Spectroscopic Observations of flare star EV Lac at NHAO

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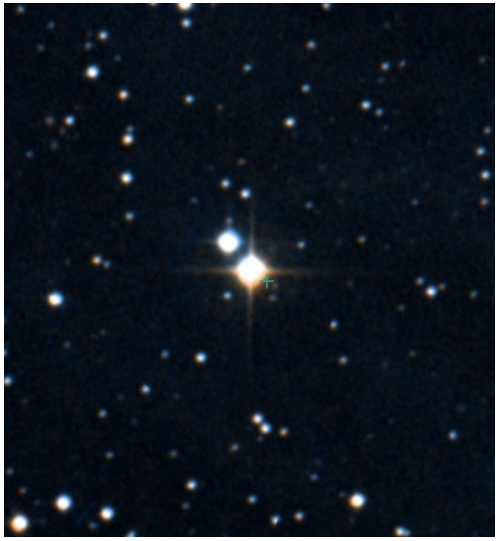
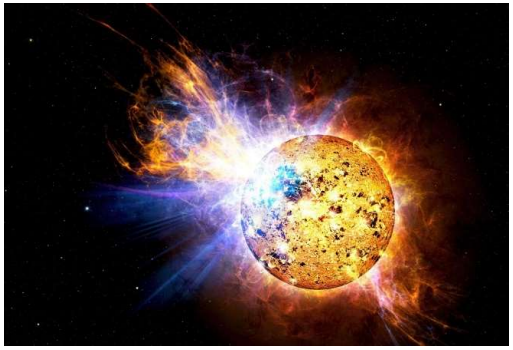
Superflare WS 2016.3.1-4 @ Kyoto

EV Lac (GJ 873)

- M4.5e V, Single flare star
- $R_{\odot}$=0.41, $M_{\odot}$= 0.34 (Sciortino et al. 1999)
- B=~11.45, V=~8.28 , Distance = 5pc, P=4.4days
- 3-4 kG (Shulyak et al. 1997)



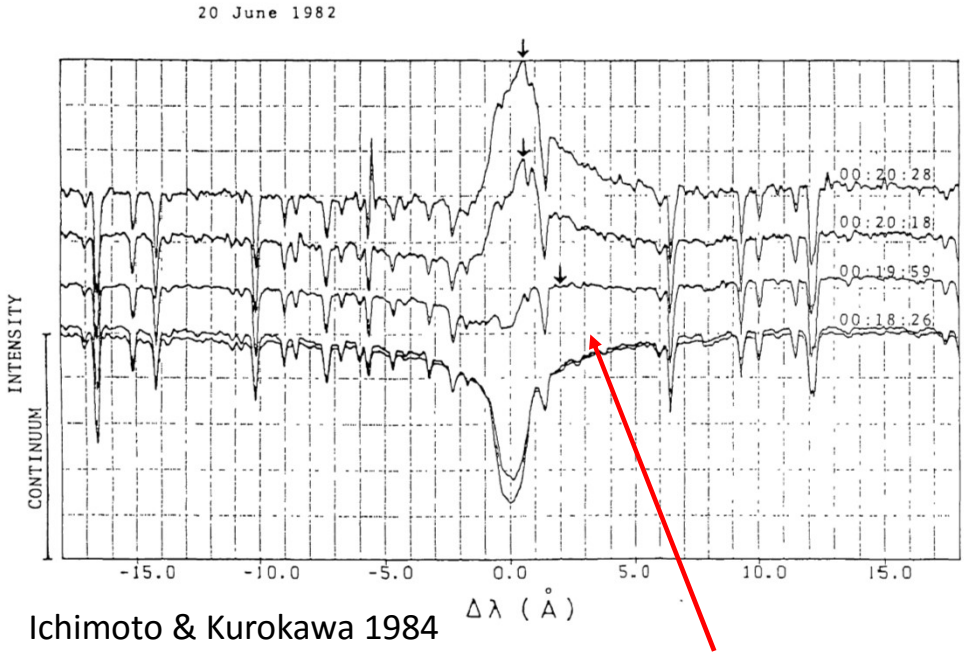
- An extreme X-ray flare observed by ASCA in 1998
  - Favata et al. 2000 A&A
- Detection of a Superflare by Swift in 2008
  - Osten et al. 2008 ATel#1499
- Frequency of the flare : 0.094[events/hours]
  - Schmidt et al. (2012) ApJ



http://www.nasa.gov/multimedia/imagegallery/image_feature_1087.html

Continuous observations of Hα line in flare

Hα asymmetry of the solar flares



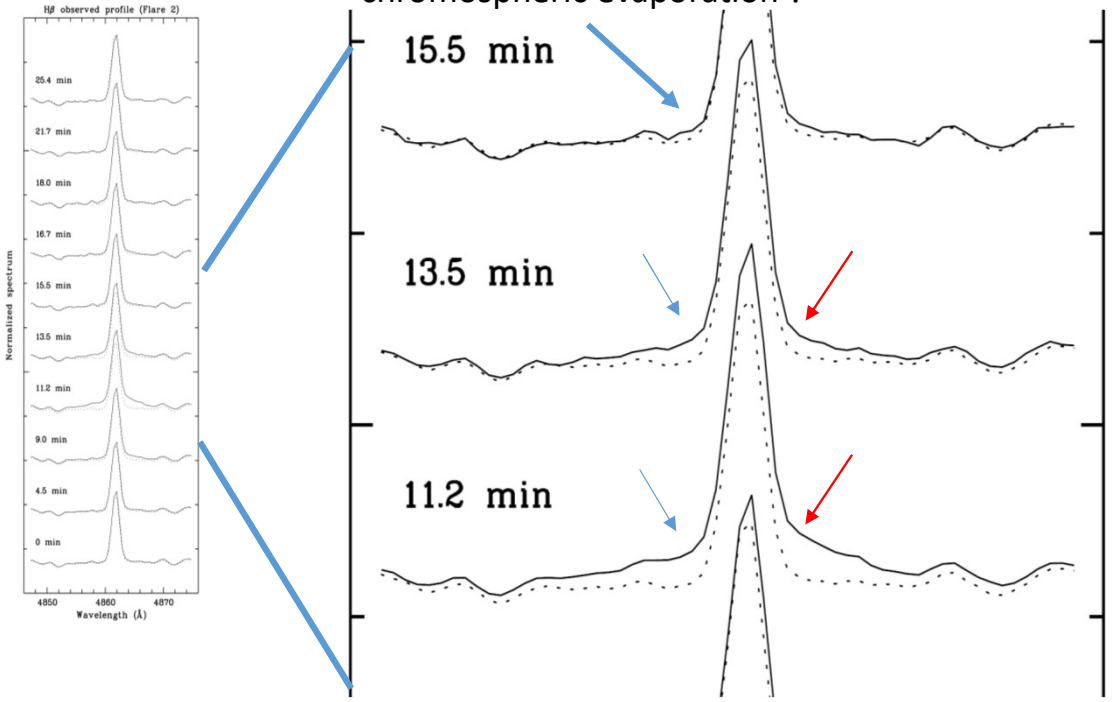
Ichimoto & Kurokawa 1984

chromospheric downward condensations

Hβ asymmetry of stellar (AD Leo) flares

mass ejection ?

chromospheric evaporation ?

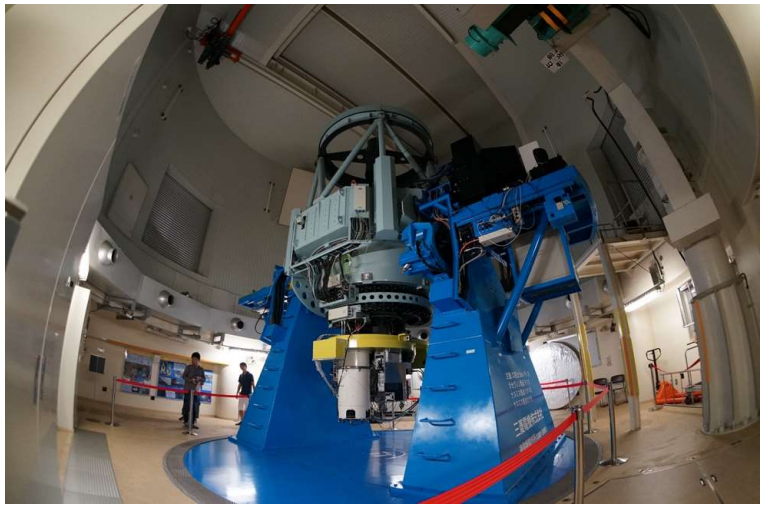


There is not enough spectra of stellar flare.

