This online essay is an extended version of the essay in the printed-edition Handbook, containing all the material of its printed-edition accompaniment, but adding material of its own. The accompanying online table is likewise an extended version of the printed-edition table, *(a)* with extra stars (the brightest 315, allowing for variability, where the printed edition has almost 30 fewer, allowing for variability: our cutoff is magnitude ~3.55), and *(b)* with additional remarks for most of the duplicated stars. The online essay and table try to address the needs of three kinds of serious amateur: amateurs who are also astrophysics students (whether or not enrolled formally at some campus); amateurs who, like many in RASC, assist in public outreach, through some form of lecturing; and amateurs who are planning their own private citizen-science observing runs, in the spirit of such "pro-am" organizations as AAVSO.

Of our selected 315 stars, three call for extra comment pertinent to our magnitude ~3.55 selection criterion. (1) κ (kappa) CMa (at RA ~6h50) brightened in the 1960s or 1970s, just managing to meet the cutoff criterion, and has remained bright. This change was unfortunately not noted in the RASC Handbook until 2019. Should κ CMa now once again fade, we propose to keep listing it for at least a few years, since it is a variable of the γ Cas type (and may therefore be liable to yet further episodes of brightening during the 21st century; in general, the γ Cas variables, whether temporarily bright or temporarily faint, are desirable targets for ongoing, regular, citizen-science spectroscopy monitoring). (2) We discontinued listing L_2 Pup (at RA ~07h14) in the 2017, 2018, and 2019 Handbooks. Now, however, we revert to our pre-2017 policy, since L_2 Pup is a semi-regular pulsator, occasionally bright. (3) T CrB (at RA ~16h00) has shown nova behaviour, brightening from its current very faint state (magnitude ~10) to magnitude 2.0 in 1866 and to magnitude 3.0 in 1946. We have for years listed this star in our table and propose to continue listing it (since the history suggests the possibility of a 21st-century outburst).

An omission from our selection of 315 stars also calls for comment: while mindful of the fact that η Car brightened greatly, attaining even magnitude 0 for a few years from 1837 onward, we omit it from our table since there is no firm prognosis of a 21st-century repetition of that outburst. (In January 2018, η Car was around V = 4.3, thus being decidedly fainter than our magnitude cutoff. The star was at that time exhibiting only small brightness fluctuations, on the order of 0.1 mag.)

Our online project, now a couple of years old, must be considered still in its early stages. We cannot claim to have fully satisfied the needs of our three constituencies. Above all, we cannot claim to have covered all the appropriate points from stellar-astronomy news in our "Remarks" column, important though news is to amateurs of all three types. We would hope in coming years to remedy our deficiencies in several ways, above all by relying more in our writing on recent primary-literature journal articles, with appropriate explicit citations. We have as of 2019 Dec. 31 supplemented our previous editions of this online publication in various ways, most notably by adding the (rather prolix) results of (rather detailed) primary-literature inspections for ο Cet, α UMi, β Per, α Tau, ε Aur, α Ori, γ^2 Vel, α Leo, α Vir, ζ Oph, and α Lyr. It can be seen from these specific cases that bright-star studies have entered a stage of rapid evolution since 2005 or 2010, thanks to improvements in ground-based interferometry, for instance at NPOI and CHARA (where the brightest stars are observationally favoured, as delivering good signal-to-noise ratios).

In our bibliographic work, we use the now-preferred astrophysics "bibcode" formalism (as documented in http://simbad.u-strasbg.fr/guide/refcode/refcode-paper.html, and again in section 1.2.3 (headed "Bibliographic Identifiers") in http://adsabs.harvard.edu/abs_doc/help_pages/data.html). The bibliographic support of http://simbad.u-strasbg.fr/simbad/ and https://ui.adsabs.harvard.edu/, as the principal tools for our primary-literature searching, is herewith gratefully acknowledged.

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Our sample of 315 stars, the Sun included ("Sample S"), is found to lie in a region, around 3000 ly in radius, essentially confined to the sandwich-filler, or "thin disk," part of the overall galactic disk. Of the few Sample-S interlopers born outside the sandwich filling, and now temporarily passing through it on orbits oblique to the thin disk, the best known is α Boo. It is convenient here to use the term "Population P" for the ensemble of non-brown-dwarf, non-white-dwarf stars in the much larger, 3000-ly radius, subdisk-of-the-thin-disk from which our (tiny) Sample S is drawn. This P-region is itself only a (tiny) fraction of the overall galactic thin-disk region, ~50,000 ly in radius.

