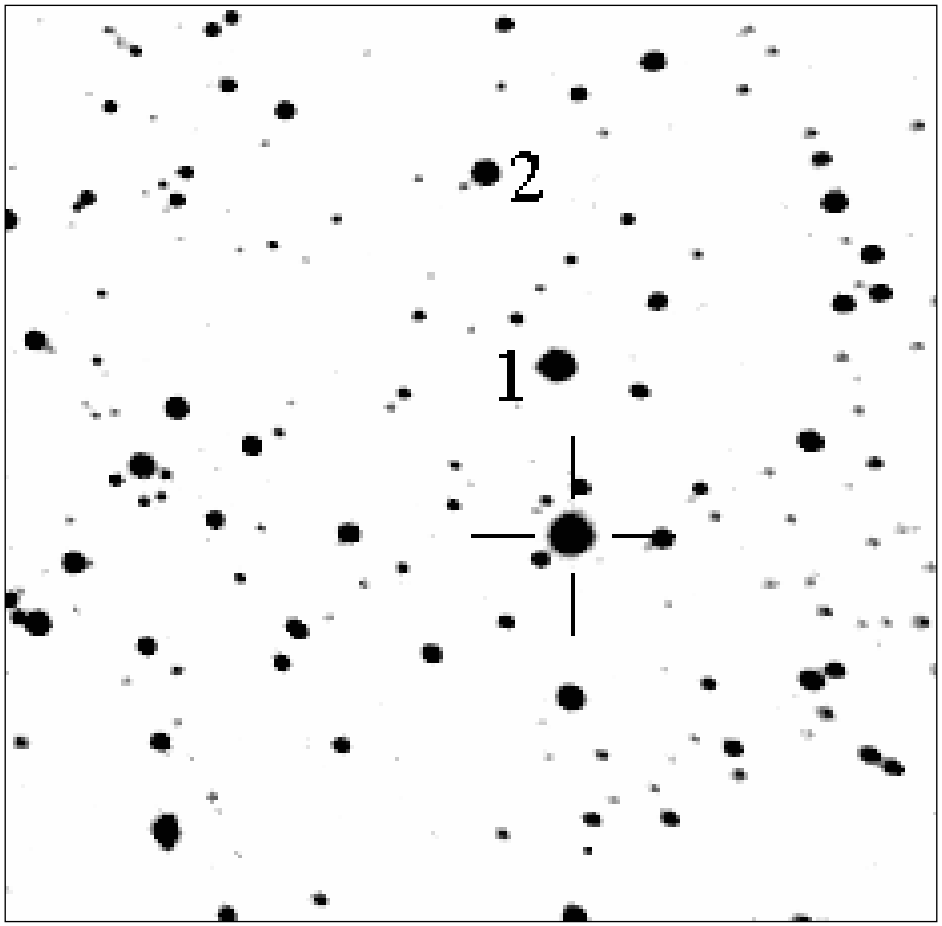
Al-Farabi Kazakh National University
Faculty of Physics and Technology

NATURE AND SPECTRAL ANALYSIS OF THE B[e]-TYPE STAR MWC 645

S. A. Khokhlov, A. S. Miroshnichenko,
N. Manset, S. V. Zharikov, V. G. Klochkova,
E. L. Chentsov, A. A. Arkharov, V. M. Larionov

Atilkhan Nodyarov

MWC 645 (V ~ 13.0 mag)



R.A. 21 53 27.486
Dec. +52 59 58.01

The 10′ x 10′ field around MWC 645 from the Digital Sky Survey

2

1. Swings J. P., Allen D. A. MWC 645 and MWC 819: Two Stars Resembling Eta Carinae //Astrophysical Letters. – 1973. – T. 14. – C. 65.
2. Miroshnichenko A.S.Toward Understanding the B[e] Phenomenon. I. Definition of the Galactic FS CMa Stars //The Astrophysical Journal. – 2007. – Vol. 667, (IF – 5.580)

The B[e] Phenomenon

The B[e] phenomenon was discovered by Allen & Swings (1976) and refers to the presence of forbidden emission lines of [Fe II] and/or [O I] in the spectra of B–type stars. IR excesses, due to circumstellar dust.

Lamers et al. (1998) recognized four subgroups of B[e] objects with known evolutionary status:

- pre-main-sequence Herbig Ae/Be stars (“HAeB[e]”),
- symbiotic binaries (“SymB[e]”),
- compact Planetary Nebulae (“cPNB[e]”),
- supergiants (“sgB[e]”),
- FS CMa objects (Miroshnichenko 2007).

