Basics of astrophysics revisited. II. Mass- luminosity- rotation relation for F, A, B, O and WR class stars

Edgars Alksnis
e1alksnis@gmail.com

Small volume statistics show, that luminosity of bright stars is proportional to their angular momentums of rotation when certain relation between stellar mass and stellar rotation speed is reached. Cause should be outside of standard stellar model. Concept allows strengthen hypotheses of 1) fast rotation of Wolf-Rayet stars and 2) low mass central black hole of the Milky Way.

Keywords: mass-luminosity relation, stellar rotation, Wolf-Rayet stars, stellar angular momentum, Sagittarius A* mass, Sagittarius A* luminosity.

In previous work (Alksnis, 2017) we have shown, that in slow rotating stars stellar luminosity is proportional to spin angular momentum of the star. This allows us to see, that there in fact are no stars outside of "main sequence" within stellar classes G, K and M.

METHOD

We have analyzed possible connection between stellar luminosity and stellar angular momentum in samples of most known F, A, B, O and WR class stars (tables 1-5). Stellar equatorial rotation speed (vsin*i*) was used as main parameter of stellar rotation when possible. Several diverse data for one star were averaged. Zero stellar rotation speed was considered as an error and corresponding star has been not included in sample.

RESULTS

F class star	**Relative mass, M⊙**	**Relative radius, R⊙**	**Luminosity, L⊙**	**Relative rotation, ω_{eq}⊙**	**$\frac{M*R^2*\omega_{eq}}{L}$**
HATP-6	1.29	1.46	3.55	2.950	2.28
α UMi B	1.39	1.38	3.90	38.573	26.18
Alpha Fornacis	1.33	2.04	4.87	0.925	1.05
ζ Her A	1.45	2.58	6.55	0.900	1.33
51 Eri A	1.75	1.45	6.70	25.998	14.28
Procyon A	1.499	2.048	6.93	0.747	0.68
ω And A	0.963	2.2	7.10	12.560	8.25
δ Aql A	1.65	2.04	7.35	20.709	19.35
Theta Ursae Majoris	1.41	2.365	7.87	1.391	1.39
36 Persei	1.54	2	8.38	6.775	4.98
ι Vir A	1.5	2.5	8.70	3.097	3.34
ρ Cap A	1.52	1.3	9.00	32.645	9.32
Omicron^2 Cancri	1.72	1.62	10.30	27.033	11.85
Gamma Tucanae	1.55	2.2	11.33	20.676	13.69
Iota Leonis	1.66	2.1	11.50	3.687	2.35
Xi Geminorum	1.706	2.7	11.57	11.847	12.73

20 Oph A	1.7	3	12.06	1.823	2.31
Iota Microscopii	1.67	2.4	12.65	16.937	12.88
44 Ophiuchi	1.77	1.9	13.00	19.866	9.76
Rho Puppis	1.85	3.4	22.00	2.135	2.08
16 Persei	1.92	3.2	23.36	22.532	18.96
Omicron^1 Eridani	1.95	3.7	27.00	14.138	13.98
υ UMa A	1.57	2.79	29.50	21.542	8.92
Alpha Hydri	2	1.8	32.00	31.723	6.42
Upsilon Pegasi	2.17	6	42.35	2.718	5.01
δ Del A	1.52	3.9	56.90	3.648	1.48
Zeta Leonis	3	5	85.00	7.007	6.18
Psi^3 Piscium	2.8	11.2	86.70	3.789	15.35
15 Orionis	3.42	5.9	300	4.921	1.95
α UMi Aa	5.4	37.5	1260	0.181	1.09
Theta Scorpii	5.66	26	1834	2.326	4.85
Delta Cephei	4.5	33.5	2000	0.130	0.33
Zeta Geminorum	7.7	65	2900	0.141	1.59
Alpha Persei	8.5	68	5000	0.142	1.12
45 Draconis	8.2	62	5450	0.078	0.45
35 Cygni	10	51	7093	0.033	0.12
89 Herculis	1	71	8350	0.157	0.09
Nu Aquilae	10.6	78	11800	0.081	0.44
Alpha Leporis	13.9	129	32000	0.079	0.57
Gamma Cygni	12.11	150	33023	0.048	0.40
Delta Canis Majoris	16.9	237	82000	0.051	0.59
Phi Cassiopeiae	8.3	263	170000	0.042	0.14

Table 1. Proportional calculations for F- class stars.