Sample S, being formally defined by an apparent-magnitude cutoff as opposed to a distance cutoff, is itself far from statistically representative of Population P. *(a)* In P, the O stars are vanishingly rare. A tabulation by Glenn Ledrew, in *JRASC* **95** (2001), pp. 32ff (bibcode 2001JRASC..95…32L) suggests an O-star frequency within P of just 0.00003%. By contrast, O stars comprise a hefty 2% of S. A similar overrepresentation occurs for the B, A, F, G, and K stars, with Ledrew's tabulation suggesting that these MK temperature types might have a respective frequency within P of 0.1%, 0.6%, 3.2%, 8.0%, and 12.9%. (A small caveat: unavoidable rounding errors make our various percentages, throughout this discussion, capable of adding up to 99% instead of 100%, or to 99.9% instead of 100.0%.) By contrast, these five types comprise 28%, 19%, 9%, 13%, and 21%, respectively, of S. *(b)* In P, something on the order of 76% or 78%—different authorities are perhaps mildly discrepant—must be M stars. (Ledrew's tabulation, in particular, suggests an M-star frequency of 78.2%.) Only a few of these (the Ledrew tabulation suggests 0.04%) have evolved to beyond the main sequence stage of stable-core hydrogen fusion. By contrast, the M stars comprise just 7% of S. All of them have evolved beyond the main sequence, having started their lives as types hotter than M or K.

The statistically anomalous character of S is further illustrated by the fact that in S, in each of the Big Six MK temperature types hotter than M, the numerical majority comprises the stars that have ended stable-core hydrogen fusion (and so have, as a generally reliable rule—we return below to a necessary caveat regarding reliability—evolved out of main sequence MK luminosity class V into one of the brighter MK luminosity classes IV, III, II, or I). In Ledrew's tabulation, the percentages of evolved stars in F, G, and K, as a percentage of the overall respective F, G, and K populations, are just 2.0%, 2.5%, and 3.8%. Consistently with this, the 1991 Gliese-Jahreiss catalogue of the nearest 1000 stars (containing, admittedly, not only the local OBAFGKM VI, V, IV, III, II, and I stars, but also at least many of the local white dwarfs) assigns less than 1% of its population to MK luminosity classes IV, III, II, or I.

Sample S—so rich in varieties of star statistically infrequent within Population P—harbours physical extremes. Although the extremes are for the most part not written into our table, they can be studied easily, from such sources as Prof. James Kaler's http://stars.astro.illinois.edu/sow/sowlist.html.

Around 58 of our 315 each radiate, across the full spectrum from X-ray through UV and optical to IR and radio, at least as much power as is radiated by 10,000 Suns. The most dramatic is ζ Ori, with a bolometric luminosity of 375,000 Suns—making ζ Ori notable not within S alone, but even within the overall galaxy. Several others are not far behind, among them ζ Pup (360,000 Suns, suggests Kaler, as of July 2008 revising his earlier, circa-1999, suggestion of ~750,000 Suns). Just two stars in Sample S, nearby τ Cet and nearby α Cen B, radiate more feebly than our Sun, each at about 0.5 of the Sun's bolometric luminosity.

The principal determinant of stellar luminosity, for any given phase in stellar evolution, is mass, with even small variations in mass translating into large variations in energy output. The exceptional luminosities of ζ Ori and ζ Pup, in particular, are a consequence of their exceptionally high respective masses, 20 $M_{\odot}$ and 40 $M_{\odot}$. (Kaler now suggests 40 $M_{\odot}$ for ζ Pup, while having previously suggested 60 $M_{\odot}$. He additionally notes from the literature the lower suggested value of 22.5 $M_{\odot}$.)

Theory does predict, although our small Sample S does not succeed in illustrating, the possibility of masses up to the Eddington stellar-mass limit, somewhere above 100 $M_{\odot}$, and even of some "super-Eddington" stars. (Eddington's limit is by definition attained when luminosity rises so high as to make the outward radiation push, tending to tear a star apart, exceed the inward gravitational pull.)

Rotation periods in Sample S vary from far in excess of our Sun's to far short of our Sun's (which we may here take as a nominal 27 d; refined treatments of solar rotation provide for rotation-period variations both with solar latitude and with solar depth). Spectroscopy yields for γ Cep a period of 781 d, i.e. of 2.14 y. Kaler suggests that the respective rotation periods of α Hya and ε Crv could be as long as 2.4 y and 3.9 y. Perhaps our slowest rotator, however, is α Ori, now (cf 2009A&A...504..115K) assigned the period of 8.4 y. At the other extreme, Kaler suggests for ζ Aql A, α Aql, and ζ Lep, respectively, 16 h, at most10 h, and around 6 h.

Radii (as distance from centre to outermost opaque layer, perpendicular to the axis of stellar rotation) are typically greater than the solar radius. Two notable instances of stellar expansion—in other words, of notably tenuous stellar atmosphere—are α Sco (with a radius of 3.4 AU, not far short of the Sun-Jupiter distance) and α Ori (with a radius of 4.1 AU or 4.6 AU from interferometry, or alternatively 3.1 AU or 3.4 AU from luminosity-temperature deductions). Results in these extreme cases depend strongly on the wavelength selected for evaluating opacity. Observations within Population P do indicate, although our sample S does not succeed in illustrating, the possibility of still more extreme stellar radii, to values approaching ~10 AU. (Among these extreme-radius cases is a vividly red star well known to binocular enthusiasts, though a bit too faint for our table, μ Cep.)

The broad range of temperatures is reflected in the fact that all of the Big Seven temperature-type bins in the MK classification scheme are well occupied, however statistically skewed (as we have argued above) is the distribution in the MK Big Five luminosity-class bins (with 7 O stars, 89 B stars, 61 A stars, 28 F stars, 41 G stars, 66 K stars, and 22 M stars). At the MK temperature extremes are the hot ζ Pup (O5; 42,000 K) and the cool ο (omicron) Cet (M5-10; a typical temperature for this variable is variously suggested as ~2000 K or ~3000 K).