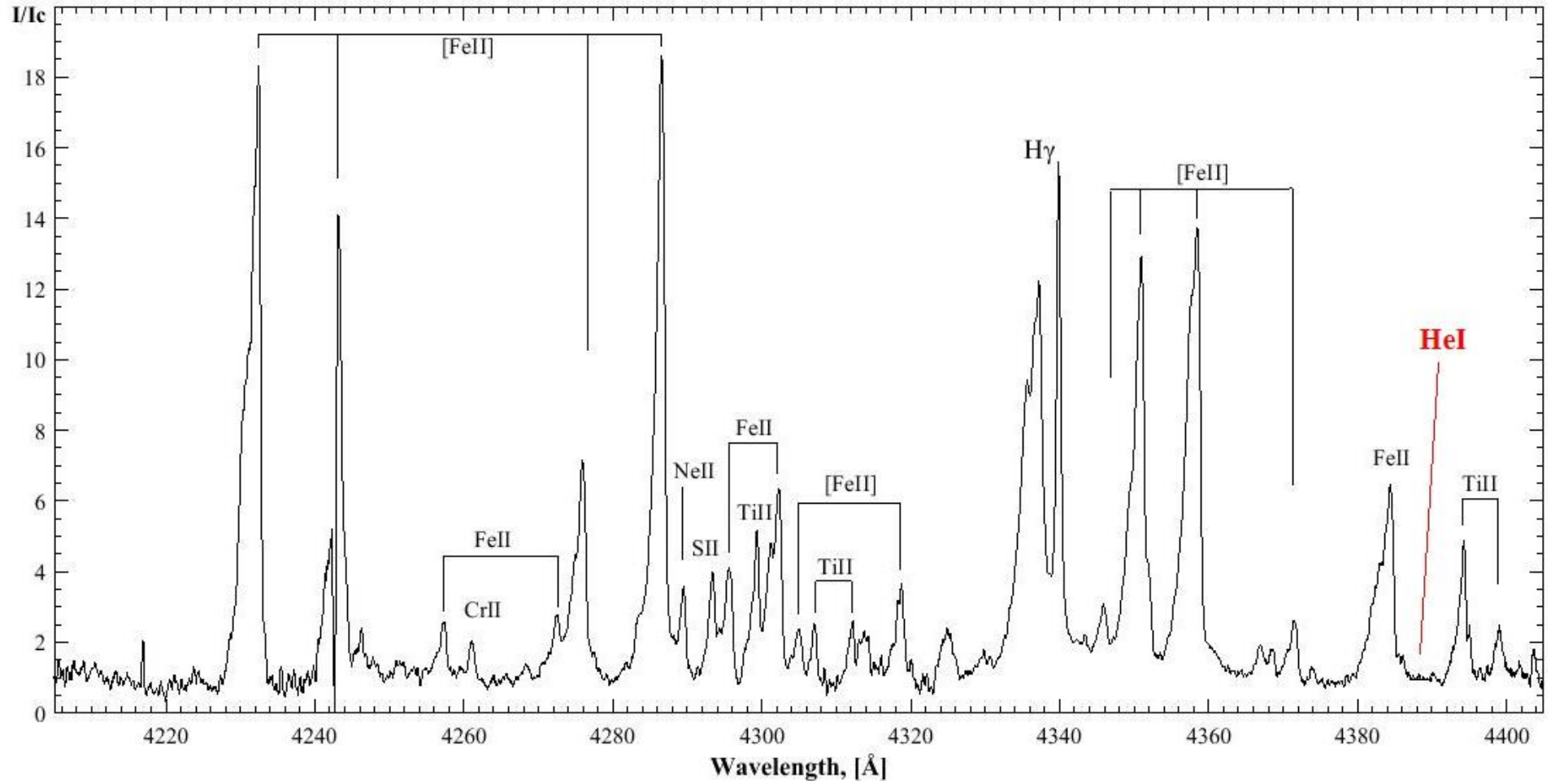
Spectroscopic Observations of MWC 645

Observatory	Location	Telescope diameter, m	Range Å	Resolution	Number of obtained spectra
CFHT	Hawaii, USA	3.6	3600 – 10500	65000	3
McDonald	Texas, USA	2.7	3600 – 10500	60000	1
OAN-SPM	Baja California, Mexico	2.1	3600 – 7300	18000	8
SAO	Nizhnij Arkhyz, Russia	6.0	5200 - 6800	60000	1