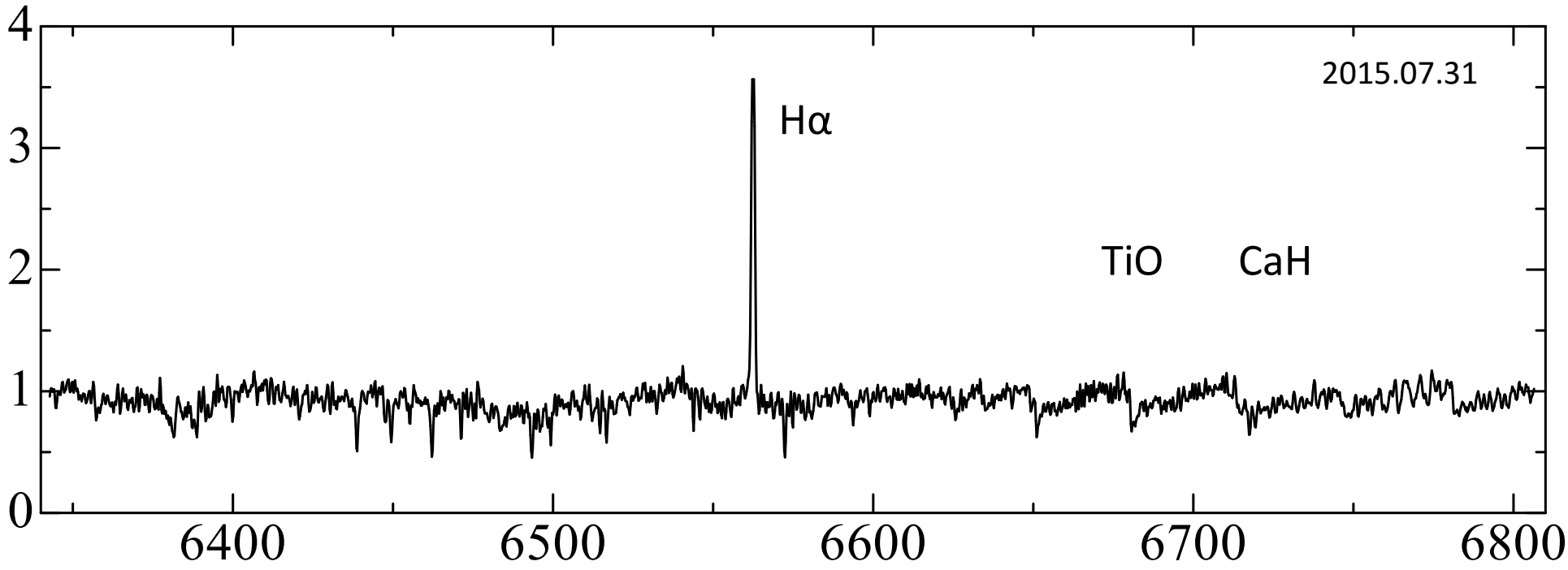
I. Crespo-Chacón et al. 2006

Observations of EV Lac with Nayuta/MALLS

- Nayuta : 2m telescope in NHAO (Univ. of Hyogo)
- MALLS : Medium And Low-dispersion Long-slit Spectrograph
- Resolving power (R) ~ 10,000 @6500A
- Observation period : 2015.7.31 – 12.25 (22nights)
- Exposure time : 3-5 min (x 5-10)
- Spectral coverage : 6350 – 6800A
- S/N = 50~100
- Continuous observations of 4 – 8 hours
  - 8/15, 8/26, 10/2, 10/3, 10/15, 10/16, 10/23
- Total ~850 flames

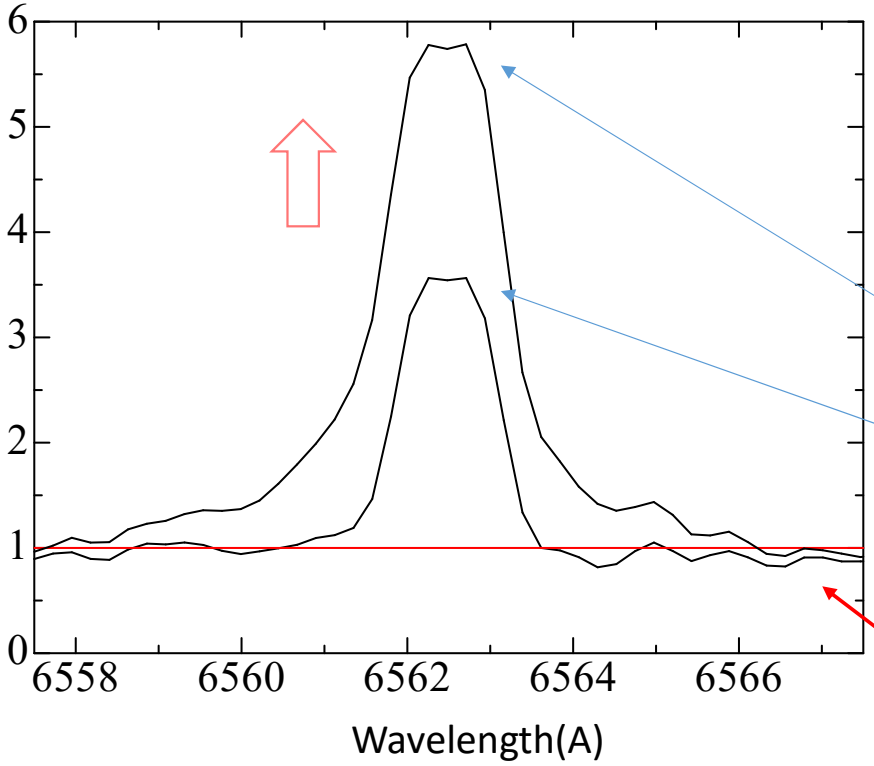


Spectrum of EV Lac (Hα 6563A region)



No Li I (6707A) line

Strength change of Hα emission line two different nights.



A large change of line intensity was seen between 2 weeks. (July31-Aug.15)

Hα equivalent width（EW）of EV Lac.

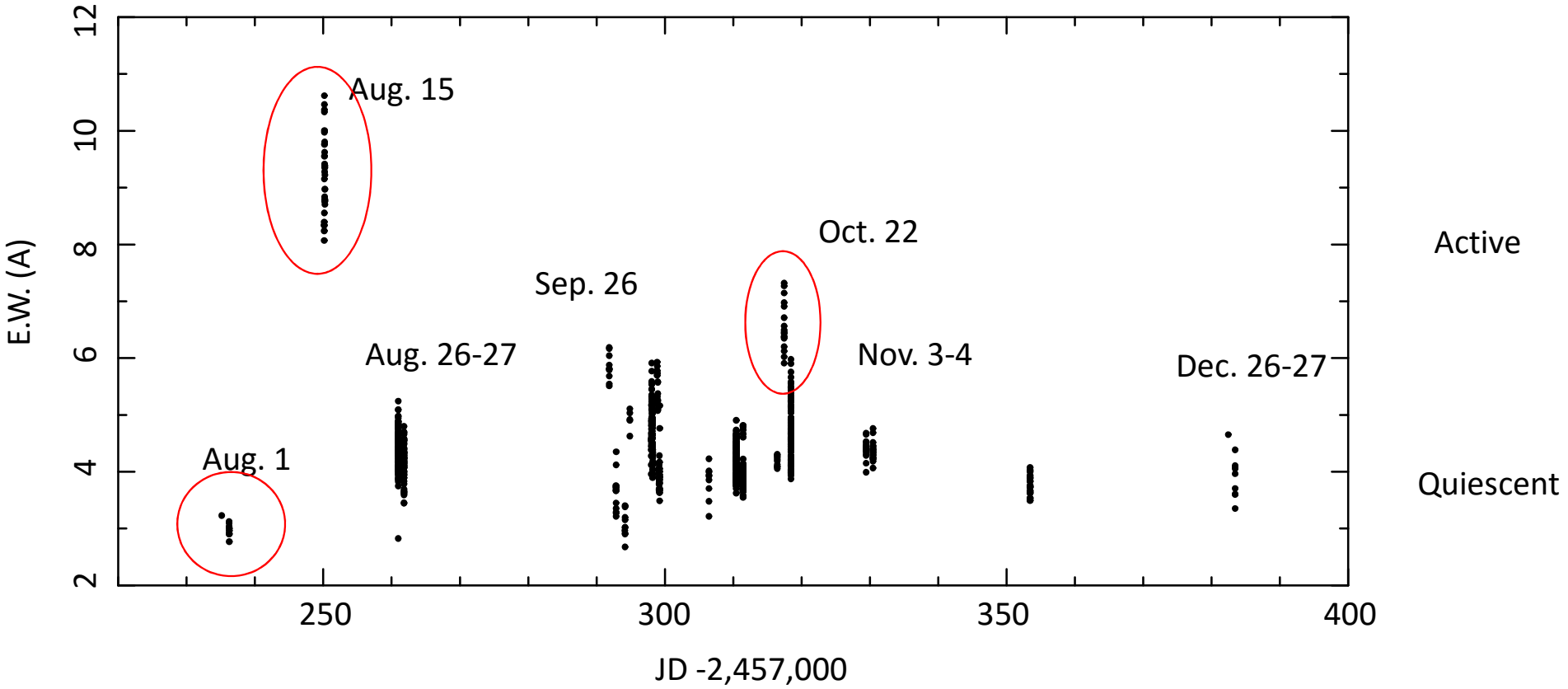
- Quiescent state : 3.5 – 5.3 Å
- Active state : 4.7 – 10.6 Å

