Clarifying the Parameters of Extragalactic WN Stars

Physics of Extreme Massive Stars
Marie-Curie-Rise project
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Nəsirəddin Tusi adına Şamaxı Astrofizika Rəsədxanası

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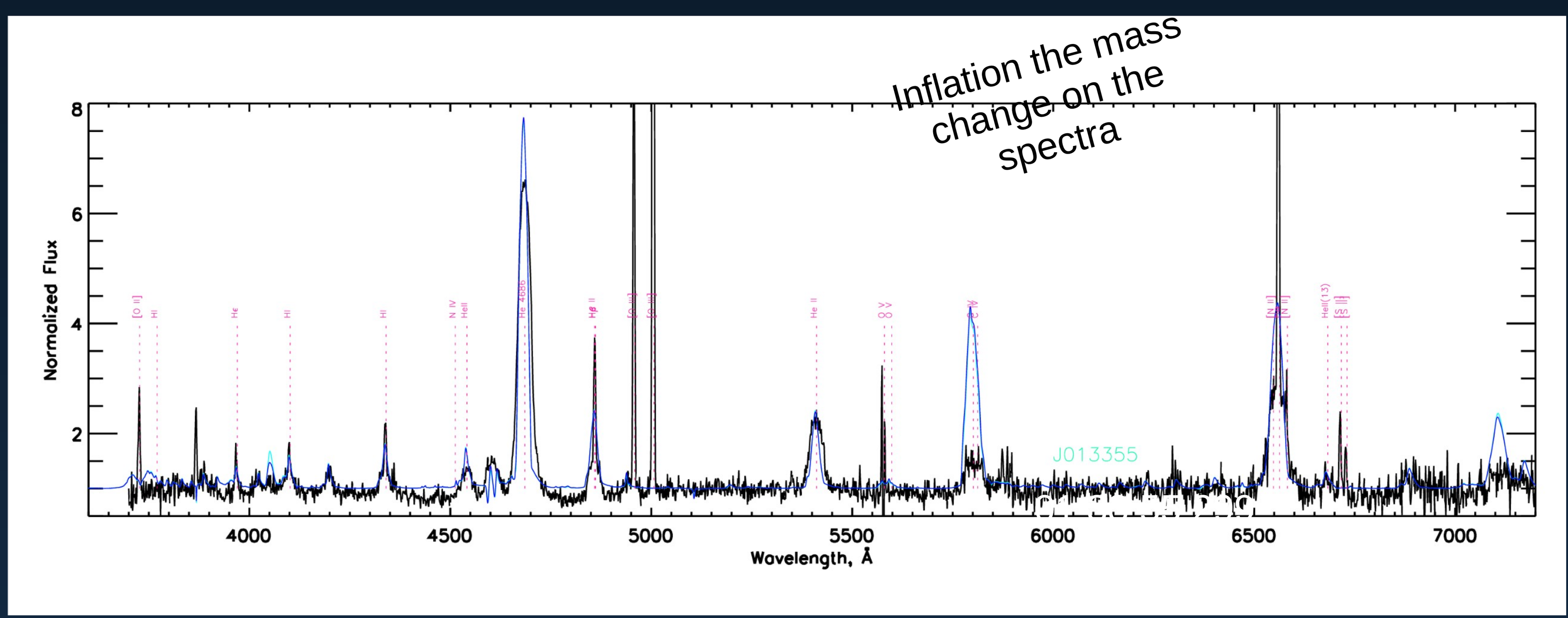
Astronomický ústav AV ČR

WN stars, as massive stars in a late evolutionary stage, exhibit strong, broad emission lines due to powerful stellar winds, significantly influencing their environments. Accurate determination of their parameters is crucial for understanding the life cycles of massive stars, stellar wind mechanics, and the chemical enrichment of galaxies.

As a case study, we began analyzing the WN stars in M33. To achieve more accurate modeling and obtain more reliable results, we utilized data from different photometric surveys in a wide spectral range, including the UV and IK bands. This dataset enables significant improvements in determining the physical parameters of stars, particularly their temperatures, which are modeled primarily using optical observations.