Interesting spectral anomalies in Sample S include the sky's brightest Wolf-Rayet star (of exotic MK type W, rather than in the everyday gamut OBAFGKM) as γ Vel Ab, and several Be, or emission-line, stars (marked in our table, and where appropriate accompanied by notations indicating "shell," or circumstellar ejecta disk aligned nearly edge-on with the observatory line of sight). Especially worth monitoring at the moment, both photometrically and (for possible Be behaviour) spectroscopically is δ Sco, a binary system stimulated into outburst by periastron passage in 2000 and 2011, and therefore perhaps due for another outburst around 2022.

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We use the flags "+nP" (n = 1, 2, ...) for companions of sub-stellar mass, such as have been found outside our Solar System, in an accelerating sequence of discoveries that has eventually reached even the tiny Sample S, from the 1990s onward. Such companions are typically planets but could in principle also be brown dwarfs. We do not attempt here to define formally the difference between a planet and a brown-dwarf companion.

We apply the WDS naming scheme for multiplicity, both in the case of true binarity and in the case of mere optical doubles. We try to supply particulars, at any rate in the online table, for binary and mere-optical companions brighter than magnitude 10.

Apparent Visual Magnitude (**m_V** = V): Apparent magnitudes, with "v" appended for large-amplitude variables, are from *HIPPARCOS*. In the case of variable, we are trying, without necessarily in all cases attaining full consistency, to take as authoritative the V-magnitude ranges, and also the periods, published in the online AAVSO(VSX) database. Our reasoning here is that AAVSO has critically appraised and filtered data originally presented in more upstream sources, such as the primary (journal-article) literature. Our "V" is the usual "V" of UBV photometry, as introduced by H.L. Johnson and W.W. Morgan in 1953ApJ…117..313J. The (yellow) V filter corresponds roughly to the response of the eye. We retain, without having attempted our own independent error analysis, the assertion of our Handbook predecessor R.F. Garrison (working essentially before *HIPPARCOS*) that the "probable error" of each of our cited V values is at most 0.03 mag. (in other words, that of the actually and potentially available V measurements from the world's duly competent photometry facilities, at least half will lie within 0.03 mag. of our own cited V values).

Spectral Classification (**MK Type**): The "temperature type" (O, B, A, F, G, K, M) is given first, followed by a finer subtype (0-9) and a "luminosity class" (Roman numerals I-V, with "a" or "b" added occasionally to indicate slightly brighter or fainter stars within the class). O stars are the hottest, M stars coolest; Ia stars are termed the most luminous "supergiants"; III stars are termed "giants"; and V stars are termed "dwarfs." V stars form the largest class in the cosmos, comprising the main sequence (as a region in two-dimensional MK-luminosity-class-versus-MK-temperature-type classification space). Other MK symbols include "e" for hydrogen emission; "f" for broad, non-hydrogen emission in hot stars; "m" for strong metallic absorption; "n" or "nn" for unusually broad absorption (a signature of rotation); "p" for peculiarities; "s" for a mixture of broad and sharp lines; and ":" for a minor uncertainty. Where a single star (e.g. α CMa A) is given two types, with the second flagged "m", the first is the type that best characterizes the hydrogen lines, the second the type that best characterizes the metal lines.

"Supergiant," "giant," "dwarf," and "main sequence" are in our present Handbook usage phenomenological labels, serving as mnemonics for referring, in a suitably memorable way, to what is actually seen in the spectra. It is a substantive astrophysical claim, going beyond our phenomenology, that what is spectrally a dwarf, in other words spectrally a main-sequence star, has a stable hydrogen-fusing core, and that our so-called "giants" and "supergiants" have evolved to differing stages at which core hydrogen fusion is finished. In assigning a star to a luminosity class, we are making a phenomenological, not an astrophysical, claim.

It can occasionally be the case that a star is phenomenologically a dwarf, and yet astrophysically has evolved beyond the core-hydrogen-fusion stage. Conversely, it can occasionally be the case that a star is too luminous (this is phenomenology) to be a dwarf, and yet astrophysically is still in the stable core-hydrogen-fusion stage. Infrequent though such a possibility is, our Sample S does illustrate it, at any rate in the case of stable core-hydrogen-fusers χ Car (B3 IV), α Tel (B3 IV), λ Uma (A1 IV), β Cru (B0.5 III), ν Cen (B2 IV), ζ Cen (B2.5 IV), ι Lup (B2.5 IVn), α Lyr (A0 Va, thanks to its rotationally flattened shape and its pole-on orientation; seen equator-on, α Lyr would be a slightly less luminous A0 V), and the celebrated variable β Cep (B1 III).

This conceptual, phenomenology-versus-astrophysics, point aside, we note (now purely at the level of phenomenology) that MK classifications are in some cases controverted. We have inherited our own phenomenological types for the most part from the judgements of our predecessor R.F. Garrison, who, as a principal historical authority in MK classification, drew both on what he judged to be the best of the literature and on some of his own unpublished classifications. As of 2019 Dec. 31, we have made only a modest beginning at flagging the cases of controverted MK phenomenology (in our online, but not in our printed-edition, "Remarks" column).