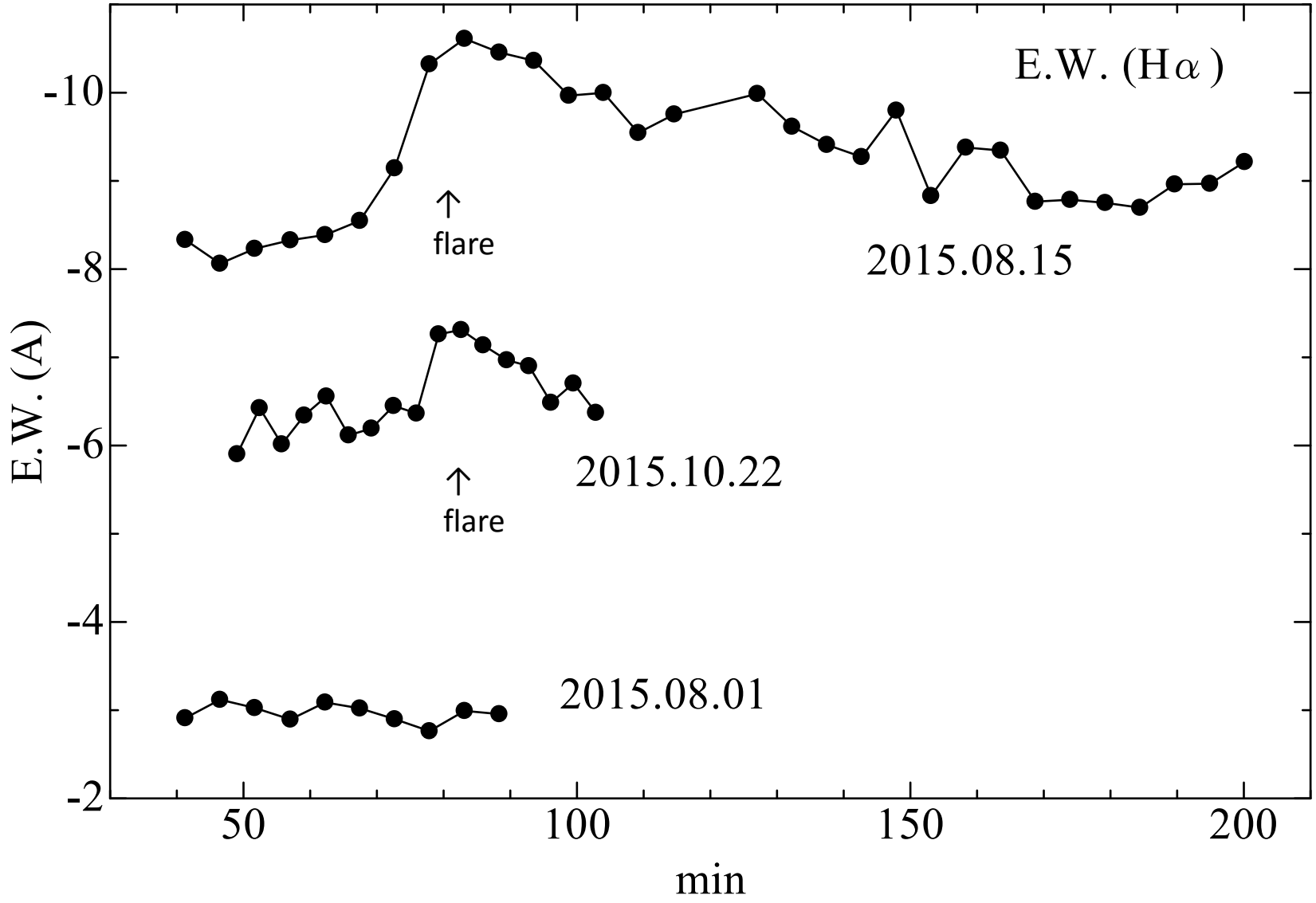
(Baranovski et al. 2001)

2015.08.15. EW ~ 10 Å
2015.07.31. EW ~ 3 Å

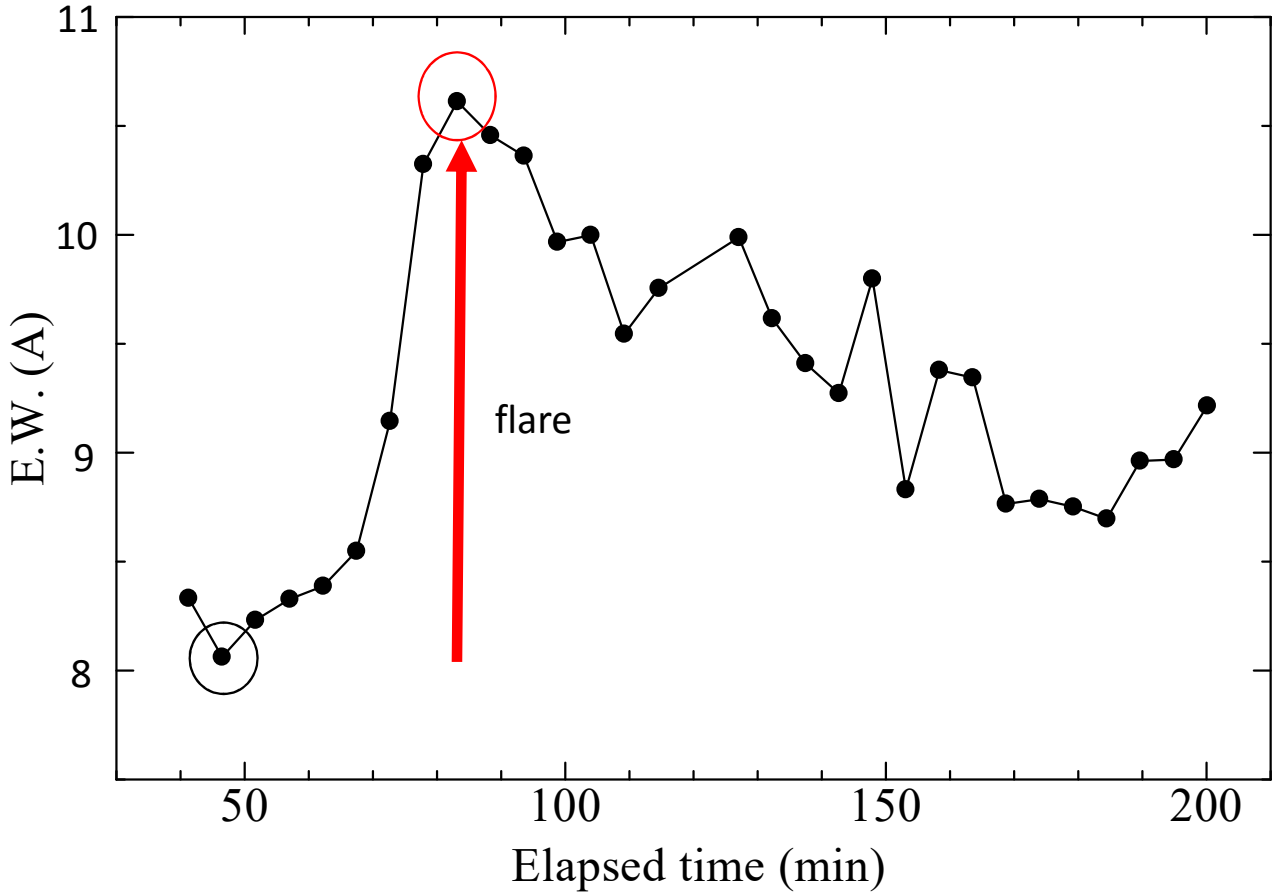
We measured this range as Hα EW.

Temporal evolution of the EW of the Hα line.




