Observations of massive stars in the GAIA band

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1 Instrumentation

The Liège team obtained observations of a sample of massive stars (O, WR) with both the ESO-NTT and OHP-1.52m telescopes (PI Nazé).

For the northern stars, the 1.52 m telescope at OHP was equipped with the Aurélie spectrograph and Grating #4 (300tr/mm, R=6000). The data were gathered in two separated 9d runs (April and August 2006) in order to cover the whole range of RA. The reduction was standard - no correction for telluric lines was made. Generally, several spectra of the same object were taken consecutively, in order to correct for cosmic rays. The spectra were reduced separately, corrected for cosmics and then averaged, taking into account the S/N: apart from AO Cas (HD 1337), one spectrum is thus available for each star. The final spectra, centered on 8500Å and covering 900Å, were normalized (only roughly for WR stars where finding the continuum is always awkward) and are available in fits and txt formats.

For the southern stars, we obtained data from the NTT equipped with the EMMI instrument. The observations were made in service mode over 7 nights (scattered from Nov 11 2006 to April 13 2007). The instrumental configuration was REMD (echelle grism #9 with cross-disperser #4), in order to cover the 5800-9900Å domain with a resolution of about 9700. Except for two objects, each star was observed only once. The data, received only last June, will be reduced at the beginning of 2008.

2 The sample

Target	α (2000.0)	δ (2000.0)	m_V	Exp. time	Spectral type
OHP O-type targets:					
HD 15570	02h32m49.4s	+61d22m42.1s	8.110	3600	O4If+
HD 190429A	20h03m29.4s	+36d01m31.0s	6.616	5400	O4If+
HD 14947	02h26m47.0s	+58d52m33.1s	7.998	6600	O5If+
HD 46150	06h31m55.5s	+04d56m34.2s	6.745	4800	O5 V((f+))
HD 192281	20h12m33.1s	+40d16m05.5s	7.550	1800	O5 Vn((f))p
HD 14434	02h21m52.4s	+56d54m18.0s	8.491	5400	O5.5Vn((f))p
λCep-HD210839	22h11m30.5s	+59d24m52.1s	5.090	600	O6 I(n)fp
HD 229196	20h23m10.8s	+40d52m29.9s	8.516	5400	O6III(n)(f)
HD 199579	20h56m34.7s	+44d55m28.9s	5.966	600	O6 V((f))
HD 190864	20h05m39.8s	+35d36m27.9s	7.79	3600	O6.5 III(f)
HD 206267	21h38m57.6s	+57d29m20.5s	5.62	2400	O6.5 V((f))
HD 42088	06h09m39.6s	+20d29m15.5s	7.551	3600	O6.5 V
HD 193514	20h19m08.4s	+39d16m24.2s	7.44	3600	O7 Ib(f)
HD 192639	20h14m30.4s	+37d21m13.8s	7.11	5400	O7 Ib(f)
HD 44811	06h09m39.6s	+20d29m15.5s	7.551	7200	O7 V
9Sge-HD188001	19h52m21.8s	+18d40m18.8s	6.230	3600	O7.5Iaf (eclip. bin.)
68Cyg-HD203064	21h18m27.2s	+43d56m45.4s	4.994	1800	O7.5III:n((f))
HD 186980	19h46m15.9s	+32d06m58.1s	7.48	8100	O7.5 III((f))
HD 225160	00h04m03.8s	+62d13m19.0s	8.196	4800	O8Ib(f)
λOriA-HD36861	05h35m08.2s	+09d56m02.9s	3.3	600	O8 III((f))
HD 41161	06h05m52.5s	+48d14m57.4s	6.765	7200	O8 Vn
HD 191978	20h10m58.3s	+41d21m09.9s	8.020	6600	O8.5 III((f))
HD 216532	22h52m30.6s	+62d26m25.9s	8.007	5400	O8.5 V((n))
HD 207198	21h44m53.2s	+62d27m38.0s	5.959	1800	O9 Ib-II
HD 191423	20h08m07.1s	+42d36m22.0s	8.030	7200	O9III:n
10Lac-HD214680	22h39m15.6s	+39d03m00.9s	4.877	1200	O9 V
HD 201345	21h07m55.4s	+33d23m49.3s	7.660	7200	ON 9V
HD 193322	20h18m07.0s	+40d43m55.4s	5.829	600	O9V:((n))
HD 93521	10h48m23.5s	+37d34m13.1s	7.040	59400	O9Vp
HD 188209	19h51m59.0s	+47d01m38.4s	5.633	3600	O9.5 Iab
19Cep-HD209975	22h05m08.7s	+62d16m47.3s	5.11	1200	O9.5 Ib
AOCas-HD1337	00h17m43.0s	+51d25m59.1s	6.102	5 obs (~1/2h)	O9.5I+O8V, P~3.5d
HD 189957	20h01m00.0s	+42d00m30.8s	7.82	7500	O9.5 III
HD 37737	05h42m31.2s	+36d12m00.5s	8.057	3600	O9.5III(n)
HD 191201	20h07m23.7s	+35d43m05.9s	7.255	3600	O9.5IV((n)) (bin.)
HD 37366	05h39m24.8s	+30d53m26.8s	7.610	5400	O9.5 V
HD 195592	20h30m34.9s	+44d18m54.8s	7.149	1200	O9.7 Ia
HD 226868	19h58m21.7s	+35d12m05.8s	8.890	3600	O9.7Iab (HMXB)
HD 13745	02h15m45.9s	+55d59m46.7s	7.86	5400	O9.7II((n))
HD 194280	20h23m26.3s	+38d56m21.0s	8.390	3600	OC 9.7Iab
HD 108	00h06m03.4s	+63d40m46.8s	7.383	3600	Of?p
HD 191612	20h09m28.6s	+35d44m01.3s	7.778	1800	Of?p
HD 60848	07h37m05.7s	+16d54m15.3s	6.850	3600	Oe (O8 V:pe var)

