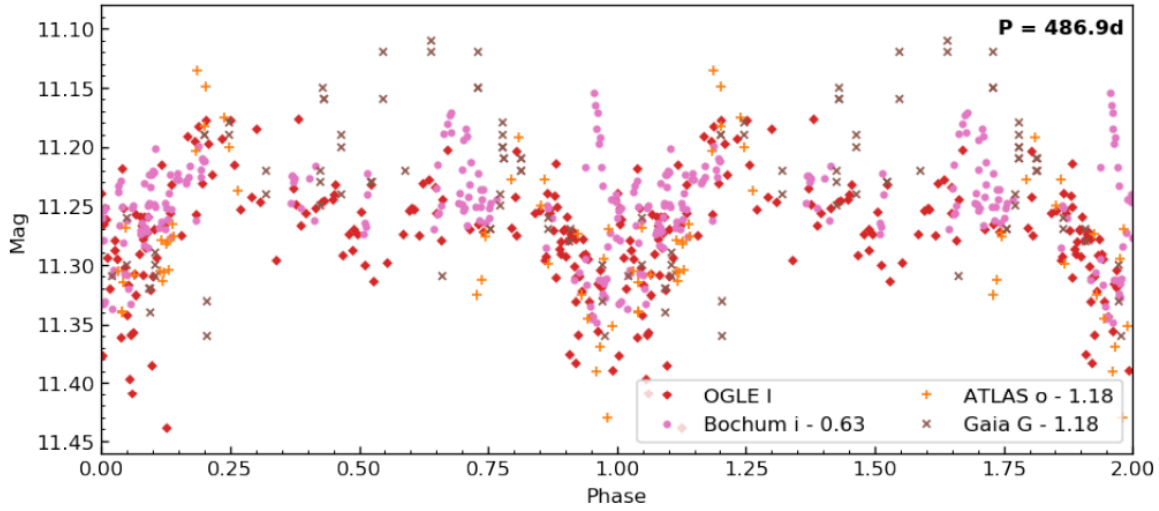

Figure: Light curves in selected filters phased with the period of P = 486.9 days.

Gaia18aen
Cool giant

References:
Merc, Mikołajewska, Gromadzki et al., 2020, Astronomy & Astrophysics
doi: 10.1051/0004-6361/202039132

- VLT/X-Shooter spectrum of Gaia18aen was used to derive **atmospheric parameters**
  - **T_{eff} = 3500 K**, log *g* = 0.0, [Fe/H] = 0.25
  - for d ~ 6 kpc: R ~ 230 $R_{\odot}$, **L ~ 7400 $L_{\odot}$**
  - one of the **brightest symbiotic giants**

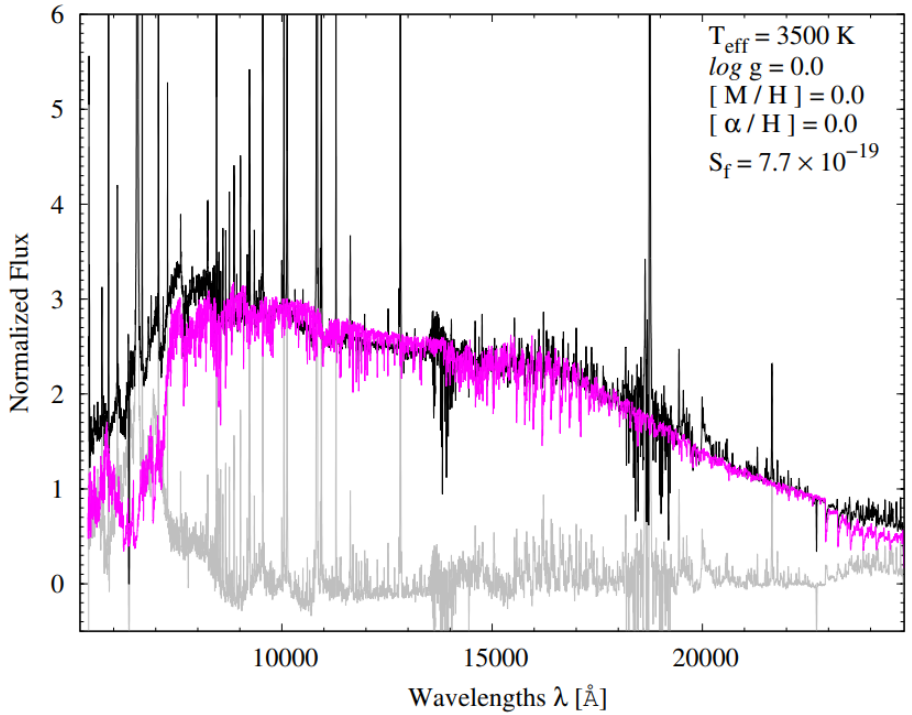

Figure: Comparison of the VLT/X-Shooter spectrum and the synthetic model.

Conclusions

Thank you for your attention.

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- Gaia18aen experienced an **outburst of 3.3 mag in 2018,** followed by several rebrightenings
- outburst was accompanied by changes in **emission spectral lines** typical for classical symbiotic stars
- the cool component is an **M giant**, one of the **brightest symbiotic giants**
- near IR spectrum and IR photometry consistent with a non-dusty **S-type symbiotic system**
- Gaia18aen is a **first** classical symbiotic star discovered by ***Gaia*** **satellite**