E.W. (Hα)
-10
-8
-6
-4
-2
E.W. (A)
flare
2015.08.15
2015.10.22
flare
2015.08.01
50
100
150
200
min

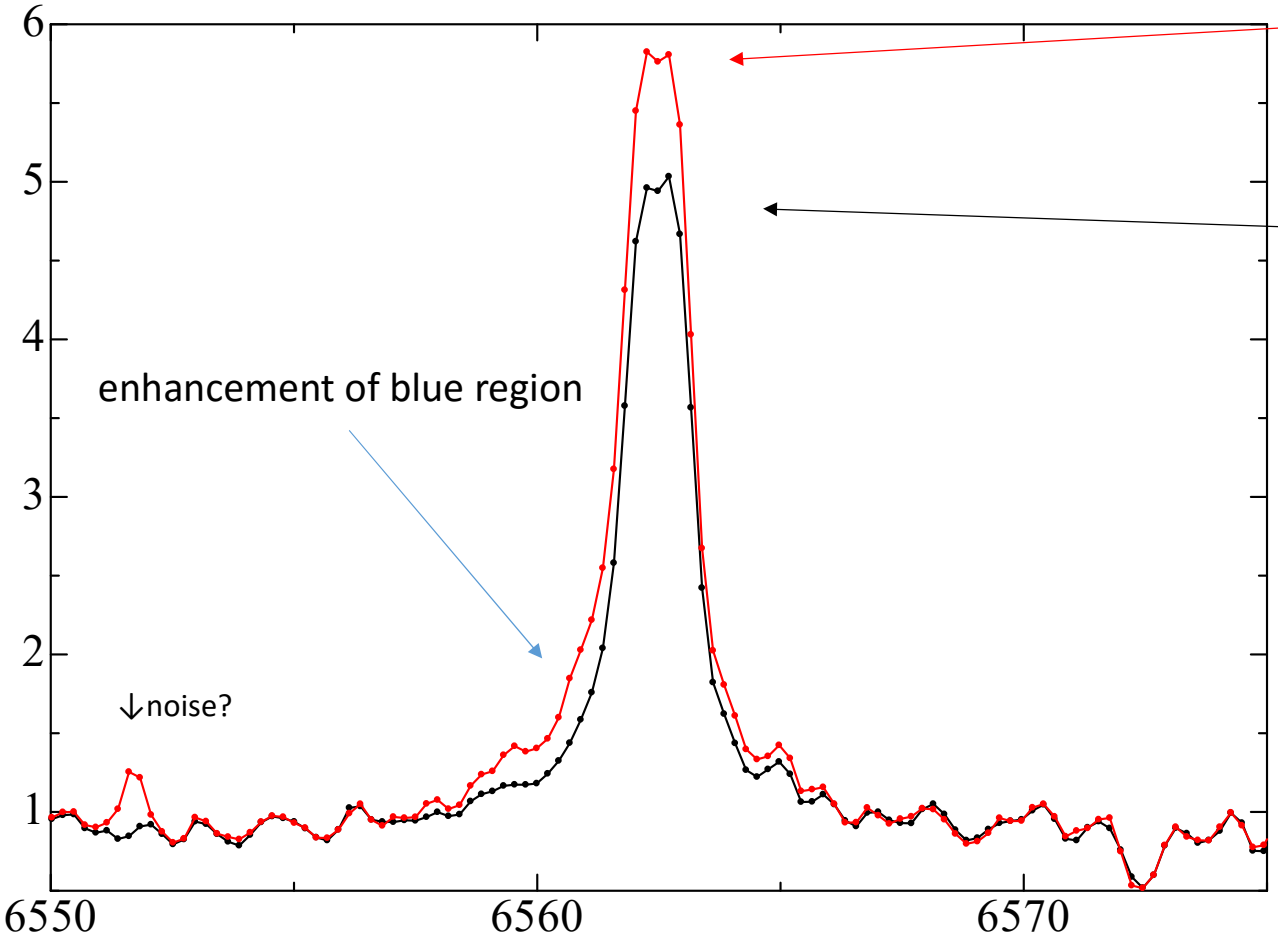
2015.08.15



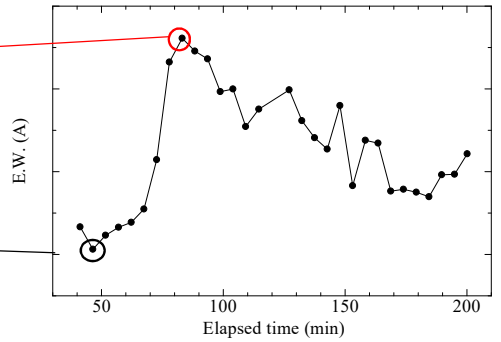
large flare ?

> 2 Å ~ 20 min

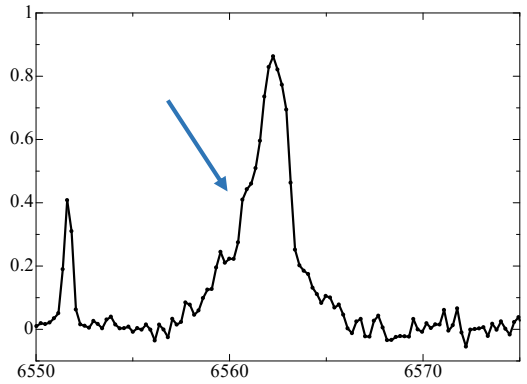
Hα emission line profiles in 2015.08.15

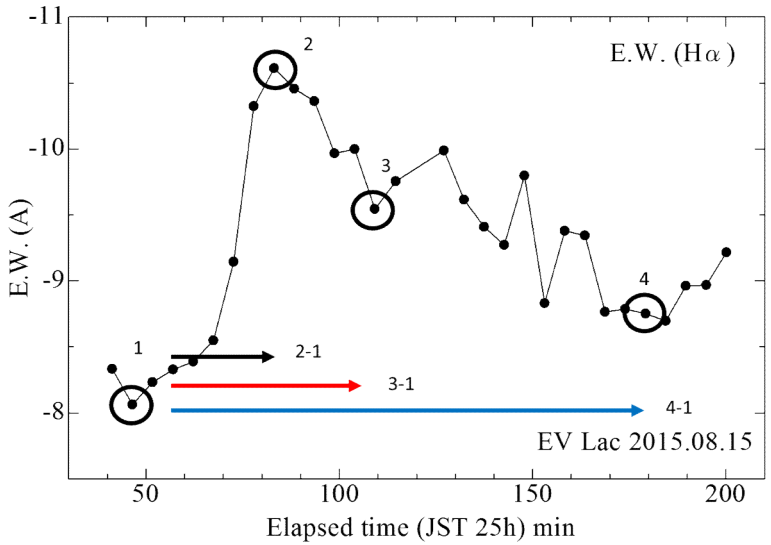


a few 100 km/s ?