Target	α (2000.0)	δ (2000.0)	m_V	Exp. time	Spectral type
ESO O-type targets:					
HD 93250	10h44m45s	−59d33m54s	7.36	100	O3.5V
HD 96715	11h07m32s	−59d57m48s	8.25	300	O4V
HD 46223	06h32m09s	+04d49m24s	7.26	100	O4V
HD 93843	10h48m37s	−60d13m25s	7.31	100	O5III
HD 46150	06h31m55s	+04d56m34s	6.74	100	O5V
HD 93204	10h44m32s	−59d44m31s	8.44	300	O5V
HD 155913	17h16m26s	−42d40m04s	8.25	300	O5V
HD 93403	10h45m44s	−59d24m28s	7.27	100	O5.5I+O7V, P=15d
HD 97253	11h10m42s	−60d23m04s	7.11	100	O5.5 III
HD 76556	08h55m07s	−47d36m27s	8.19	100	O5.5 V
HD 169582	18h25m43s	−09d45m11s	8.70	300	O6 I
HD 93160	10h44m07s	−59d34m30s	7.81	100	O6 III
HD 91572	10h33m12s	−58d10m13s	8.22	300	O6 V
HD 101131	11h37m48s	−63d19m23s	7.14	100	O6 V
HD 124314	14h15m01s	−61d42m24s	6.64	100	O6 V
HD 148937	16h33m52s	−48d06m40s	6.72	100	O6.5 f?p
HD 150958	16h46m38s	−47d05m24s	7.29	100	O6.5 Ia
HD 163758	17h59m28s	−36d01m15s	7.32	100	O6.5 Ia
HD 69464	08h15m48s	−35d37m52s	8.80	300	O6.5 Ib
HD 94963	10h56m35s	−61d42m32s	7.16	100	O6.5 III
HD 157857	17h26m17s	−10d59m34s	7.78	100	O6.5 III
HD 54662	07h09m20s	−10d20m47s	6.21	100	O6.5 V
HD 93146	10h44m00s	−60d05m09s	8.43	300	O6.5 V
HD 150135	16h41m19s	−48d45m47s	6.88	100	O6.5 V
HD 166734	18h12m24s	−10d43m53s	8.42	300	O7 Ib
HD 151515	16h49m48s	−42d00m06s	7.16	100	O7 II
HD 46573	06h34m23s	+02d32m02s	7.93	100	O7 III
HD 93222	10h44m36s	−60d05m28s	8.10	100	O7 III
HD 152248	16h54m10s	−41d49m30s	6.13	100	O7III+O7.5III, P=6d
HD 48099	06h41m59s	+06d20m43s	6.36	100	O7 V
HD 91824	10h34m46s	−58d09m22s	8.17	100	O7 V
HD 162978	17h54m54s	−24d53m13s	6.19	100	O7.5 II
HD 97166	11h10m05s	−60d14m56s	7.88	100	O7.5 III
HD 326331	16h54m25s	−41d49m55s	7.46	100	O7.5 III
HD 53975	07h06m35s	−12d23m38s	6.47	100	O7.5 V
HD 152590	16h56m05s	−40d20m57s	8.44	300	O7.5 V
HD 124979	14h18m11s	−51d30m13s	8.51	300	O8 ((f))
HD 47129	06h37m24s	+06d08m07s	6.06	100	O8 p
HD 96670	11h07m13s	−59d52m23s	7.44	2 obs (100s)	O8 p
HD 156154	17h17m27s	−35d32m12s	8.05	100	O8 Iab
HD 120521	13h51m33s	−58d32m22s	8.57	300	O8 Ib
HD 175754	18h57m35s	−19d09m11s	7.01	100	O8 II
HD 120678	13h52m56s	−62d43m14s	7.87	100	O8 III:
HD 48279	06h42m40s	+01d42m58s	7.91	100	O8 V
HD 101413	11h39m45s	−63d28m40s	8.35	300	O8 V
HD 161853	17h49m16s	−31d15m18s	7.92	100	O8 V