The initial portions of Richard Gray and Chris Corbally, *Stellar Spectral Classification* (Princeton University Press; in the "bibcode" formalism, 2009ssc..book…..G) provide a background briefing on MK classification.

Parallax (**π**), *Proper Motion* (**μ**), and *Position Angle* (**PA**): Parallaxes, in milliarcseconds (mas), proper-motion vector norms (″/y), and vector position-angles (degrees, from N through E) are derived from the *HIPPARCOS* 2007 data reduction, with a few exceptions. It may be hoped that in future years more precise parallaxes will be forthcoming from the *Gaia* mission, which has now found an engineering solution significantly easing its initial restriction to the fainter stars. (Detector overload had been feared.) Like *HIPPARCOS*, *Gaia* has to cope with the special challenges posed in measuring to high precision (*i*) the parallax of a (orbitally wobbling) star possessing a gravitationally bound, and not necessarily well documented, companion, and (*ii*) the parallax of a star with perturbed photosphere, and consequently with displaced photocentre (as when a tight binary system contains a bright mass-transfer stream).

Absolute Visual Magnitude ($\mathbf{M_V}$) and *Distance in Light-Years* (**D**): Absolute magnitudes and distances are determined from parallaxes, except where a colon follows the absolute magnitude; in these cases, both quantities are determined from a calibration of the spectral classification. The absolute magnitude is left uncorrected for interstellar absorption. The appropriate correction is typically ~+0.06 mag. per 100 ly outside the Local Bubble, i.e. beyond ~100 ly. A special difficulty, not fully grasped by us, arises in the case of the controverted ε Aur distance (for which we now use *Gaia* DR2, additionally supplying references to the recent literature).

We take account of uncertainties in parallaxes by stating the derived distances, in ly, to no more than the appropriate number of significant figures (rounding where necessary). In cases where rounding would itself be misleading, we use a tilde as an indicator of imprecision.

Radial Velocity ($\mathbf{V_{rad}}$): Radial velocities are from BSC5. "SB" indicates a spectroscopic binary, an unresolved system whose duplicity is revealed by periodic Doppler oscillations in its spectrum and for which an orbit is possibly known. If the lines of both stars are detectable, "SB2" is used; "+" and "–" indicate, respectively, motion away from and toward the observer. "V" indicates a variable velocity in a star not observable as a spectroscopic binary. (In most "V" cases, the orbit is unknown.)

Remarks: Remarks include data on variability and spectra, particulars of any companions, and (for the most part, only in our online table) prominent bits of observational-astronomy news. In a departure from our practice prior to 2017, we now give star names in all and only those cases in which star names are formally promulgated in the International Astronomical Union (IAU) star-naming project, as launched in 2016 at http:/www.iau.org/public/themes/naming_stars. In contrast with traditional naming practice, IAU names are meant never to apply to an entire binary (or higher-multiplicity) system, but only to the primary star. Readers requiring further information on names could start with the individual star descriptions in http://stars.astro.illinois.edu/sow/sowlist.html. Richard Hinckley Allen's 1899 book *Star Names: Their Lore and Meaning* has been much cited over the decades. More recent scholarship, with due professional attention to Arabic philology, is however, presented in Paul Kunitzsch and Tim Smart, *Short Guide to Modern Star Names and their Derivations* (Wiesbaden, 1986), and (by the same pair of authors) *Dictionary of Modern Star Names: A Short Guide to 254 Star Names and their Derivations* (Cambridge, MA, circa 2006). In the **Remarks** column, a **boldface** star name indicates a navigation star.

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The following is a glossary of the acronyms or similar designations used in our essay and table. We omit, as sufficiently obvious, a small handful of universally known acronyms (e.g. NASA), designations of chemical elements and chemical compounds (e.g. CO, for carbon monoxide), and designations of particular satellites or similar space missions (e.g. *Gaia*, *HIPPARCOS*, *MOST*, *ROSAT*).