J013355.33+302001.0 - M33 object

01 33 55.29
+30 20 00.89
WN3 + neb

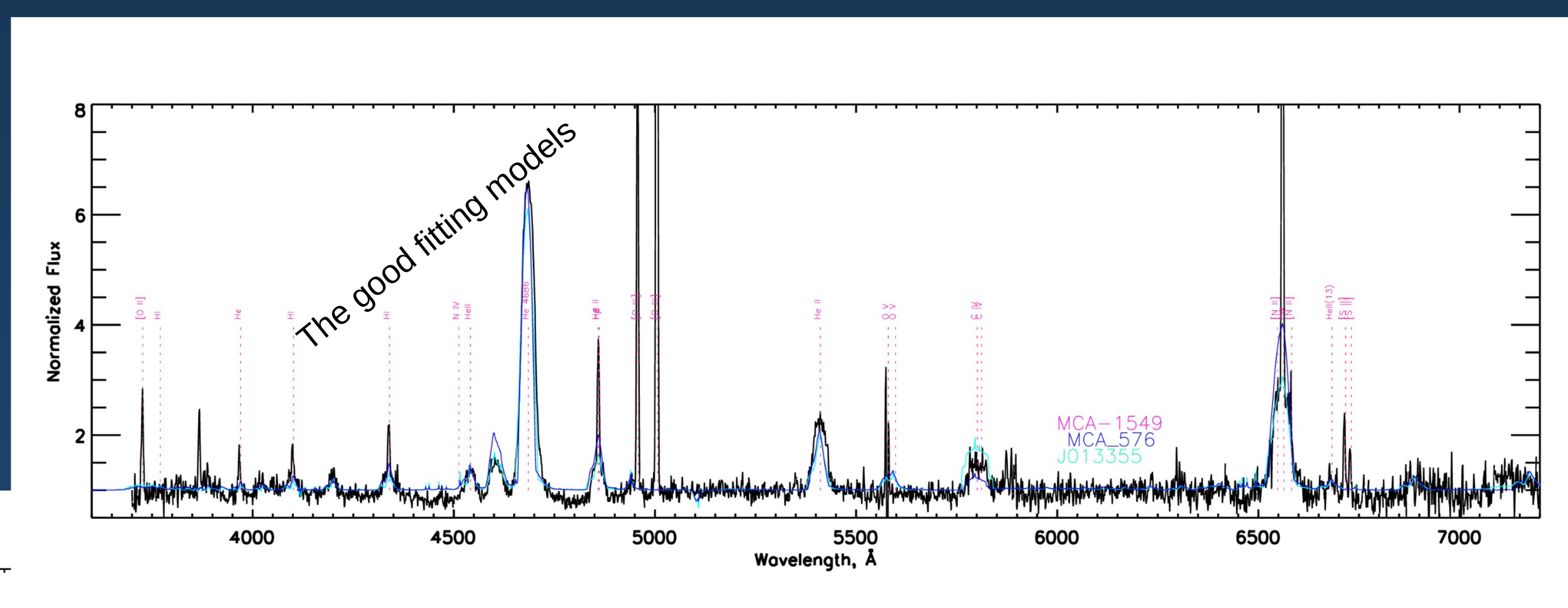
Model N	H	He	C	N	O	Ne	Na	Mg	Al	Si	S	Ar	Cal	Fe
1547	0.985	0.794	$5x10^{-4}$	$1.945x10^{-4}$	$2.541x10^{-3}$	$0.79x10^{-3}$	$-1.72x10^{-5}$	$-3.23x10^{-4}$	$2.79x10^{-5}$	$3.6x10^{-4}$	$1.91x10^{-4}$	$0.52x10^{-4}$	$3.07x10^{-5}$	$0.68x10^{-3}$
1548	0.985	0.794	$5x10^{-4}$	$1.945x10^{-4}$	$2.541x10^{-3}$	$0.79x10^{-3}$	$-1.72x10^{-5}$	$-3.23x10^{-4}$	$2.79x10^{-5}$	$3.6x10^{-4}$	$1.91x10^{-4}$	$0.52x10^{-4}$	$3.07x10^{-5}$	$0.68x10^{-3}$
576	0.04722	0.9445	$5x10^{-4}$	$2.314x10^{-3}$	$3.022x10^{-3}$	$0.79x10^{-3}$	$-1.72x10^{-5}$	$-3.23x10^{-4}$	$2.79x10^{-5}$	$3.6x10^{-4}$	$1.91x10^{-4}$	$0.52x10^{-4}$	$3.07x10^{-5}$	$0.68x10^{-3}$
1549	0.985	0.794	$5x10^{-4}$	$1.945x10^{-4}$	$2.541x10^{-3}$	$0.79x10^{-3}$	$-1.72x10^{-5}$	$-3.23x10^{-4}$	$2.79x10^{-5}$	$3.6x10^{-4}$	$1.91x10^{-4}$	$0.52x10^{-4}$	$3.07x10^{-5}$	$0.68x10^{-3}$