Target	α (2000.0)	δ (2000.0)	m_V	Exp. time	Spectral type
Continued					
HD 74194	08h40m47s	−45d03m30s	7.55	100	O8.5 Ib
HD 96917	11h08m42s	−57d03m56s	7.07	100	O8.5 Ib
HD 125241	14h20m22s	−60d53m22s	8.27	300	O8.5 Ib
HD 46149	06h31m52s	+05d01m59s	7.60	100	O8.5 V
HD 73882	08h39m09s	−40d25m09s	7.21	100	O8.5 V
HD 92504	10h39m36s	−57d27m40s	8.41	300	O8.5 V
HD 148546	16h30m23s	−37d58m21s	7.71	100	O9 Ia
HD 303492	10h51m52s	−58d58m35s	8.85	300	O9 Ia
HD 76341	08h54m00s	−42d29m08s	7.15	100	O9 Ib
HD 151003	16h46m34s	−41d36m38s	7.07	100	O9 II
HD 90087	10h22m20s	−59d45m19s	7.78	100	O9 II
HD 105627	12h09m44s	−62d34m54s	8.14	100	O9 II-III
HD 153426	17h01m13s	−38d12m11s	7.47	100	O9 II-III
HD 93249	10h44m43s	−59d21m25s	8.36	300	O9 III
HD 114737	13h13m45s	−63d35m11s	7.99	100	O9 III
HD 57682	07h22m02s	−08d58m45s	6.41	100	O9 IV
HD 163892	17h59m26s	−22d28m00s	7.44	100	O9 IV
HD 46202	06h32m10s	+04d57m59s	8.18	100	O9 V
HD 93028	10h43m15s	−60d12m04s	8.36	300	O9 V
HD 117490	13h32m08s	−60d48m55s	8.90	300	O9 V
HD 154368	17h06m28s	−35d27m03s	6.13	100	O9.5 Iab
HD 71304	08h24m55s	−44d18m03s	8.26	300	O9.5 Ib
HD 55879	07h14m28s	−10d18m58s	6.01	100	O9.5 II-III
HD 152247	16h54m11s	−41d38m30s	7.17	100	O9.5 II-III
HD 117856	13h34m43s	−63d20m07s	7.37	100	O9.5 III
HD 154643	17h08m13s	−35d00m15s	7.16	100	O9.5 III
HD 89137	10h15m40s	−51d15m24s	7.97	100	O9.5 III
HD 96622	11h06m59s	−59d40m04s	8.90	300	O9.5 IV
HD 152218	16h53m59s	−41d42m52s	7.60	100	O9.5 IV
HD 54879	07h10m08s	−11d48m09s	7.64	100	O9.5 V
HD 93027	10h43m17s	−60d08m03s	8.72	300	O9.5 V
HD 104649	12h02m58s	−62d40m19s	7.94	100	O9.5 V
HD 158186	17h29m12s	−31d32m03s	7.00	100	O9.5 V
HD 123056	14h07m25s	−60d28m14s	8.14	100	O9.5 V
HD 152003	16h52m47s	−41d47m09s	7.03	100	O9.7 Iab
HD 47432	06h38m38s	+01d36m48s	6.22	100	O9.7 Ib
HD 76968	08h57m28s	−50d44m58s	7.08	100	O9.7 Ib
HD 154811	17h09m53s	−47d01m53s	6.92	100	OC9.7 Iab
HD 150574	16h44m07s	−46d08m29s	8.49	300	ON9 III
HD 105056	12h05m49s	−69d34m23s	7.43	100	ON9.7 Ia
HD 123008	14h07m30s	−64d28m08s	8.83	300	ON9.7 Iab