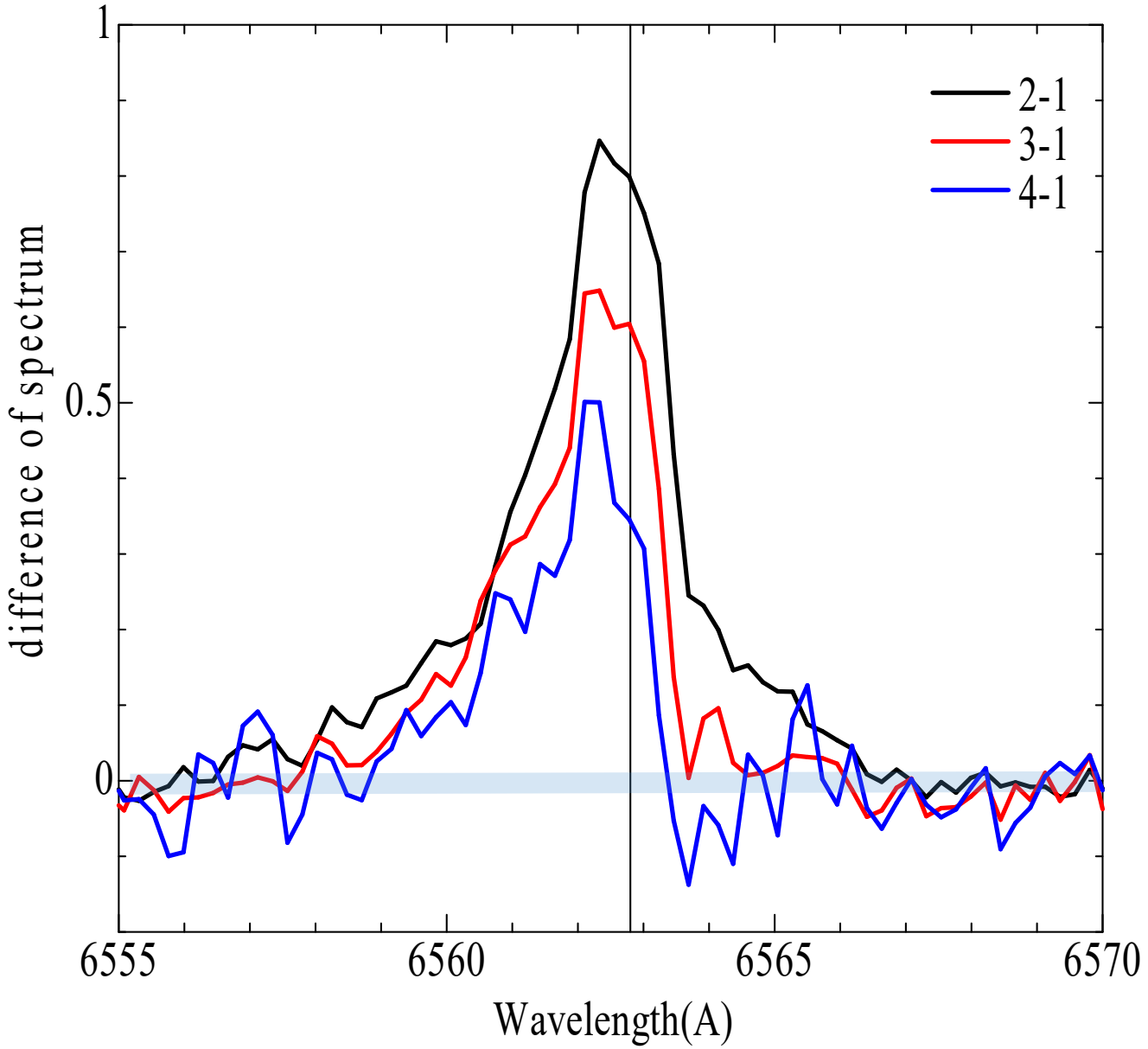


difference of two spectrum



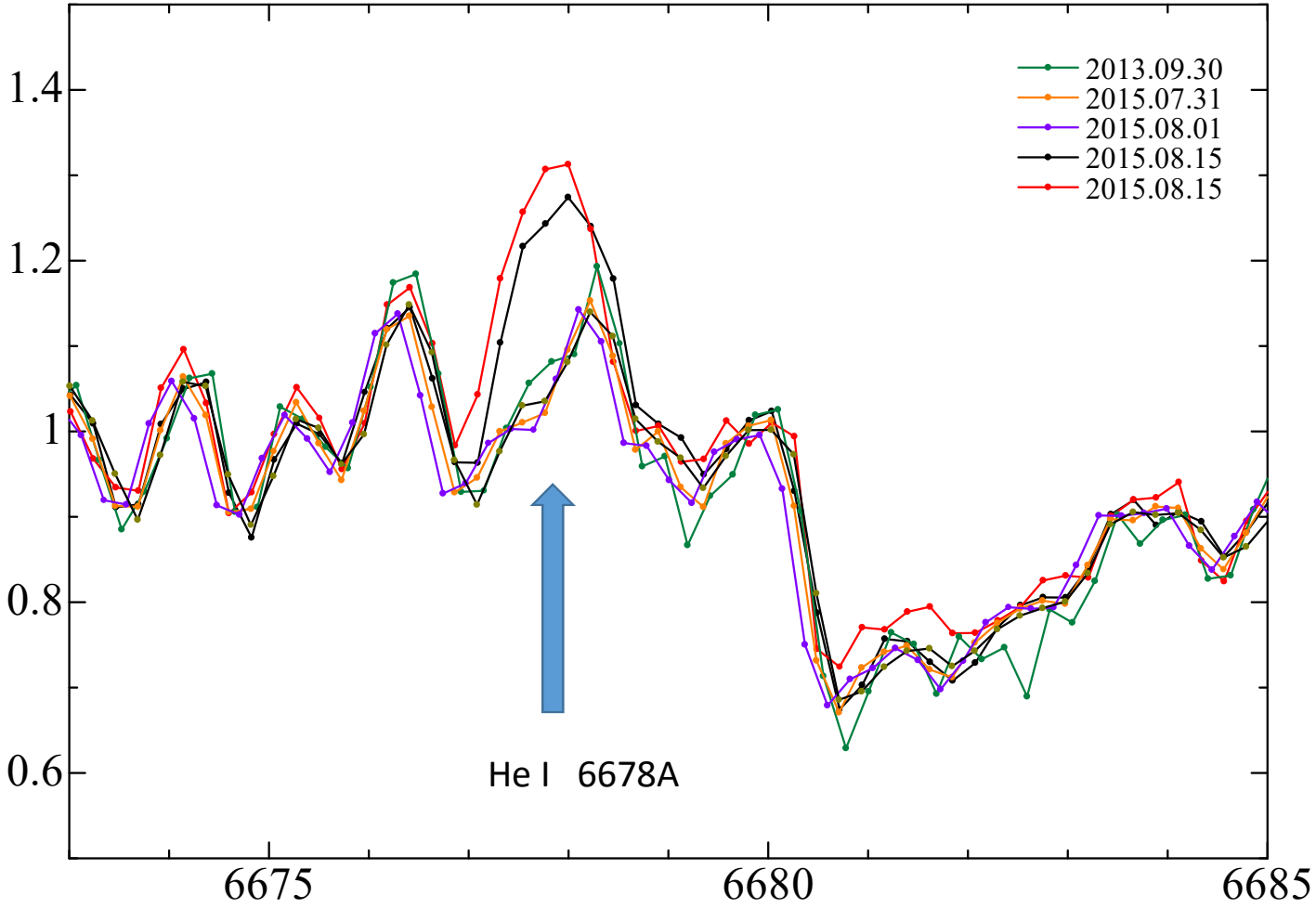


Enhancement of blue component continued 2h~

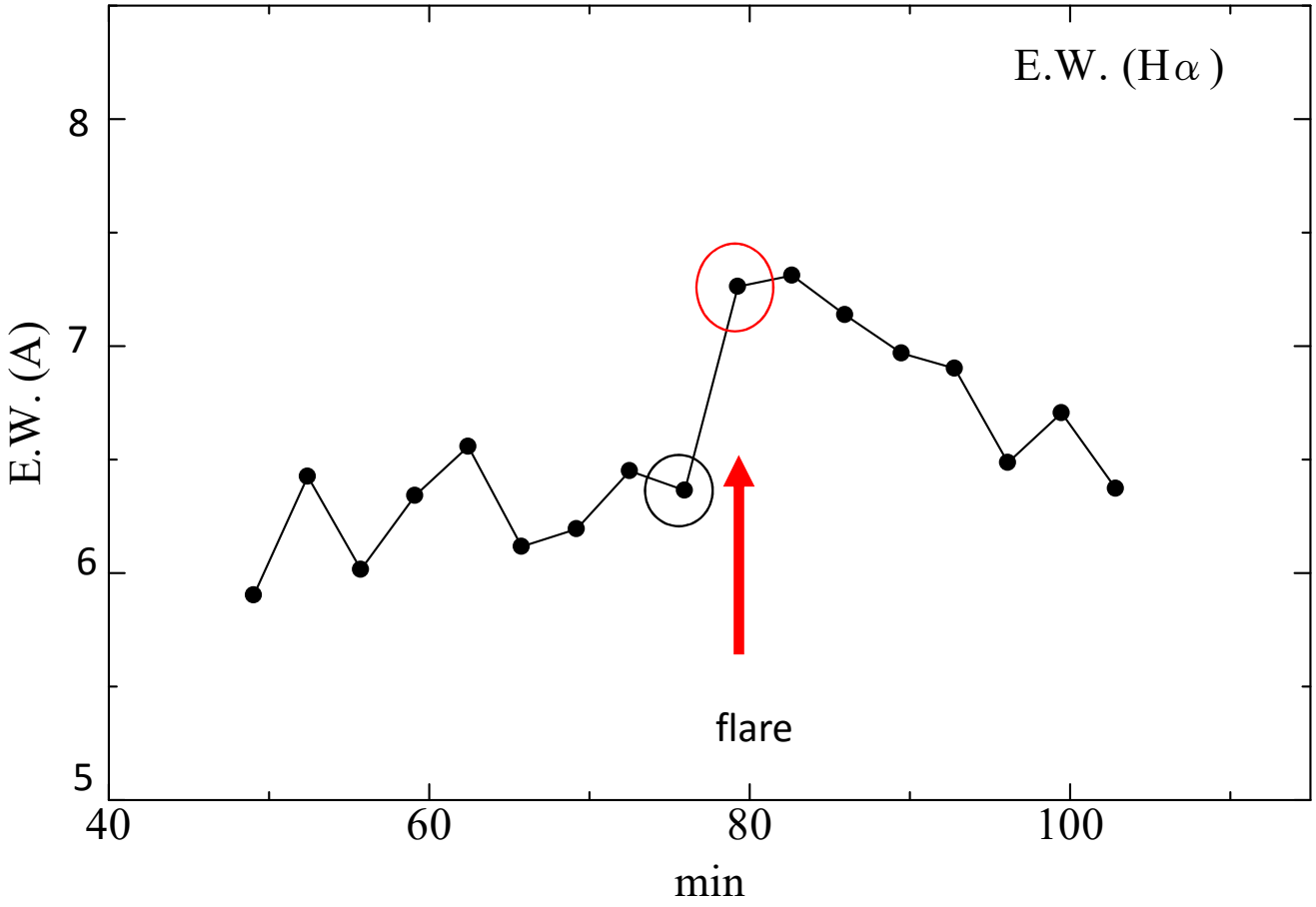


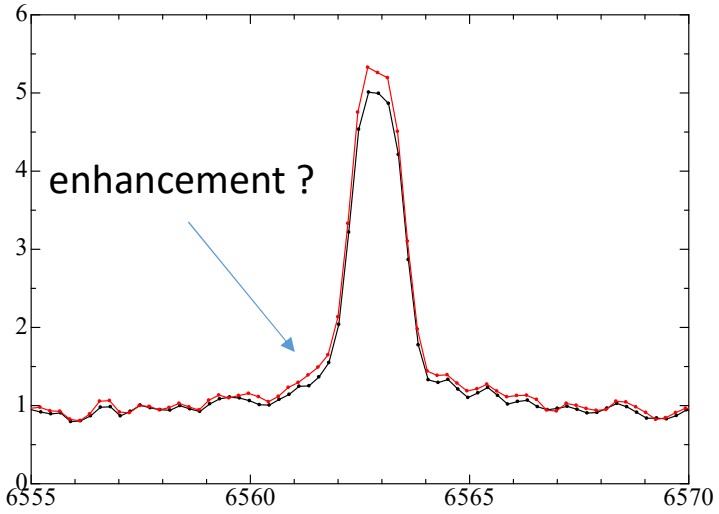
He I

Aug.15 spectrum