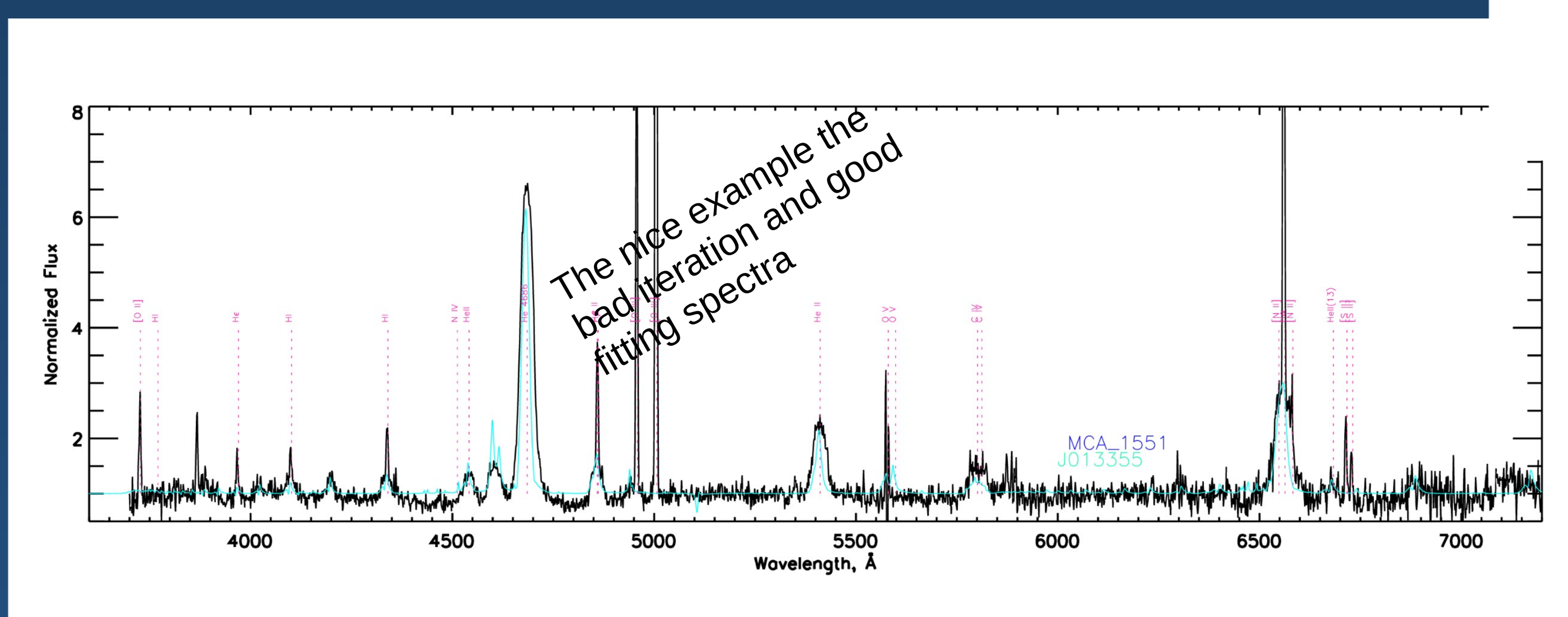
Model N	$R_*(R_\odot)$	V_{law}	V_{phot}	V_∞	T_*	beta	$\dot{M}$	$L_*(L_\odot)$	$M_*(M_\odot)$	Umag	Bmag	Vmag	Rmag	Imag
										20.419	20.191	20.71	20.812	21.136
1547	21.148297	3	100	1350	71690	2	$8x10^{-6}$	$2.2x10^5$	48	18.81	20.02	20.33	20.38	20.61
1548	21.148297	3	100	1350	71690	2	$8x10^{-6}$	$2.2x10^5$	42	19.323	20.463	20.649	20.627	20.787
576	16.771661	3	100	1800	80500	1	3.50E-06	$2.2x10^5$	48	19.518	20.7841	21.205	21.354	21.604
1549	16.163676	3	100	1450	82000	1	4.50E-06	$2.2x10^5$	42	20.1	21.237	21.545	21.603	21.733

CMFGEN atmosphere code

The purpose :

- Obtain synthetic spectra
- Run models with different beta law
- Follow the changes and influences on the spectra
- Clarify the uncertainites related with magnitude of synthetic spectra





The distance accepted 847 kpc

Av = 0.132

For magnitudes of J013355

M33 GALEX catalogue of UV point sources (Mudd+, 2015)

Umag	Bmag	Vmag	Rmag	Imag
20.419	20.191	20.710	20.812	21.136

Another magnitude data :

Gaia EDR3 (Gaia Collaboration, 2020), (STScI, 2020), (Gaia Collaboration, 2022), (Zhou+ 1995-2005), (Massey+, 2007), (Yershov, 2015), (Chambers+, 2016), (Page+ 2023),

Results

Now we have two model of J013355. They are good fitting, but the magnitude weaker than observational for both models.

If you are going to calculate with higher beta law, it will make synthetic spectra more intence and narrow,

Beta law and Vphot gives you Pcyg profile addition on spectra,

Higher *beta low* and V_{phot} cause Pcyg profile in lines.

The mass changes affect the magnitude of models. The small uncertainities of magnitude can related with mass of star.

To be continued