Target	α (2000.0)	δ (2000.0)	m_V	Exp. time	Spectral type
OHP WR-type targets:					
WR137	20h14m31.8s	+36d39m39.6s	7.95	3600	WC7+O9, P$\sim$4765d
WR140	20h20m27.9s	+43d51m16.2s	6.887	3600	WC7pd+O4-5, P$\sim$2900d
WR135	20h11m53.5s	+36d11m50.5s	8.11	3600	WC8
WR133	20h05m57.3s	+35d47m18.1s	6.81	2400	WN5+O9I, P$\sim$112d
WR138	20h17m00.0s	+37d25m23.8s	8.06	1800	WN5+B?, P$\sim$1538d
WR139	20h19m32.4s	+38d43m54.0s	8.02	3600	WN5+O6, P$\sim$4.2d
WR134	20h10m14.2s	+36d10m35.1s	8.02	1800	WN6
WR136	20h12m06.5s	+38d21m17.7s	7.48	3600	WN6(h)
ESO WR-type targets:					
WR52	13h18m28s	−58d08m14s	9.86	900	WC4
WR111	18h08m28s	−21d15m11s	8.23	300	WC5
WR23	10h41m38s	−58d46m19s	9.67	900	WC6
WR90	17h19m30s	−45d38m24s	7.45	100	WC7
WR79	16h54m20s	−41d49m12s	6.95	2 obs (100s)	WC7+O, P=9d
WR57	13h43m16s	−67d24m05s	10.0	900	WC8
WR103	18h01m43s	−32d42m55s	8.86	300	WC9+?, dust maker
WR69	15h24m11s	−62d40m38s	9.43	900	WC9+OB, P=2d
WR46	12h05m19s	−62d03m10s	10.9	1800	WN3+OB?
WR6	06h54m13s	−23d55m42s	6.94	100	WN4
WR94	17h33m07s	−33d38m24s	12.27	3600	WN5
WR24	10h43m52s	−60d07m04s	6.49	100	WN6
WR25	10h44m10s	−59d43m11s	8.14	100	WN6+O4, P=208d
WR78	16h52m19s	−41d51m16s	6.61	100	WN7
WR22	10h41m18s	−59d40m37s	6.44	100	WN7+O9, P=80d
WR16	09h54m53s	−57d43m38s	8.44	300	WN8
WR40	11h06m17s	−65d30m35s	7.85	100	WN8
WR79b	16h55m06s	−44d59m21s	8.32	300	WN9
WR31b	10h56m12s	−60d27m13s	7.09	100	WN11