Photometric Observations of MWC 645

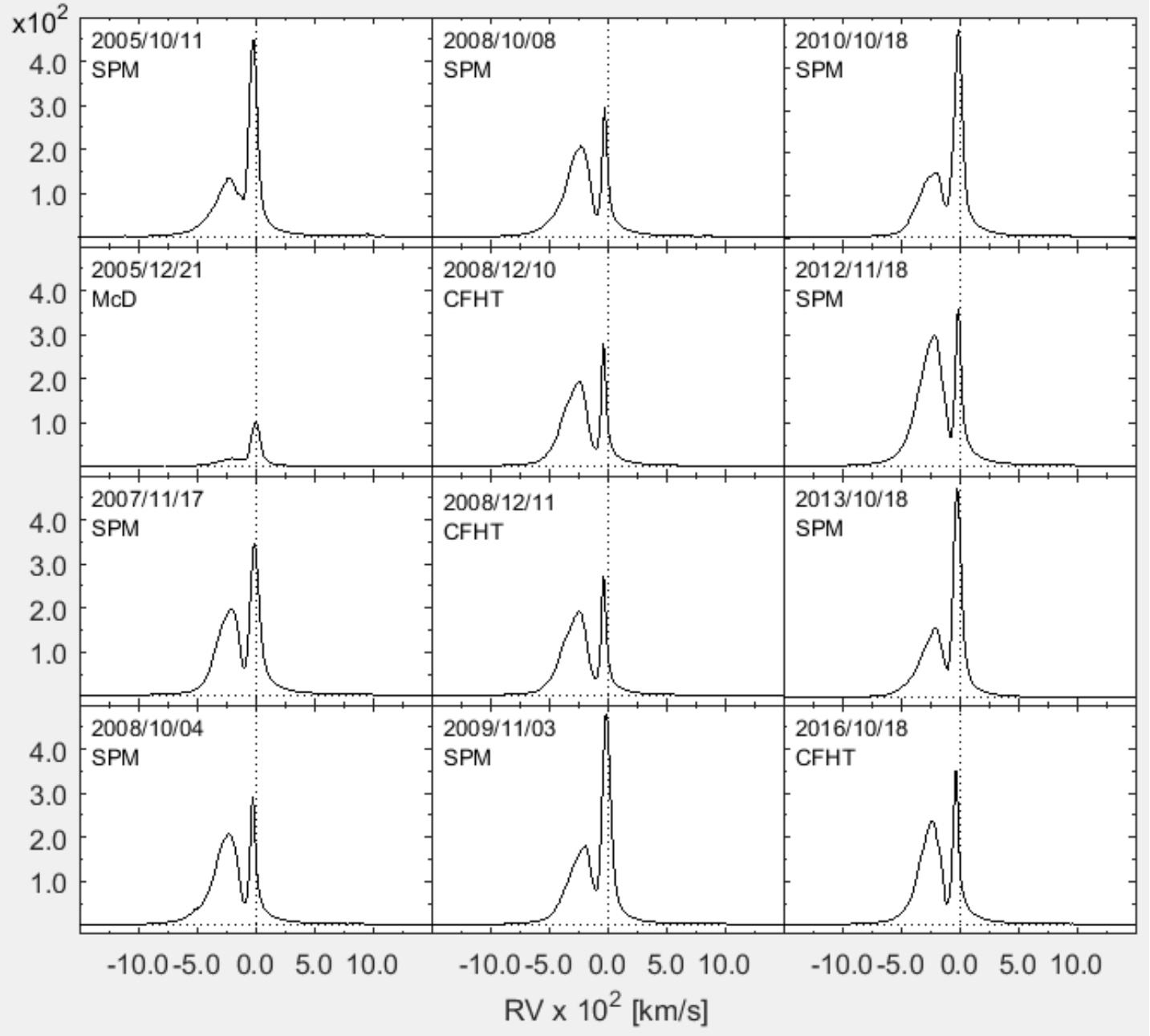
Observatory	Location	Telescope diameter, m	Filter	Data	
Maidanak Observatory	Uzbekistan	1.5	UBVR	2004-2005	4
Observatory Campo Imperatore	Italy	1.0	JHK	2008-2011	
Crimean Astrophysical Observatory (CrAO)	Crimea	2.6	UBVR	2008	