- AAVSO: American Association of Variable Star Observers
- AAVSO(VSX): AAVSO International Variable Star Index (www.aavso.org/vsx/)
- ALMA: internationally funded Chile-based radio interferometer ("Atacama Large Millimetre/submillimetre Array")
- AMBER: spectro-interferometer at VLT ("Astronomical Multi-BEam combineR")
- AGB: asymptotic giant branch (as a region in the two-dimensional luminosity-versus-temperature stellar classification space)
- AU: astronomical unit (the formal 1976 IAU definition is in effect a precisification of the earlier epoch-of-Kepler AU concept, under which the AU was the average of the Earth-Sun distances at aphelion and at perihelion)
- Be star: star of MK temperature type B, with some spectral lines in emission rather than in absorption
- BSC5: Yale Bright Star Catalog, Version 5
- BSG: blue supergiant
- CHARA: the Mount Wilson optical interferometer (Center for High Angular Resolution Astronomy)
- CME: coronal mass ejection
- COAST: the Cambridge optical interferometer (Cambridge Optical Aperture Synthesis Telescope)
- CODEX: a series of computer codes for the numerical simulation of stellar atmospheres
  (Cool Opacity-sampling Dynamic EXtended)
- DR2: Data Release 2 (at *Gaia*)
- FDU: First Dredge-Up (as a stage in stellar evolution, soon after a star evolves out of the MS)
- FUV: far ultraviolet
- GCVS: General Catalogue of Variable Stars (Sternberg Astronomical Institute, Moscow)
- GTR: general theory of relativity
- IAU: International Astronomical Union (Paris)
- ISM: interstellar medium
- IR: infrared
- Hp: a visible-light passband used for photometry at *HIPPARCOS*
- HM Nautical: "Her/His Majesty's Nautical" (for UK publications and UK agencies)
- HR diagram, HR plot: two-dimensional luminosity-versus-temperature plot for the members of some given population of stars
- IS: instability strip (as a region in the two-dimensional luminosity-versus-temperature stellar-classification space)
- LPV: long-period variable
- LSR: Local Standard of Rest (as reference frame for kinematics of bodies in our own galaxy)
- $M_\odot$: solar mass
- mas: milliarcsecond
- MK: Morgan-Keenan (two-dimensional stellar classification scheme, with "MK luminosity classes" and "MK temperature types")
- MS: main sequence (as a region in the two-dimensional luminosity-versus-temperature stellar classification space)
- My: megayears
- NCP: North Celestial Pole
- NPOI: a US Naval Observatory facility (Navy Precision Optical Interferometer)
- NSV: New Catalogue of Suspected Variable Stars (Sternberg Astronomical Institute, Moscow)
- PA: position angle
- PTI: Palomar Testbed Interferometer
- $R_\odot$: solar radius
- R*: stellar radius (with reference to some given, reasonably spherical, star)
- Req: equatorial radius (with reference to some given rotationally flattened star)
- RGB: red giant branch (as a region in the two-dimensional luminosity-versus-temperature stellar classification space)
- Rpol: polar radius (with reference to some given rotationally flattened star)

- RSG: red supergiant
- SAAO: South African Astronomical Observatory
- SB: spectral binary
- SETI: search for extraterrestrial intelligence
- SMEI: Solar Mass Ejection Imager, as an instrument on the *CORIOLIS* satellite
- SN: supernova
- SNR: supernova remnant
- SWB: stellar-wind bubble
- UV: ultraviolet
- V: the visible-light passband in the UBVRI photometric passband system which best approximates the response of the human eye, as lying between the blue (“B”) and red (“R”) visible-light passbands
- VLT: a Chile-based facility of the European Southern Observatory (Very Large Telescope)
- VLTI: the interferometer at VLT
- VSX: AAVSO International Variable Star Index (www.aavso.org/vsx)
- WFC3: Wide Field Camera 3 (as an instrument on the *Hubble Space Telescope*)
- WFPC2: Wide Field and Planetary Camera 2 (as an instrument on the *Hubble Space Telescope*)
- WD: white dwarf
- WR: Wolf-Rayet (as a type of star)
- WDS: Washington Double Star Catalog
- ZAMS: zero-age main sequence (the subregion of the MS comprising stars that have just begun stable core-hydrogen fusion)

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This version of our online essay-cum-table is **major.minor.patch** = **3.0.4**, under **UTC_timestamp** = **20200130T034000Z**.

	Star Name	RA (2020.5) h m	Dec ° ′	m_V	$B-V$	MK Type	π mas	M_V	*D* ly	μ ″/y	PA °	V_{rad} km/s	Remarks	
	Sun			−26.75	0.63	G2 V		4.8	8 lm					
A	And Aa,Ab	0 09.5	+29 12	2.07	−0.04	B9p IV: (HgMn)	34	−0.3	97	0.214	140	−12 SB	Aa,Ab < 0.001″	**Alpheratz**
β	Cas A	0 10.3	+59 16	2.28v	0.38	F2 III	60	1.2	55	0.554	109	+12 SB	var.: 2.25–2.29 in V, 0.1010 d	Caph
γ	Peg A	0 14.3	+15 18	2.83v	−0.19	B2 IV	8	−2.6	400	0.009	168	+4 SB	var. in β Cep class: 2.82–2.86 in V, 0.1518 d ¶ E(B–V) =+0.01	Algenib
β	Hyi	0 26.8	−77 08	2.82	0.62	G1 IV	134.1	3.5	24.3	2.243	82	+23	possible exoplanet ¶ high space velocity (interloper from remoter galactic region?)	
α	Phe	0 27.3	−42 12	2.40	1.08	K0 IIIb	38.5	0.3	~85	0.426	147	+75 SB		Ankaa
δ	And Aa,Ab	0 40.4	+30 58	3.27	1.27	K3 III	~30.9	0.7	106	0.142	126	−7 SB	Aa,Ab 0.40″ ¶ possible debris disk	
α	Cas A	0 41.7	+56 39	2.24	1.17	K0 IIIa	~14.3	−2.0	230	0.060	122	−4 V?	now classified by AAVSO as not a variable ¶ limb darkening observed interferometrically (disk 5.25 mas)	Schedar
β	Cet	0 44.6	−17 52	2.04	1.02	K0 III	~33.9	−0.3	96	0.235	82	+13 V?	anomalous in being X-ray-bright and yet a slow rotator ¶ evolutionary status uncertain (He core ignited already, or still contracting?)	Diphda
η	Cas A	0 50.4	+57 55	3.46	0.59	G0 V	168	4.6	19.4	1.222	117	+9 SB	B:7.51, K4 Ve, 13.4″, PA:62°→325°, 1779→2016 orbit 480 y	Achird
γ	Cas A	0 58.0	+60 50	2.15v	−0.05	B0 IVnpe (shell)	5	−4.2	600	0.026	98	−7 SB	var.:1.6–3.0 in V; B: 8.8, 2.1″, PA:255°→259°, 1888→2002 ¶ orbit > 1500 y ¶ first Be discovery (Secchi, 1866); the prototype for the γ Cas type of eruptive irregular variables; for background on Be phenomena and γ Cas, consult www.aavso.org/vsots_gammacas; 2002ASPC..279..221H summarizes the observational history, including major shell phases in 1935–1936	