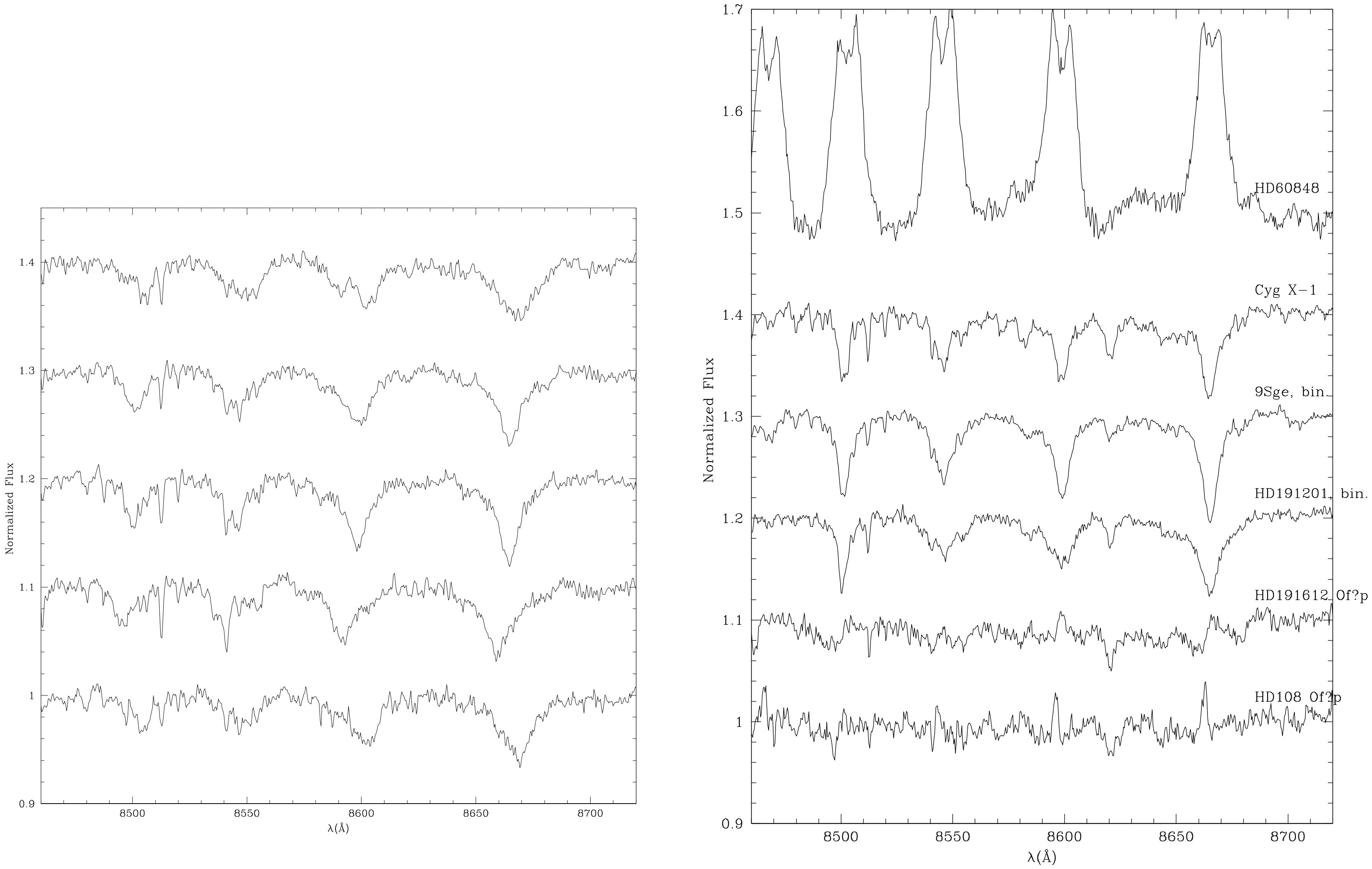

Figure 1: *Left:* The five observations of the binary AO Cas. The shifts due to orbital motion are clearly detected. *Right:* Some observations of peculiar objects. The Of?p objects were observed close to their quiescent state.