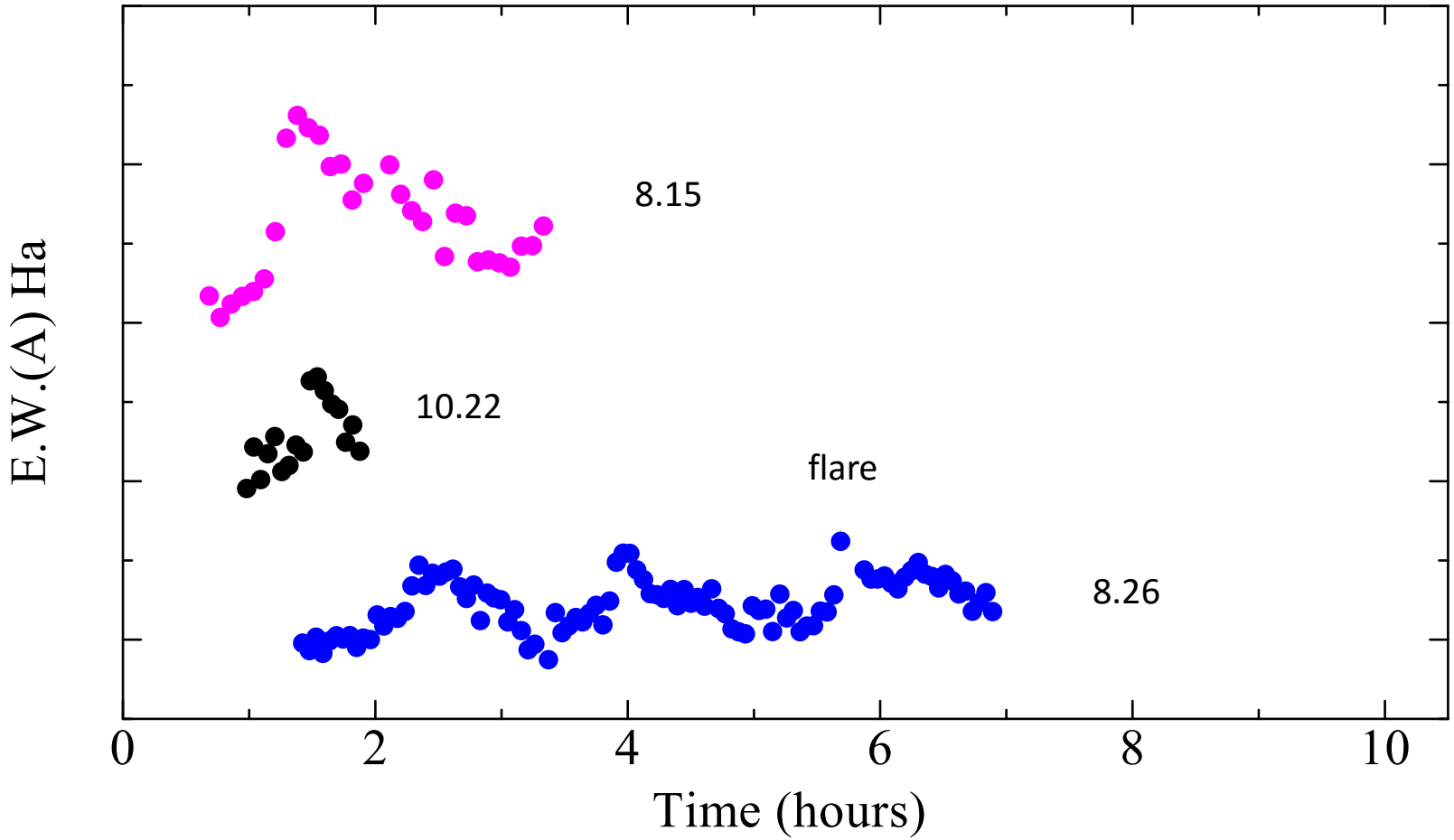


2015.10.22


E.W. (Hα)
E.W. (A)
8
7
6
5
40
60
80
100
min
flare


enhancement ?
6
5
4
3
2
1
0
6555
6560
6565
6570

Temporal evolution of the EW of the Hα line.



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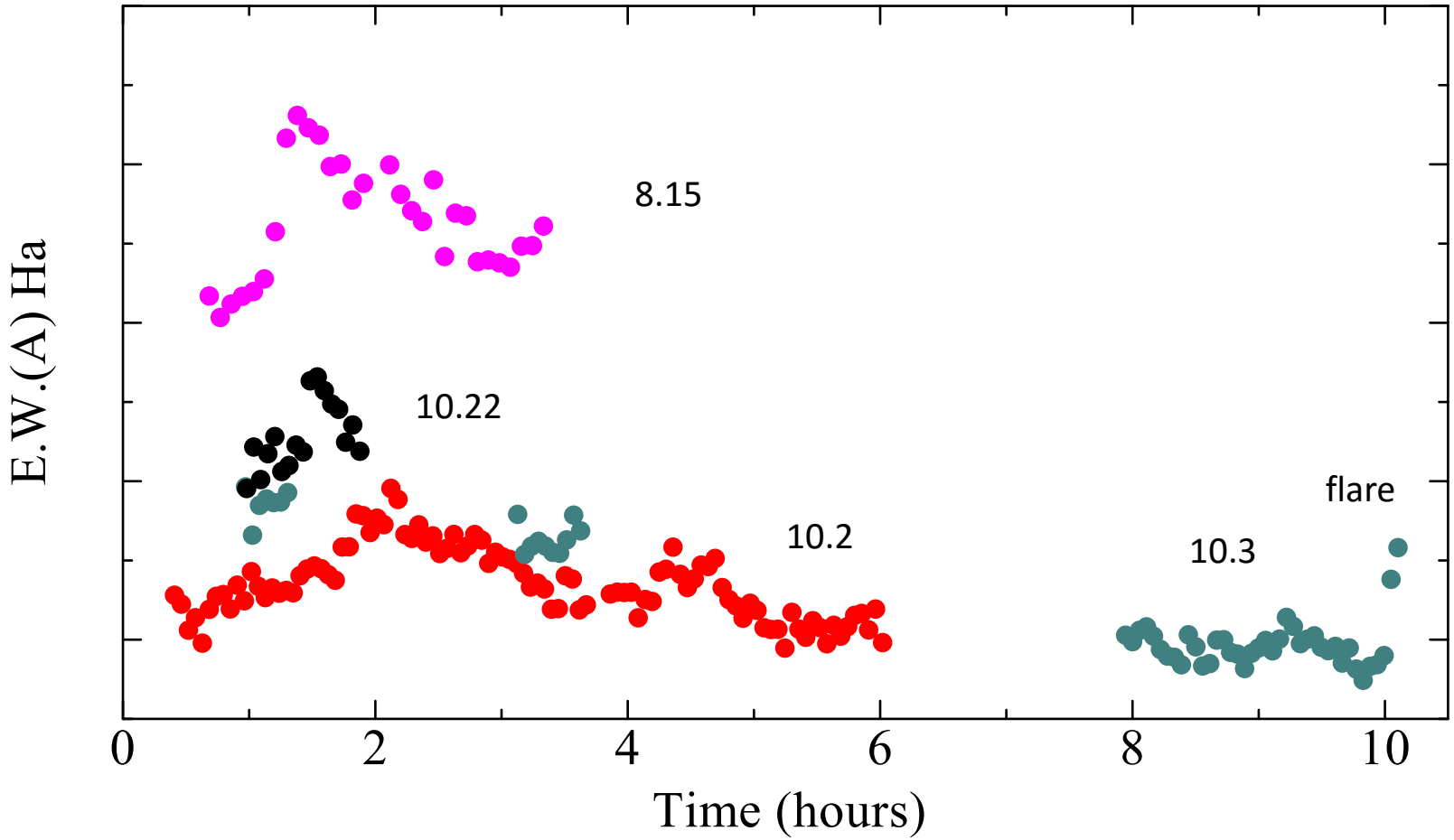