													and 1939–1940; 2007JAVSO.35.357S calls for amateur-astronomer assistance with photometry: has been as bright as V mag. 1.6, as faint as V mag. 3 ¶ rotationally flattened (period = 1.21 d, axial tilt=45°) ¶ an X-ray source (cf, e.g. 2012A&A...537A..59N) ¶ dimming through ISM dust, ~0.35 mag.	
β	Phe AB	1 07.0	−46 37	3.32	0.88	G8 III	16	0.3:	~180	0.088	293	−1	AB similar, 0.7″, PA: 26°→84°, 1891→2016 orbit 168 y, highly eccentric; masses nearly equal	
η	Cet A+2P	1 09.6	−10 04	3.46	1.16	K1.5 III CN1	26.3	0.6	124	0.257	123	+12V		
β	And A	1 10.9	+35 44	2.07	1.58	M0 IIIa	17	−1.8	200	0.209	123	+3 V	slight var.? (AAVSO(VSX): 2.01–2.10 in V)	Mirach
δ	Cas	1 27.2	+60 20	2.66v	0.16	A5 IV	32.8	0.2	99	0.301	99	+7 SB	var.: 2.68–2.76 in V, 759 d E(B−V) =+0.27	Ruchbah
γ	Phe	1 29.3	−43 13	3.41v	1.54	K7 IIIa	14	−0.9	230	0.209	185	+26 SB	SB period 193.85 d; also var.: 3.39–3.49 in V, 194.1 d	
α	Eri	1 38.5	−57 08	0.45v	−0.16	B3 Vnp (shell?)	23	−2.7	140	0.095	114	+16 V	var.: 0.40–0.46 in Hp, 1.263 d variable in λ Eri class (pulsation? or, rather, starspots?); fast rotator (< 2.1 d); interferometry shows deformation into oblate spheroid	**Achernar**
τ	Cet A	1 45.0	−15 50	3.49	0.73	G8 V	~274.0	5.7	11.9	1.921	296	−16 V	mass < 1 M$_{\odot}$ (unusual in Sample S, although typical in Population P) ¶ high space velocity, low metallicity: interloper from thick galactic disk ¶ on original Frank Drake (1960) SETI target list **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
α	Tri A	1 54.3	+29 41	3.42	0.49	F6 IV	52	2.0	63	0.234	177	−13 SB		Mothallah
β	Ari AB	1 55.8	+20 54	2.64	0.16	A4 V	56	1.4	59	0.148	138	−2 SB	β Ari B is SB companion of β Ari A exceptionally elongated orbit (0.08 AU min, 1.2 AU max, 107 d); the SB companion has been resolved interferometrically; one of only a few tens of binaries in which orbit is ascertainable both with spectroscopy and with micrometer astrometry (this duplication facilitates model testing)	Sheratan
ε	Cas	1 55.9	+63 46	3.35	−0.15	B3 IV:p (shell?)	8	−2.2	400	0.037	121	−8 V	slow rotator ¶ He-weak (cp α And, α Tel)	
α	Hyi	1 59.4	−61 28	2.86	0.29	F0n III–IV	45	1.1	72	0.265	84	+1 V	rapid rotator (< 30 h) ¶ metal-rich	
γ	And A	2 05.2	+42 26	2.10	1.37	K3 IIb	9	−3.1	400	~0.065	~139	−12 SB	B: 5.4, B9 V, 9.8″; C: 6.2, A0 V; BC 0.2″ BC orbit: 63.7 y ¶ limb darkening observed interferometrically (disk 6.80 mas)	Almach
α	Ari +1P	2 08.3	+23 34	2.01	1.15	K2 IIIab	~49.6	0.5	66	0.240	128	−14 SB	calcium weak?	**Hamal**
β	Tri	2 10.8	+35 05	3.00	0.14	A5 IV	26	0.1	130	0.154	105	+10 SB2	SB orbit rather elongated (0.17 AU min, 0.42 AU max) ¶ IR excess (circumstellar matter? possible harbinger of planetesimals)	
o	Cet Aa,Ab	2 20.4	−2 53	6.47v	0.97	M5–10 IIIe	11	1.7	300	0.238	178	+64 V	LPV, 2-10.1; Ab (VZ Cet) WD, 10.4, 0.5”, ~500-600 y ¶ recent maxima January 2018 (V~3.2), December 2018 (V~3.9); recent minimum August-September 2018 (~9.4); typical recent AAVSO is mag. 6.5, on 2019 Sep. 13: 2009ApJ...691.1470T discusses variability, including variation in dominant (333 d) pulsation period and the question of longer-period variations ¶ times of maxima are, and times of minima are not, independent of wavelength: minima are at least coarsely correlated with maximum diameter of o Cet Aa ¶ 2016A&A...586A..69P discusses discrepancies in distance determinations (350 ly, 380 ly, 340 ly, and (least reliable?) *HIPPARCOS* 300 ly) ¶ prototype of the AGB variables, mass ~1 M$_{\odot}$: the first O-rich AGB star with a CI detection (2018A&A...612L..11S) ¶ physical radius ~2 AU in visual, ~4 AU in IR, still greater upon taking instead the “radio photosphere,” which itself increases in radius as progressively longer radio wavelengths are selected: 2015ApJ...808...36M draws parallels with α Ori, attributing radio inhomogeneities in both cases to convective cells (and cf also 2016A&A...592A..42K, which summarizes some recent radio work) ¶ nearest instance of (weak) symbiotic binarity, and the only symbiotic to be observed in all wavelength regimes from X-ray to (mm, also cm) radio; interferometry (in IR) is available from VLT, and *CASSINI* has yielded (via Saturn-ring occultations) tomographically recovered imaging (2016MNRAS.457.1410S); *GALEX* has found bow shock, tail (length 13 ly) in ISM: mass-lot rate ~2.5e-7 M$_{\odot}$ /y ¶ o Cet Aa has an asymmetric atmosphere (2016MNRAS.457.1410S)	Mira