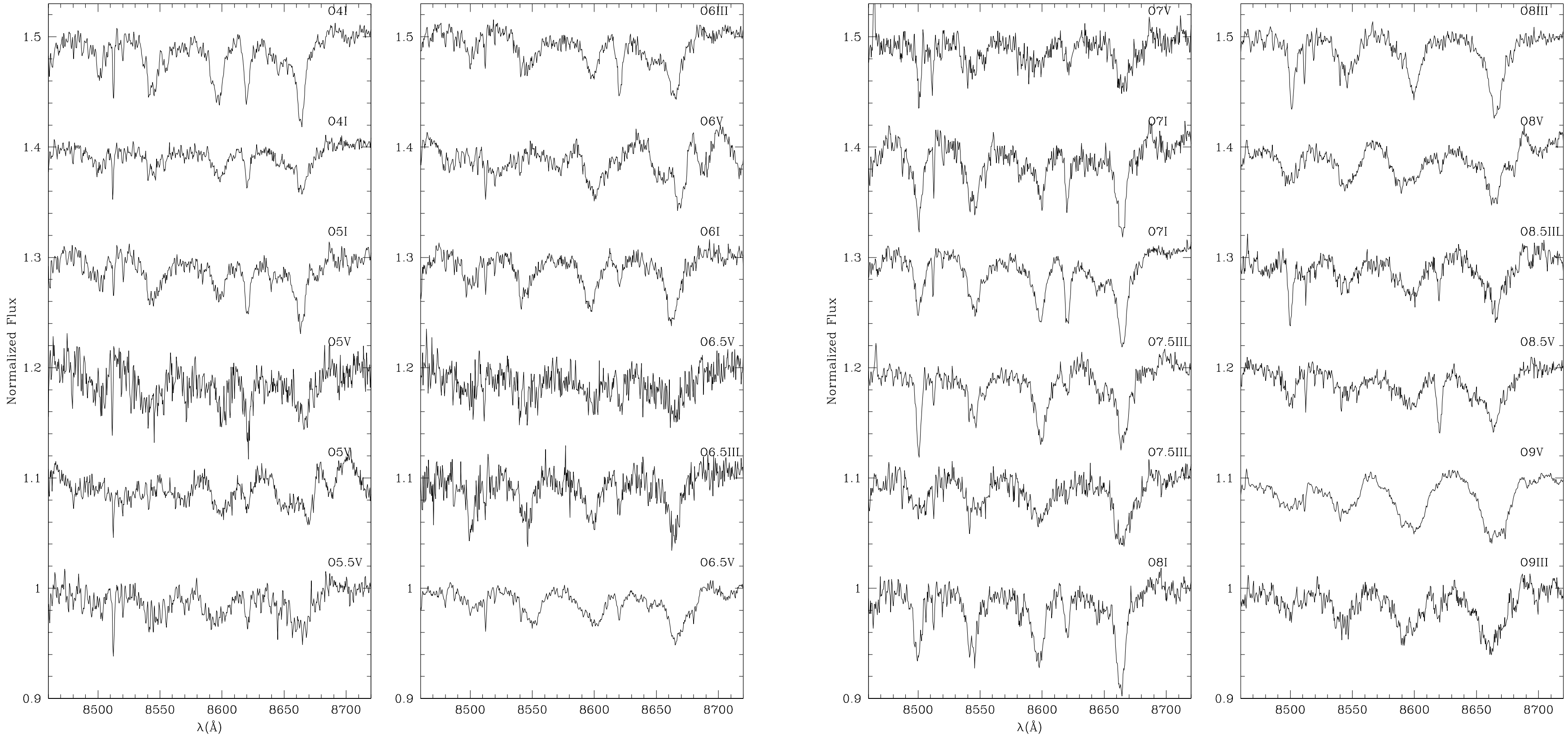

Figure 2: Typical spectra of O-type stars in the GAIA band, ranked by spectral type. Note that there are DIBs at 8620.75 (strong, narrow) and 8649 (shallow, broad) Å (Herbig 1995, ARA&A, 33, 19).