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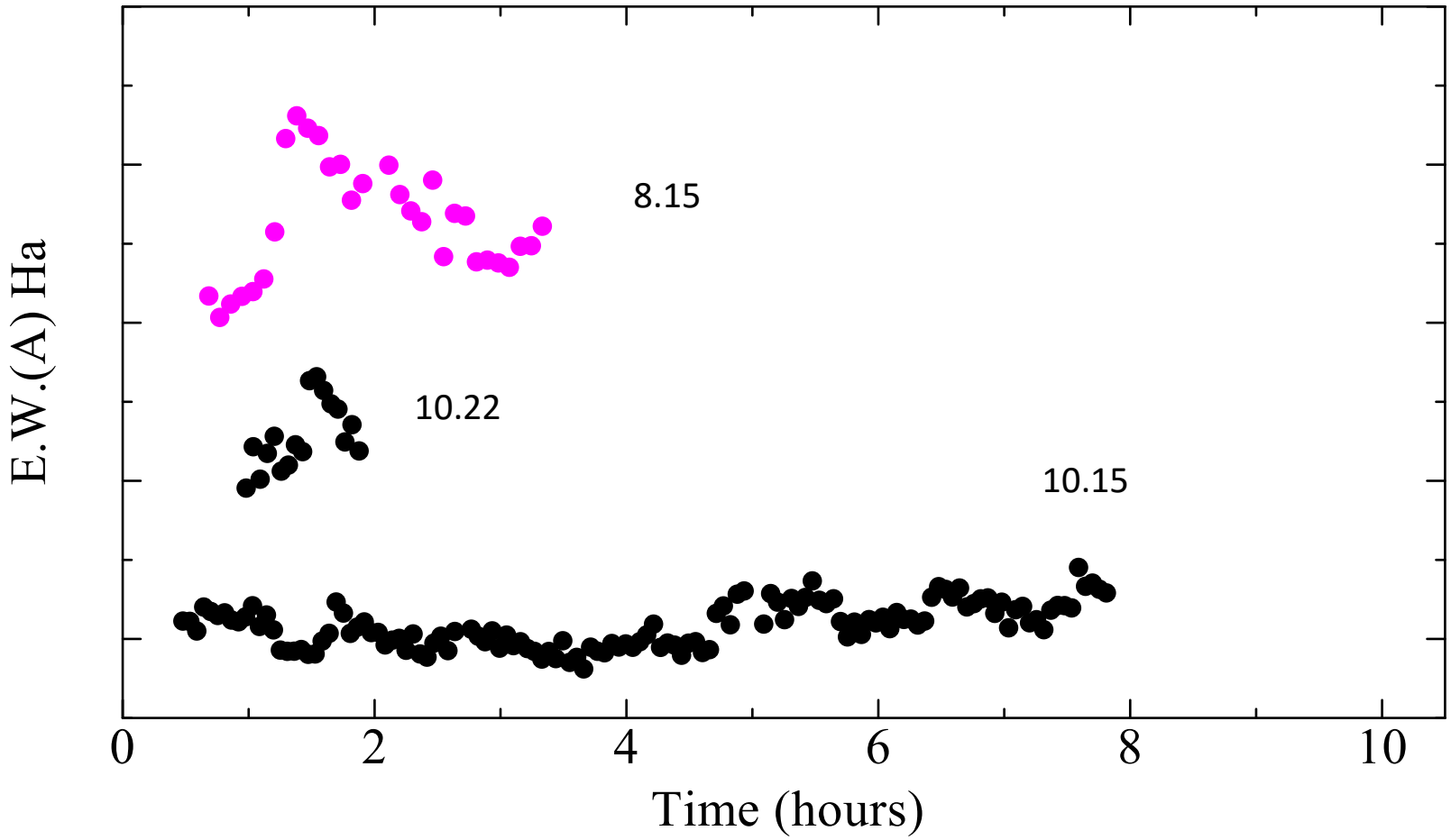

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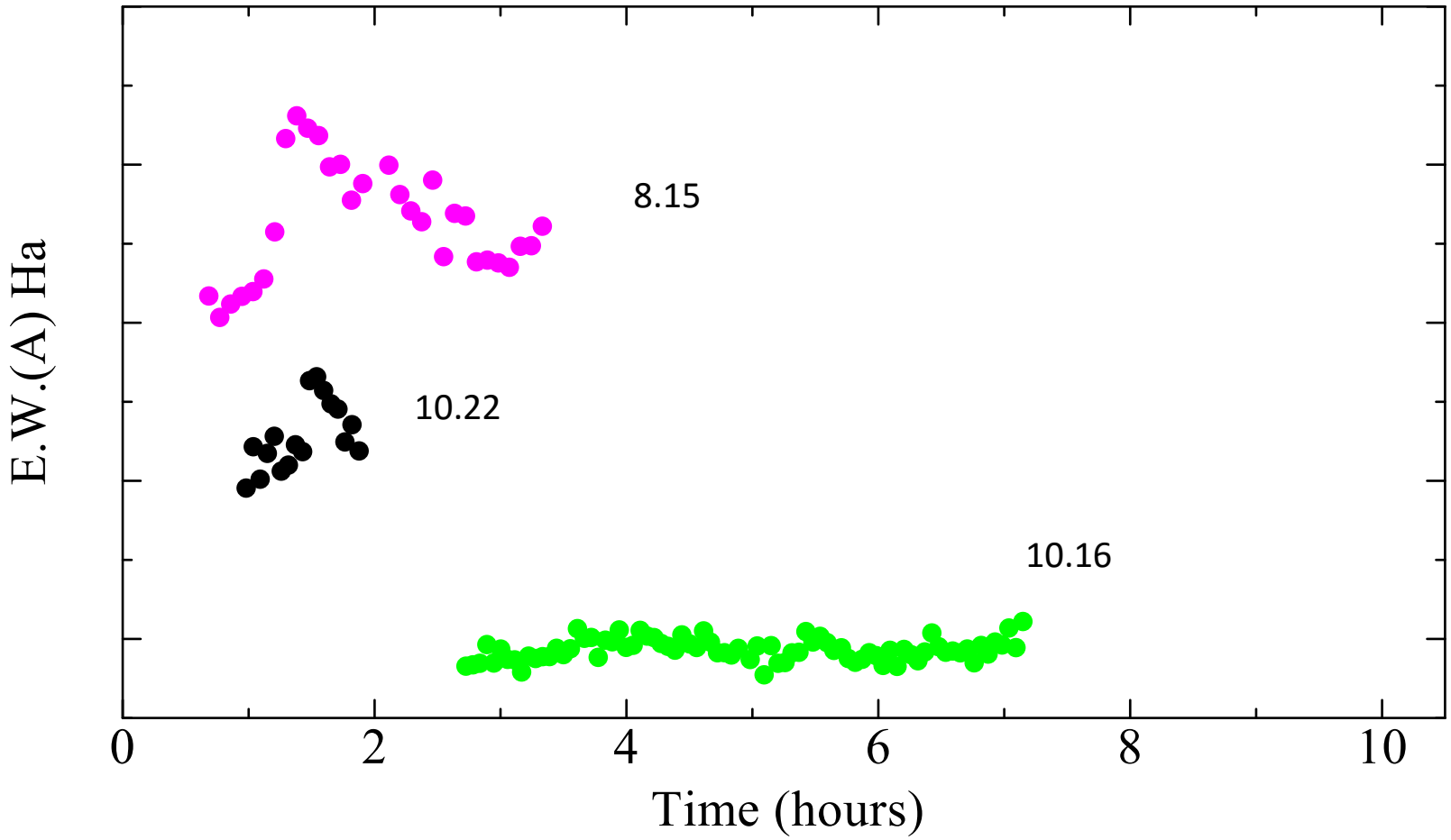