													¶ 2018A&A...620A..75K reports dust trail linking Aa,Ab (consistently with other reports of Aa-to-Ab mass transfer) ¶ 2016A&A...592A..42K (2017A&A...599A..59K) discusses o Cet Aa dust nucleation generally, with reference to aluminum (resp. titanium) species: in o Cet Aa, it is silicates that dominate the spectrum (in contrast with less-evolved stars, in which alumina features are spectrally dominant); 2016A&A...590A.127W discusses SiO gas, o Cet Aa inner dust shells: it seems still an open question whether o Cet Aa dust formation is cyclic, as part of the photometrically evident pulsation cycle, or proceeds independently of the pulsations ¶ X-ray emission from o Cet Aa was reported in 2005 (2005ApJ...623L.137K, as the first X-ray detection from an AGB star), and OH, SiO maser emission has also been reported (cf, e.g. 2017MNRAS.468.1703E); further, 2015A&A...577L...4V asserts a hot spot, proposing magnetic activity as the cause ¶ 2016A&A...590A.127W summarizes history of modelling: models generally agree that near o Cet are alternating circumstellar layers of infall and outflow, and that at greater radii is an accelerating outflow, from dust-driven winds: recent observations have tended to agree with overall results from running CODEX (e.g. 2014A&A...565A.119S) ¶ Aa,Ab orbit would, if better known, yield improved total mass of Aa,Ab system, thereby advancing the overall theory of AGB stars ¶ protoplanetary disk was detected around Ab in 2007 ¶ Fabricius noted variability in 1956; Hevelius proposed the name Mira in 1642 ¶ for entry-level briefing-with-bibliography, cf www.aavso.org/vsots_mira2, updating www.aavso.org/vsots_mira; and for summary of recent primary literature, cf first section of 2016MNRAS.460..673N	
γ	Cet A	2 44.4	+3 19	3.54	0.09	A2 Va	41	1.5	80	0.207	225	−5 V	B: 6.23, 2.0″, PA:283°→299°, 1825→2015 orbit ≥ 320 y	
α	UMi Aa,Ab	2 57.8	+89 21	1.97v	0.64	F5–8 Ib	7.5	−3.6	430	~0.046	~105?	−17 SB	low-amp. Cep., 4.0 d; B: 9.1, F3 V, 18.4″ (2016) the brightest of the Cepheids, but not a classical Cepheid, matching instead the “s-Cepheid” light-curve phenomenology of 1995A&A...303..137B ¶ AAVSO(VSX) as at 2019 Dec. 28 gives V-mag. range 1.97–2.00, period 3.9696 d: period is increasing ~4.4–4.9s/y, with sudden change around 1963, and with *CORIOLIS* satellite suggesting a further recent change: period change is often in Cepheid theory linked to evolution, but this may not be the whole story here (in particular, pulsation-driven mass loss through stellar wind, as affirmed by some recent authors (denial also published) would increase the rate of period change) ¶ pulsation mode (1st overtone? 2nd? fundamental?), evolutionary history (1st crossing of IS? or 3rd crossing?), and distance are controverted by various 2010-through-2018 authors (we here use *Gaia* DR2 distance for α UMi B as a proxy, assuming with the current literature that B is indeed gravitationally bound with Aa,Ab) ¶ α Umi Aa is first Cepheid with mass determined through purely dynamical means (via the Aa,Ab orbit: Aa is single-lined SB, and Aa, Ab have been resolved with HST, as first announced (0.17″) in 2008AJ....136.1137E (orbit ~30 y) ¶ α Umi Aa is significant for general astrophysics as a possible anchor point for the Cepheid period-luminosity relation at the heart of extragalactic distance determinations, and is important also as a case study in the “Cepheid mass discrepancy” problem (Cepheid masses deduced from pulsation periods are found to be too low in comparison with masses from stellar-evolution modelling) ¶ strictly a three-star system, UMi Aa+ UMi Ab+Umi B; Aa,Ab has period 29.6 y, separation 6.7 AU min, 27 AU max, 17 AU average; B experiences Aa,Ab as essentially a point mass, with period ≥ 42,000 y, separation at least 2400 AU; B is mag. 9.1, at angular distance 18″ ¶ α Umi Aa, Ab,B is approaching NCP: closest approach will be 14′, in ~2105 ¶ B has E(B–V)=0.0 ¶ 2018ApJ...863..187E summarizes recent work	**Polaris**
θ	Eri A	2 59.0	−40 13	3.28	0.17	A5 IV	30	0.5	100	0.057	293	+12 SB2	B: 4.35, A1 Va, 8.6″, PA:82°→91°, 1835→2013	**Acamar**
α	Cet	3 03.4	+4 10	2.54v	1.63	M2 III	13	−1.9	250	0.078	188	−26 V	2.45–2.54 in V	**Menkar**

