ER UMa - Dwarf Nova persistently switching from positive to negative superhumps?

Polina Zemko Sternberg Astronomical Institute, Lomonosov Moscow State University Sergey Yu. Shugarov, N. Katysheva Sternberg Astronomical Institute Moscow University and O. Antonyuk, D. Samsonov, A. Baklanov, E. Pavlenko, M. Andreev

ER UMa Discovery and peculiarities

Was originally discovered already in 1986
 Showed not only normal outbursts with amplitudes about 2 magnitudes, but superoutbursts, too - SU UMa type star.
 The recurrence time of these superoutbursts – <u>supercycle</u> – was extremely small: 43 d.
 Light-curve modulation, that is supposed to be a

<u>superhumps</u>.

 \checkmark Supposed to show both positive and negative superhumps.

Observations

<u>8 months</u> of CCD observations (25-th of February to 4-th of October 2011)

Crimean Laboratory of SAI and Observatory of Slovak Academy of Sciences

≻ U B V Rc Ic filters

> We used about <u>20 000</u> CCD images obtained by our group, E. Pavlenko (arXiv:1207.2705v1)

and P. Dubowsky http://var2.astro.cz/EN/obslog.p hp?obs_id=1&star=ER%20UMa.







Light-curve



JD

Light-curve



JD

O-C diagram for supercycle

🗸 1995 – 2012 years

✓ Supercycle changes abruptly once in ~1120 days



O-C diagram for supercycle

 ✓ O-C diagram shows that supercycle changes from 38 to 51 days

Possibly connected
 with solar-like magnetic
 activity of the
 secondary component

 According to Y. Osaki
 (Osaki, Y. 1995, PASJ, 47, L11)
 it corresponds to 27,5 %
 change of mass transfer
 rate





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JD







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Light-curves with secondary maxima



Bright spot is deeper in the primaries potential



Bright spot is at the disks rim



Bright spot is deeper in the primaries potential













Light-curves with secondary maxima



Sudden period change

Light-curves with secondary maxima



Sudden period change

Irregular light-curves



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Irregular light-curves



Irregular light-curves



No reliable period

O-C diagram

The mean period
 0.06226 d.



 ✓O-C residuals for secondary maxima lie significantly higher

✓The main trend – sinus (??)



O-C diagram

The mean period
 0.06226 d.



 ✓O-C residuals for secondary maxima lie significantly higher

✓ The main trend – sinus (??)



O-C diagram



O – C diagrams



Zoomed O-C diagram

 Nights with more then 3 peaks observed

2.Linear approximation

3.Line inclination is changing dramatically from night to night

4.Period is changing abruptly

5.The main trend + stepwise period change



Light-curves with secondary maxima



Sudden period change

Light-curves with secondary maxima



Sudden period change

Period determination

✓Used 3 methods:

- 1. Lafler-Kingman
- 2. Furier analysis
- 3. O-C diagram
- Thorstensen et al.
 (1997) P_{orb} =
 0.06366
- Two supercycles folded



Orbital period ER UMa Porb = 0.06366 d., 0,075 Thorstensen et al. (1997) 0,070 0,065 0 Period (d) Ο -0 0 0,060 Ф О 0,055 Ж

Ж

10

20

0,050

0

P_{orb} = **0.06366 d.**,

30

Days of supercycle

Thorstensen et al. (1997)

40

50

Orbital period

P_{orb} = **0.06366 d.**,
 Thorstensen et al.
 (1997)

P_{orb} = 0.06573 d +/o.00005 d. and
o.06549 +/- 0.00003
d.,
Kato T., Kunijaya C.
(1995)



Light-curve

O-C diagram

Period change



Bright spot is deeper in the primaries potential



Superhumps amplitude



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Conclusions

1) Supercycle is not stable -> mass transfer rate changes

- 2) The form of the light-curve is rather complicated especially in the minima of brightness
- 3) In several nights secondary maxima were observed
- 4) The period of the negative superhumps in ER UMa is constantly changing, sometimes abruptly

5) Amplitude of the superhumps increases dramatically at the moments of the superoutbursts

Open questions

- **1**. What is the nature of supercycle change?
- 2. What is the origin of the secondary maxima?
- 3. What is the orbital period?
- 4. Negative superhumps or negative + positive?

Thank you for your attention