Part of a high-resolution CFHT spectrum of MWC 645

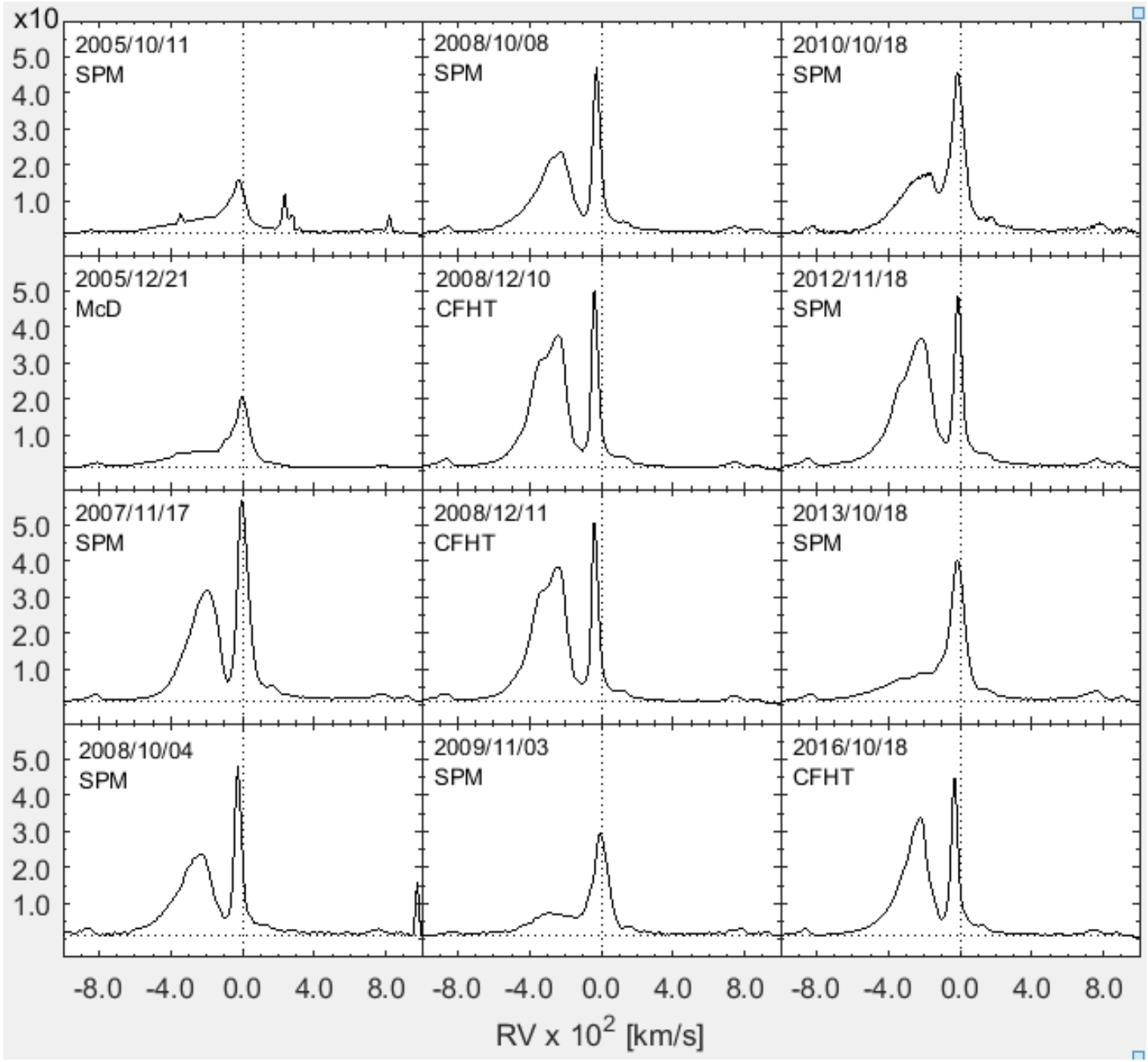


3. Coluzzi, R. 1993, Bull. CDS, 43, 7, Vizier Online Data Catalog, VI, 71A

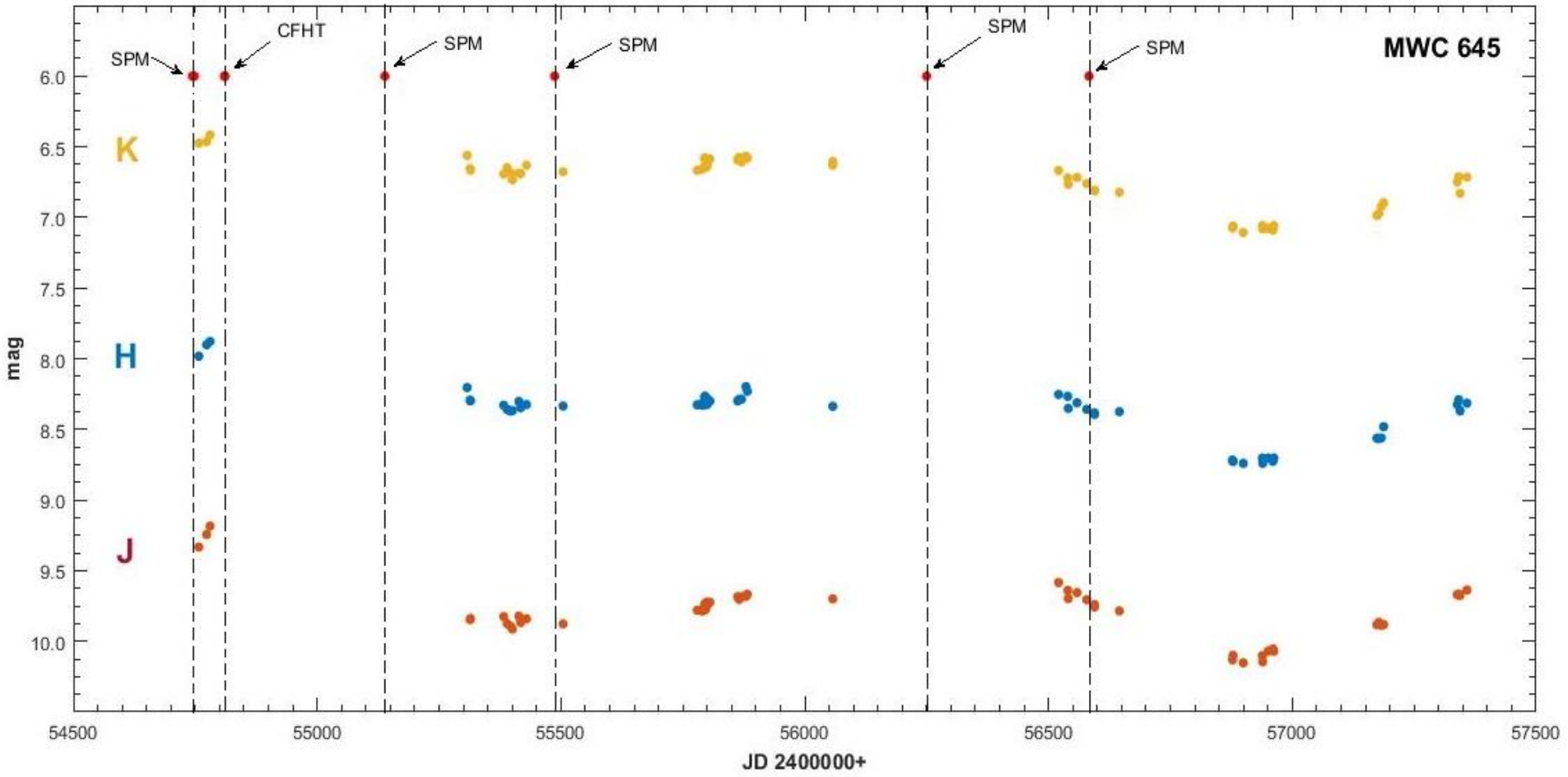