O class star	Relative mass, M⊙	Relative radius,R⊙	Luminosity, L⊙	Relative rotation, ω_{eq}⊙	$\frac{M*R^2*\omega_{eq}}{L}$
σ Ori B	14	5	15800	24.196	0.54
σ Ori Ab	13	4.8	18600	3.529	0.06
HD 48099 sec	19	6.5	40000	13.773	0.28
σ Ori Aa	18	5.6	41700	11.666	0.16
AE Aurigae	23	7.47	59000	1.620	0.04
AO Cassiopeiae V	15.59	4.61	66000	13.646	0.07
Zeta Ophiuchi	20	8.5	91000	22.772	0.36
HD 150136 tert	33	8.24	102000	4.228	0.09
10 Lacertae	26.9	8.27	102000	2.048	0.04
AO Cassiopeiae II	9.65	9.43	115000	6.158	0.05
V3903 Sagittarii A	27.3	8.09	122000	13.758	0.20
Plaskett's Star	56	10.8	123000	13.442	0.71
LH54-425 O5	28	8.1	160000	10.873	0.12
Theta^1 Orionis C1	33	10.6	204000	1.096	0.02
HD 150136 sec	40	9.54	209000	6.899	0.12
S Monocerotis Aa	29.1	9.9	214000	5.866	0.08
19 Cephei	20	17	224000	1.366	0.04
Alnitak Aa	33	20	250000	2.662	0.14

AB7 O	44	14	316000	5.185	0.14
Mu Normae	33.3	25	339000	1.103	0.07
Cygnus X-1	15	21	350000	4.370	0.08
HD 48099 prim	55	11.6	450000	13.766	0.23
LH54-425 O3	47	11.4	500000	8.362	0.10
Alpha Cam	30.9	29	620000	1.335	0.06
Lambda Cephei	51.4	19.5	630000	5.211	0.16
SMC AB8 O	61	14	708000	4.148	0.07
HD 5980 C	34	24	708000	2.420	0.07
HD 150136 prim	63	12.13	724000	6.822	0.09
BI 253	84	10.7	912000	9.045	0.10
HD 93129 Aa	110	22.5	1480000	2.796	0.11
HD 5980 A	61	24	2200000	5.041	0.08
Melnick 42	189	21.1	3600000	5.504	0.13

Table 2. Proportional calculations for O- class stars.

A class star	**Relative mass, M☉**	**Relative radius,R☉**	**Luminosity, L☉**	**Relative rotation, ω_{eq}☉**	**$\frac{M*R^2*\omega_{eq}}{L}$**
Iota Boötis	1.81	1.6	9.60	43.552	21.02
44 Ophiuchi	1.77	1.9	13.00	19.866	9.76
Alpha Cephei	1.74	2.3	17.00	51.758	28.02
Fomalhaut	1.92	1.84	16.60	24.459	9.58
β Aur A	2.39	2.77	48.00	5.765	2.20
β Aur B	2.33	2.63	48	6.256	2.10
Beta Eridani	2	2.4	25	39.519	18.21
α Oph A	2.4	2.6	25	44.669	28.64
Pi Draconis	2.7	3.2	60	3.932	1.81
Epsilon Ursae Majoris	2.91	4.2	108	3.802	1.81
Alpha Sextantis	2.96	4.5	120	2.258	1.13
Alpha Doradus	3.33	3.5	195	8.400	1.76
Beta Carinae	3.5	6.8	288	10.369	5.83
α Dra A	2.8	3.4	479	3.729	0.25
HD 59612	12.9	44	10864	0.297	0.68
Eta Leonis	10	47	19000	0.021	0.02
HD 21389	19.3	97	55000	0.125	0.41
Nu Cephei	16.5	137	102000	0.053	0.16
6 Cassiopeiae	22	217	200000	0.112	0.58
HD 160529	13	249	290000	0.066	0.18
Deneb	19	203	196000	0.048	0.19
AG Carinae	55	275	1500000	0.387	1.07

Table 3. Proportional calculations for A- class stars.