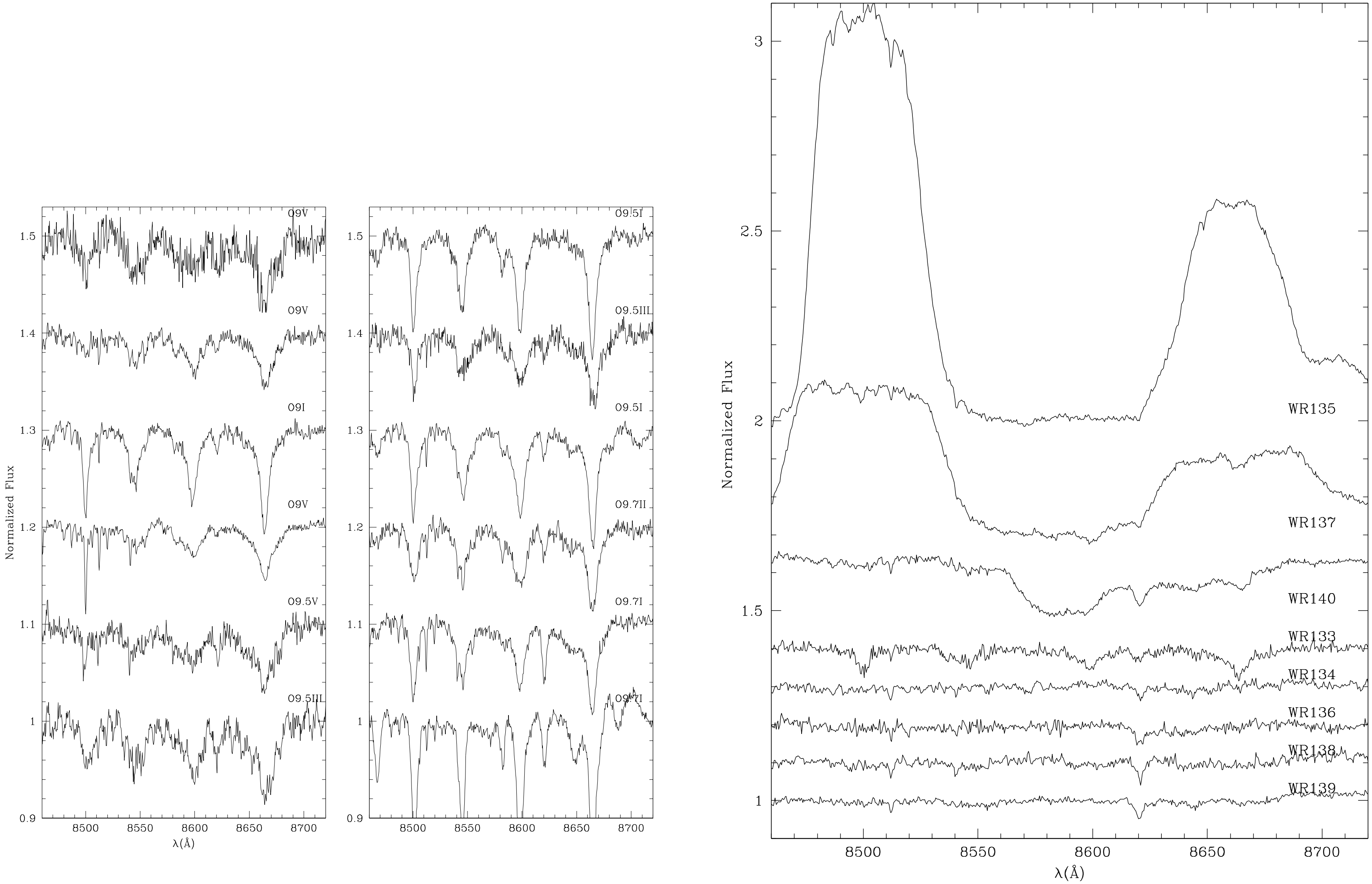

Figure 3: *Left:* Typical spectra of O-type stars in the GAIA band, ranked by spectral type (continued). *Right:* Typical spectra of some WR stars in the GAIA band. Note that the signature of the companion is easily distinguished in the WN+O system WR133.