Hα of the MWC 645



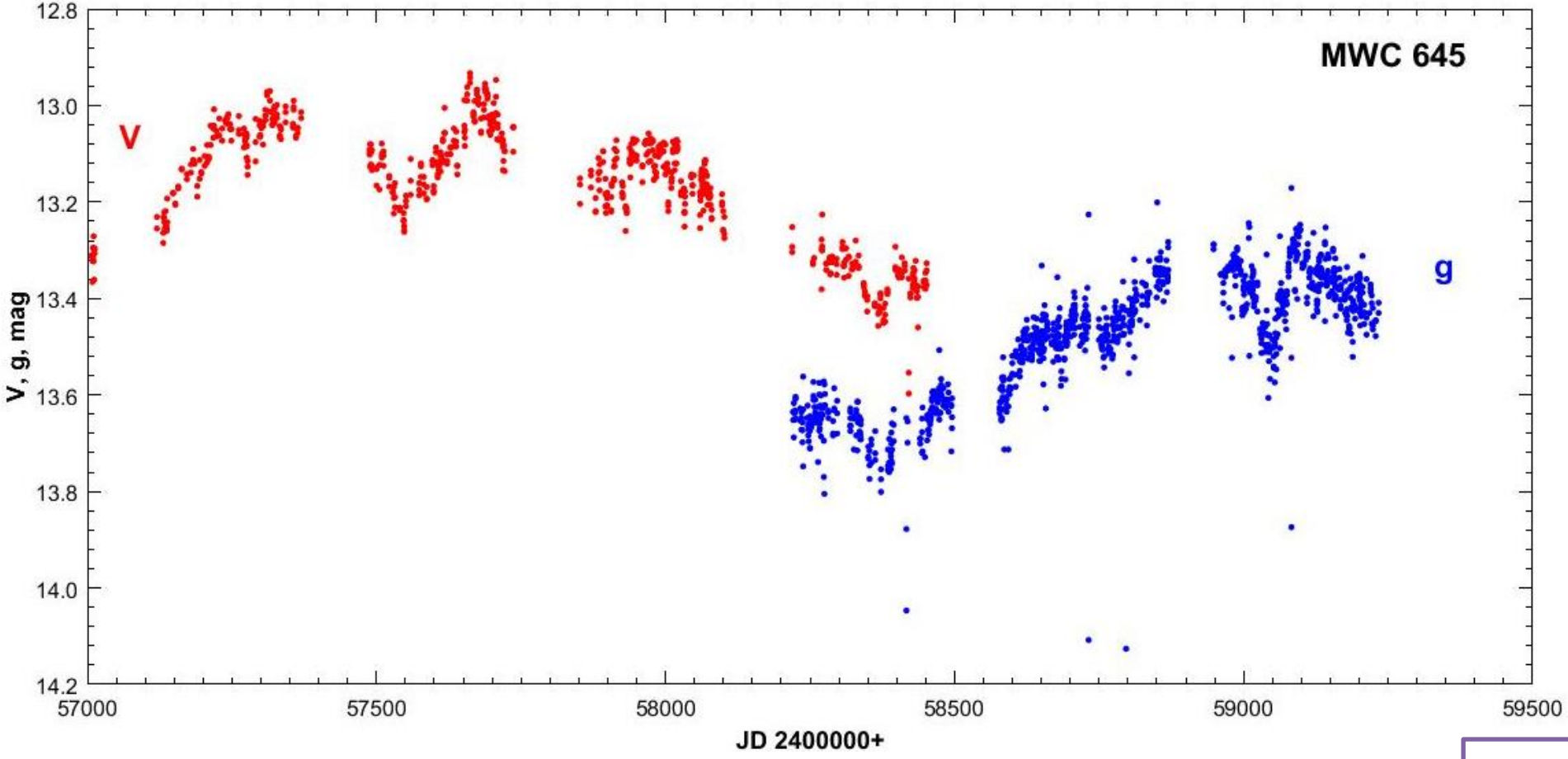
Hβ of the MWC 645



Light curve of the MWC 645 in JHK bands

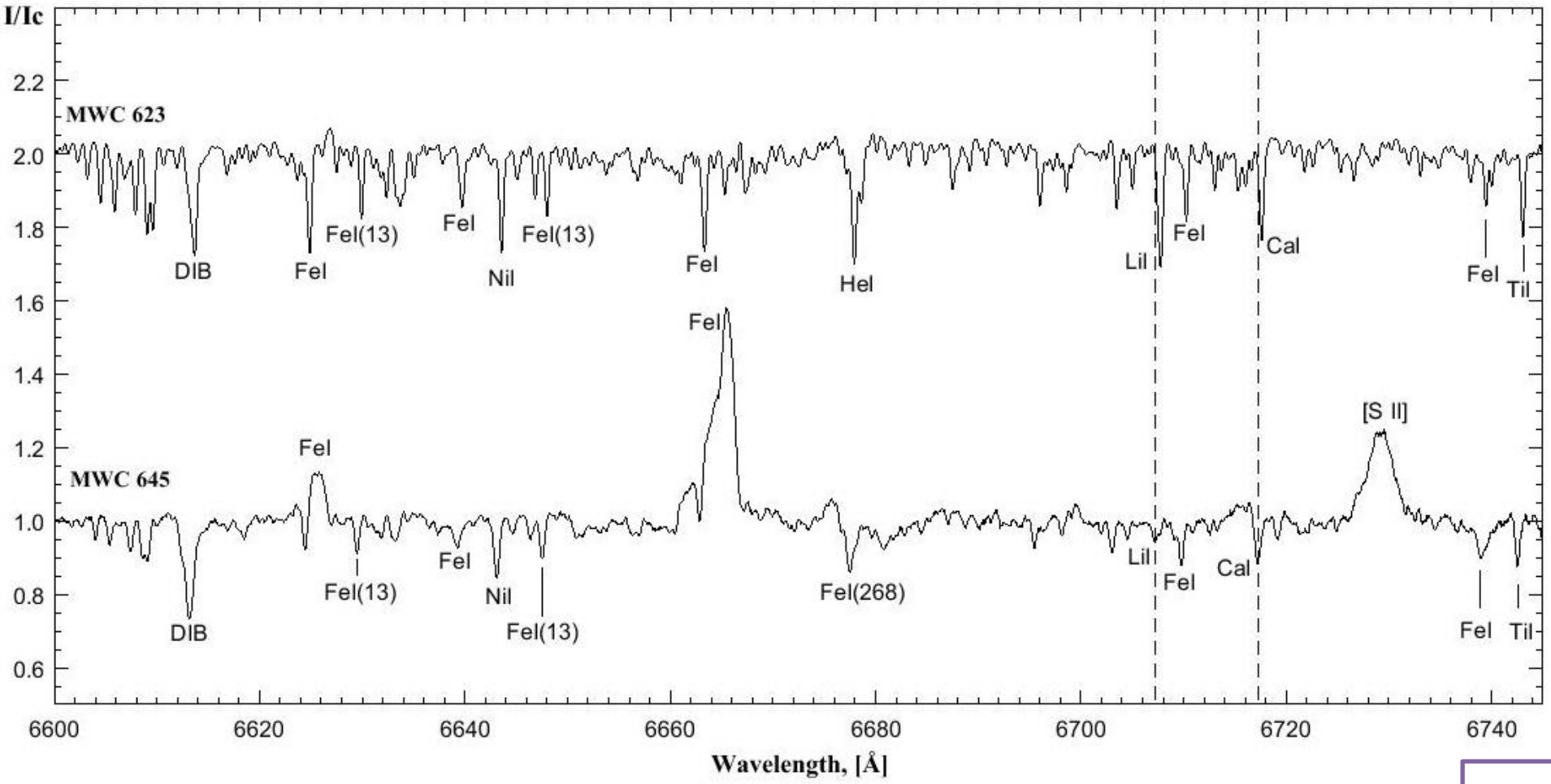


Light curve of the MWC 645 in V and g band