B class star	Relative mass, M☉	Relative radius, R☉	Luminosity, L☉	Relative rotation, ω_{eq}☉	$\frac{M*R^2*\omega_{eq}}{L}$
Lambda Aquilae	3.1	1.9	55	26.233	5.34
Alpha Sagittarii	2.95	2.49	117	13.798	2.16
β Per Aa1	3.17	2.73	182	8.686	1.13
Beta Canis Minoris	3.5	3.5	195	29.035	6.38
Alpha Gruis	4	3.4	263	30.600	5.38
A Centauri	3.58	2.75	306	28.155	2.49
Epsilon Doradus	4.31	3.8	556	2.165	0.24
Lambda Librae	5.01	3.9	743	19.232	1.97
Spica (sec)	6.97	3.64	1500	11.566	0.71
ε Cas	9.2	6	2500	2.420	0.32
Achernar**	6.7	9.35	3150	12.939	2.41
β Sco C	8.2	2.9	3200	9.178	0.20
1 Scorpii	10.3	3.7	3890	40.544	1.47
Alpha Muscae	8.8	4.8	4000	11.493	0.58
Alpha Arae	9.6	4.5	5800	40.326	1.35
Omega Orionis	7	5.9	6031	14.681	0.59
Eta Centauri	12	5.5	8700	29.035	1.21
Spica (primary)	10.25	7.4	12100	13.013	0.60
Omega Canis Majoris	10.1	6.2	13081	6.244	0.19
δ Ori Aa2	8.4	6.5	16000	11.167	0.25
X Persei	15.5	6.5	29000	16.006	0.07
Beta Crucis A	16	8.4	34000	2.016	0.15
η Ori A	20	10	38000	2.903	0.40
δ Ori Ab	22.5	10.4	63000	10.237	0.08
Beta Cephei	15.85	5.6	15100	2.420	0.31
CS Camelopardalis	19	85.7	75900	0.169	0.34
DS Crucis	29	112	79400	0.073	0.15
Chi Aurigae	17.75	42.3	95000	0.458	0.25
Aludra	19.19	56.3	106442	0.430	0.20
3 Geminorum	21	36.6	129000	0.939	0.07
Markova & Puls 2008	12	32	129000	0.681	0.06
9 Cephei	21	39.8	151000	0.888	0.20
10 Persei	26	51.4	250000	0.772	0.21
DL Crucis	30	42	251000	0.495	0.10
BU Crucis	29.2	41.6	275000	0.872	0.16
55 Cygni*	23	59.5	401000	0.496	0.10
Chi^2 Orionis	42.3	61.9	446000	0.563	0.20
BP Crucis	43	70	470000	0.380	0.17
CPD−57° 2874	18	60	500000	0.290	0.04
P Cygni	30	76	610000	0.223	0.06
Alnilam	47.25	42	832000	0.634	0.06
$Zeta^1$ Scorpii	36	103	850000	0.282	0.13

Table 4. Proportional calculations for B- class stars.

WR star class	Relative radius, R⊙	Relative mass ,M⊙	Luminosity, L⊙	Relative rotation, ω_{eq}⊙ (calculated)
WN2	0.89	16	280 000	2210
WN3	2.3	19	220,000	219
WN4	2.3	15	200,000	252
WN5	3.7	15	160,000	78
WN6	5.7	18	160,000	27
WN6h	25	74	3,300,000	7.1
WN7	6.0	21	350,000	49
WN7h	23	52	2,000,000	7.3
WN8h	22	39	1,300,000	6.9
WN9h	23	33	940,000	5.4

Table 5. Speculative calculation of relative rotation of WR stars.

DISCUSSION

Within our concept stellar spin is involved in generation of stellar luminosity. If stellar spin is only factor which influences stellar luminosity, stellar angular momentum/stellar luminosity relation should be over one, what is not always the case. Within angular momentum/luminosity relation in stars two departures from linearity could be expected- 1) nonlinearity connected with rising of mass, 2) nonlinearity connected with rise of rotation speed. We cannot see first type of nonlinearity in data. Fast rotating stars (class F, class A and partially class B) typically give poor correlation between stellar angular momentum and stellar luminosity perhaps due to non optimal mass- rotation speed relation. Stellar data generally strengthen low mass black hole concept.

CHECKING ANGULAR MOMENTUM- LUMINOSITY RELATION FOR BLACK HOLE

Known measurement of far infrared luminosity of Sagittarius A* (Becklin et al, 2002) allow us to check validity of low mass central black hole concept (De Mees, 2009). DeMees considered accepted value of mass of Sagittarius A* seriously overestimated due to incorrect application of laws of celestial mechanics (cf. Alksnis, 2016).

Let us analyze two sets of data of Sagittarius A* (table 6):

	Supermassive Sagittarius A*	**Low mass Sagittarius A***
Relative mass, M⊙	4 000 000	10 000
Relative radius, R⊙	31.6	31.6
Rotation, km/sec	30 000	1000
Relative spin, ω_{eq}⊙	453	16.3
Luminosity L⊙	20 000 000	20 000 000
$\frac{M*R^2*\omega_{eq}}{L}$	90 000	8.1

Also within this speculative relation, accepted value of Sagittarius A* mass look overestimated.

References

Alksnis E. (2016) Dark matter? No Descartes and Kozyrev's Universe! viXra:1603.0366

Alksnis E. (2017) Basics of Astrophysics Revisited. I. Mass-luminosity Relation for K, M and G Class Stars. viXra:1709.0129

Becklin E. et al. (1982) Far-infrared observations od Sagittarius A: the luminosity and dust density in the central parsec of the galaxy. The Astrophysical Journal, **258**, 135

De Mees T. (2009) How Really Massive are the Super-Massive Rotating Black Holes in the Milky Way's Bulge? *General Science Journal*.