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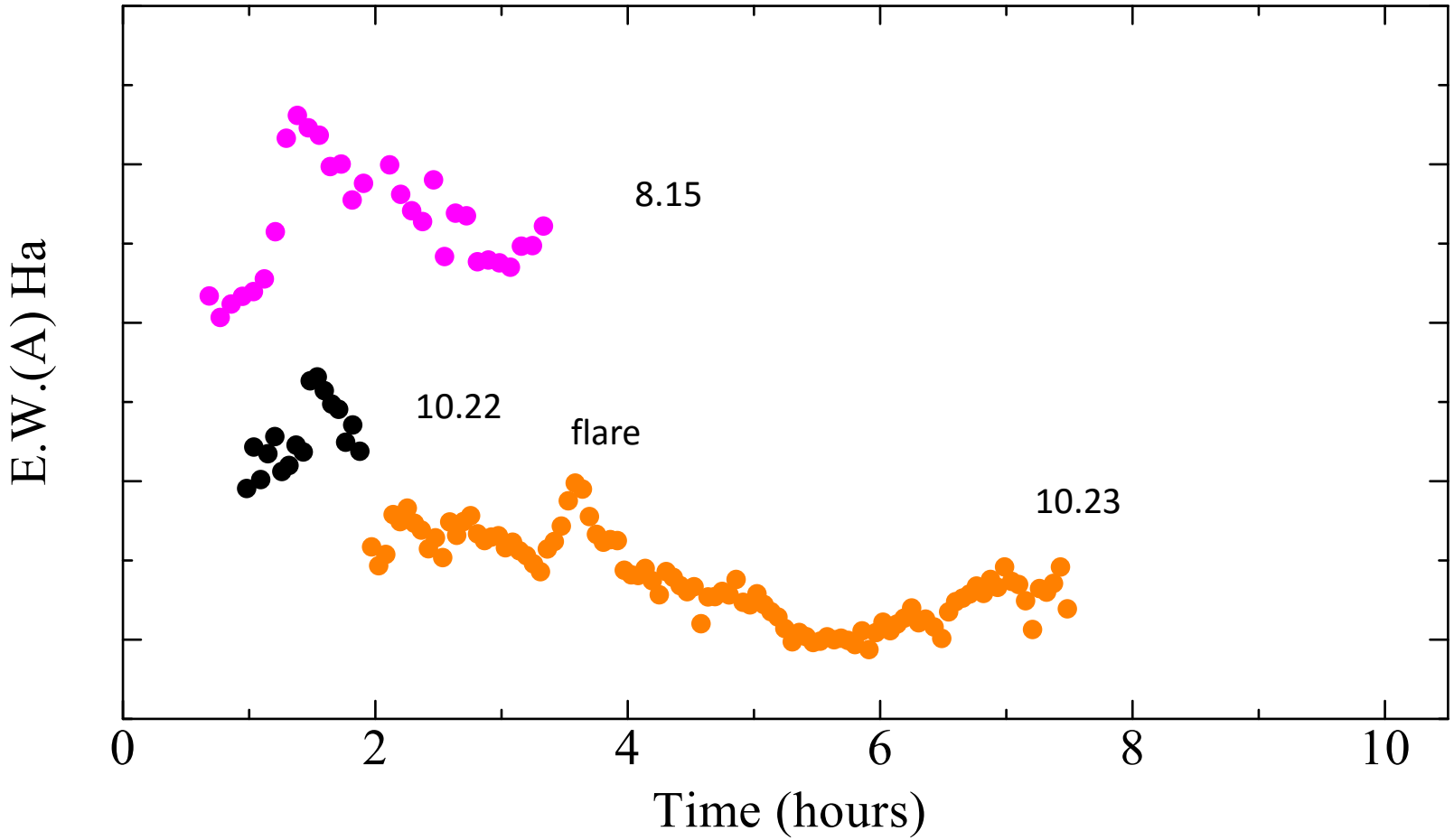
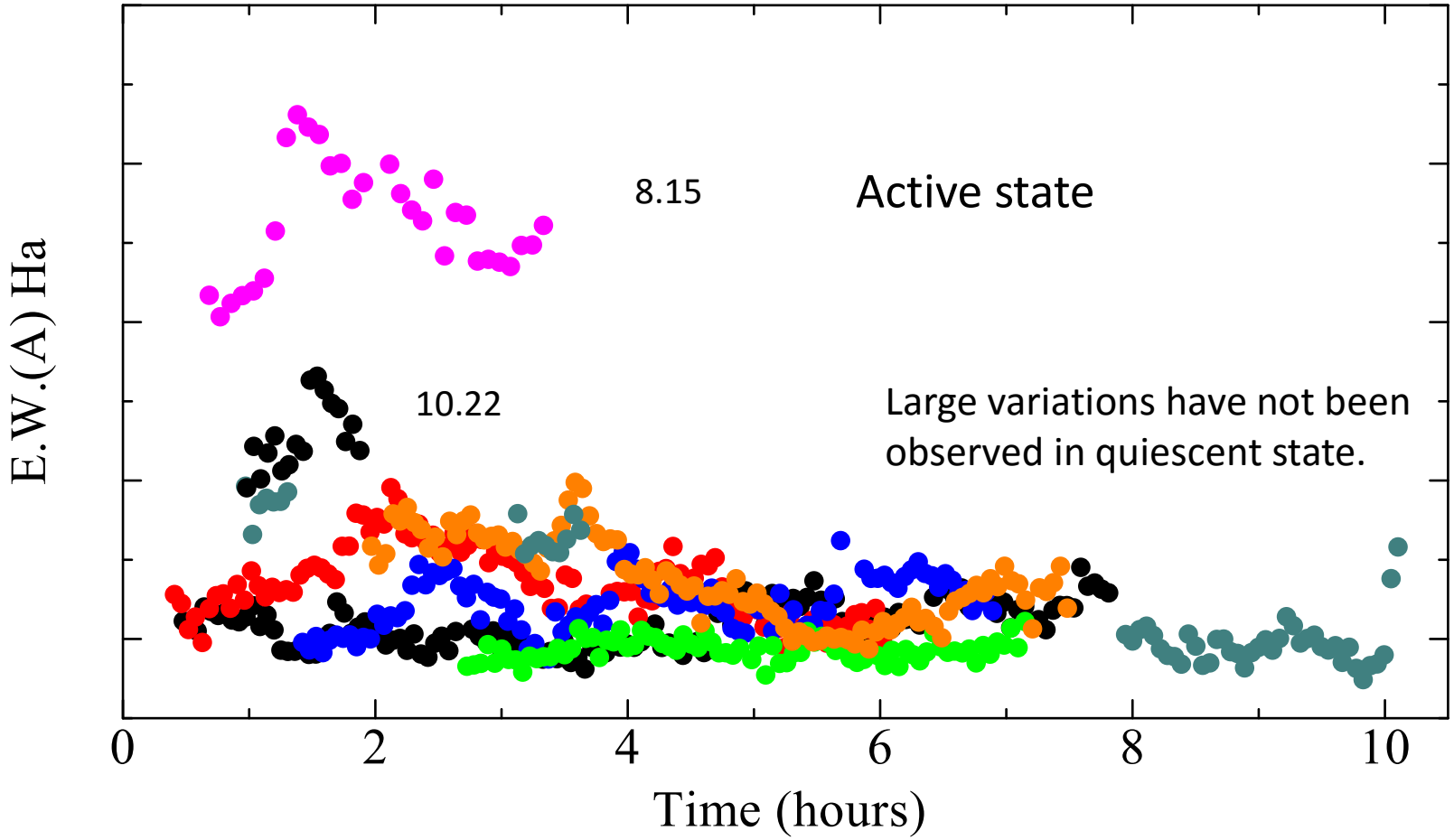


Temporal evolution of the EW of the Hα line.



Summary

- We have observed the dMe flare star (EV Lac) by Nayuta telescope.
- Equivalent widths of Hα line showed the very strong in Aug. 15.
- In Aug. 15, rapid brightening of Hα EW and He I emission line by flare were seen.
- The flare spectrum shows asymmetry (blue).
- EW of Ha in EV Lac show active state and quiescence state.
- In active state, large flare tends to occur, but large variations have not been observed in quiescent state.