Light Curve of the object plotted using photometric data in V and g bands taken from ASAS SN catalog(data from 2014 to 2021(January)).

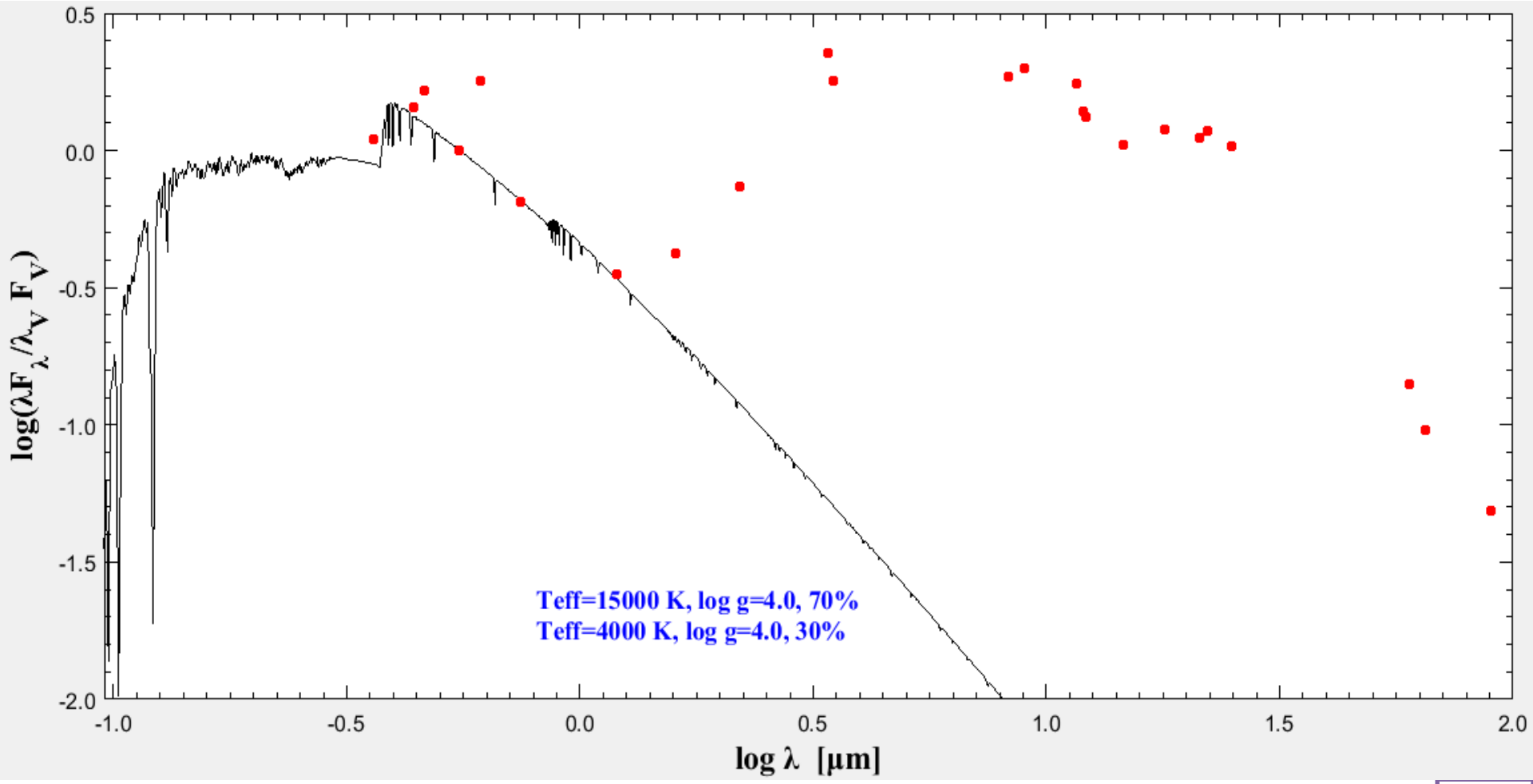
Absorption lines in the CFHT spectra of MWC 645 and MWC 623



4. Craine E. R., Tapia S. UBVr sequences for two eta Carinae-like objects //Publications of the Astronomical Society of the Pacific. – 1975. – Т. 87. – №. 515. – С. 131.

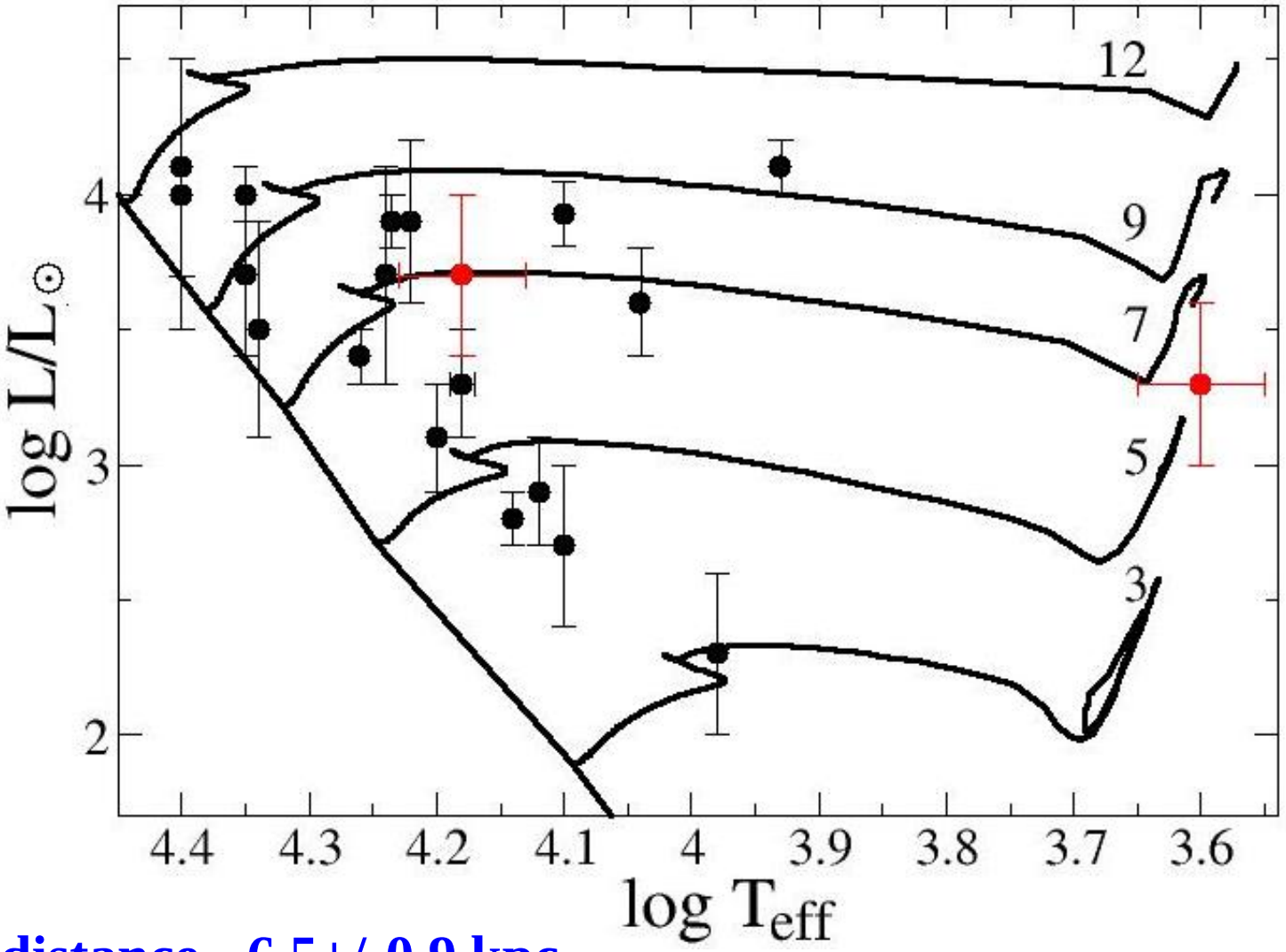
5. Zickgraf F. J., Stahl O. The peculiar B (e) star MWC 623-A binary system with a Li-rich K star //Astronomy and Astrophysics. – 1989. – Т. 223. – С. 165-171.

Spectral energy distribution (SED) of MWC 645



6.Kurucz R. Solar abundance model atmospheres for 0, 1, 2, 4, 8 km/s //Solar abundance model atmospheres for 0. – 1994. – T. 19.

HR diagram of the MWC 645 system



GAIA distance - 6.5+/-0.9 kpc

7. Zickgraf F. J. New spectroscopic observations of the B [e]/K binary system MWC 623 //Astronomy & Astrophysics. – 2001. – Т. 375. – №. 1. – С. 122-129.

Conclusion

♦ MWC 645 shows strong Balmer emission lines, narrow permitted and forbidden low-excitation emission lines of FeII, [FeII], and OI.

♦ The optical spectrum contains many emission lines and weak absorption lines including diffuse interstellar bands (DIBs).

♦ We measured a heliocentric radial velocity of~ -65 km/s from emission lines and ~ -22 km/s from absorption lines. Strong emission lines suggest a high temperature of the underlying star, while the absence of helium lines (HeI) may indicate either a lack of helium or a hot star temperature of < 20,000 K.

♦ By comparing spectra of MWC 645 and MWC 623 (a binary FS CMa object) we identified lines of neutral metals (LiI 6708Å, CaI 6717Å, FeI, TiI, etc.) that characterize the cool component of the binary system.

♦ Hα line has an unusual double-peaked profile in the spectrum of MWC 645 and shows strong variations.

♦ The spectral energy distribution (SED) also confirms the B[e] phenomenon. MWC 645 has a gas and dust circumstellar envelope that emits a strong infrared excess.

♦ Our data for the first time suggest that MWC 645 is a binary system which consists of a hot star with the B[e] phenomenon and a cold star.

References

1. J. P. Swings, D. A. Allen // MWC 645 and MWC 819: Two Stars Resembling Eta Carinae // Astrophysical Letters. – Vol. 14, pp. 65-68, (IF – 8.374)
2. Miroshnichenko A.S.Toward Understanding the B[e] Phenomenon. I. Definition of the Galactic FS CMa Stars //The Astrophysical Journal. – 2007. – Vol. 667, (IF – 5.580)
3. Coluzzi, R. 1993, Bull. CDS, 43, 7, Vizier Online Data Catalog, VI, 71°
4. Craine E. R., Tapia S. UBVr sequences for two eta Carinae-like objects //Publications of the Astronomical Society of the Pacific. – 1975. – T. 87. – №. 515. – C. 131.
5. Zickgraf F. J., Stahl O. The peculiar B (e) star MWC 623-A binary system with a Li-rich K star //Astronomy and Astrophysics. – 1989. – T. 223. – C. 165-171
6. Kurucz R. Solar abundance model atmospheres for 0, 1, 2, 4, 8 km/s //Solar abundance model atmospheres for 0. – 1994. – T. 19.
7. Gray R. O. SPECTRUM: A stellar spectral synthesis program //Astrophysics source code library. – 1999. – C. ascl: 9910.002.
7. Miroshnichenko A.S., Manset N., Kusakin A.V.et. al. Toward Understanding the B[e] Phenomenon. II. New Galactic FS CMa Stars //The Astrophysical Journal. – 2007. – Vol. 671, № 1. – P. 828-841. (IF – 5.580)
8. F.-J. Zickgraf // Kinematical structure of the circumstellar environments of galactic B[e]-type stars // Astronomy & Astrophysics. – 2003. – Vol. 408, 257–285 (IF – 6.209)
9. M. Jaschek, Y. Andrillat and C. Jaschek // B[e] stars. III. MWC 645 // Astronomy & Astrophysics supplement series . – 1996. – Ser. 120, 99-105 (IF – 8.311)
10. D. A. Allen, J. P. Swings // The Spectra of Peculiar Be Stars with Infrared Excesses // Astronomy & Astrophysics. – 1976. – Vol. 47, 293-302, (IF – 6.209)
11. Polster J., Korcakova D., Votruba V., Skoda et.al. Time-dependent spectral-feature variations of stars displaying the B[e] phenomenon. I. V2028 Cygni. A&A, V 542A, 57-57 (2012/6-1)




THANKS FOR YOUR ATTENTION !!!