													mildly variable, in the “giant irregular” class ¶ radio source (due to stellar wind) ¶ notably deficient in carbon
γ	Per Aa,Ab	3 06.3	+53 35	2.91	0.72	G8 III + A2 V	13	−1.5	240	0.006	175	+3 SB2	composite spectrum; orbit 14.6 y, next eclipse 2035 eclipse duration < 2 weeks, with AAVSO(VSX) ephemeris giving 2019 Dec. 25 as midpoint date; eclipse variation ~ threshold of naked-eye detection, with AAVSO(VSX) giving V-mag. range 2.91–3.21 (and giving period 5346 d (14.64 y)) ¶ orbit is highly elliptical
ρ	Per	3 06.5	+38 55	3.32v	1.53	M4 II	11	−1.6	310	0.167	129	+28	semiregular var.: 3.3–4.0 in V, ~50 d period ~50 d, with possibly also a longer period
β	PerAa,Ab	3 09.5	+41 02	2.09v	0.00	B8 V + K2 IV?	36	−0.1	90	0.003	119	+4 SB	Aa=compos. spectrum Aa1,2 ecl,;2.09-3.30 in V, 2.9 d Algol ¶ in older terminology, β Per Aa1 = β Per A, β Per Aa2 = β Per B, β Per Ab = β Per C: but WDS, following the current terminology, uses the “B” and “C” for other purposes (since there are optical neighbours B,C,D,E,F,G,H; all are between 5″ and 100″ from the Aa1,Aa2,Ab triple, and all are fainter than mag. 10); system is hierarchical, with outlying Ab experiencing the close (separation 14.14 $R_\odot$) Aa1,Aa2 pair as essentially a point mass; angular distance between Aa1,Aa2 and Ab is ~0.1″ (WDS 1973, 2010) ¶ the most visually prominent of the eclipsing binaries, and for theoreticians the most familiar of the semidetached binaries (i.e., binaries in which one of the two Roche equipotential surfaces is fully occupied, the other not) ¶ Aa2 is tidally locked, in a rapid circular orbit with Aa1; the consequent rapid spin of Aa2 causes dynamo action in Aa2 convection zone, with A2 consequently having complex magnetosphere (mass-transfer stream possibly even deflected out of Aa1,Aa2 orbital plane by magnetics; 2012ApJ...760....8R; Aa2 has additionally a meridional coronal loop, approximately as high as the diameter of Aa2 (the size exceeds what has been anticipated from modelling) believed pointing at all times to Aa1), X-ray emission, varying radio morphology (double-lobed when radio-loudest) and CME episodes (2017ApJ...850..191M suggests the 1997 Aug. 30 superflare event supplies “arguably the best candidate” for a non-solar CME) ¶ the (unsteady) Aa2-to-Aa1 mass transfer, while ongoing, and indeed responsible for an annulus around Aa1, is no longer copious (in contrast with the copious transfer still present in, e.g. β Lyr) ¶ it is not the (now modest) unsteady mass transfer, but possibly instead the Applegate mechanism (1992ApJ...385..621A), implicating a stellar magnetic activity cycle, which dominates the Aa2,Aa1 period variation (increase-decrease-increase cycle, not quite strictly periodic, 32 y: there are additionally period modulations of 1.9 y and 180 y; as at 2019 Nov. 27, AAVSO(VSX) asserts period 2.86736 d); full amplitude of the Aa1 Aa2 period variation is ~0.8 s; such alternating period changes in binaries are still not, however, well understood ¶ it is the (several My ago rapid and copious) mass transfer that resolves the “Algol paradox” of a lower-mass more evolved (in this case, sub-giant) star in orbit with a higher-mass less evolved (indeed MS) star; masses are well known in this particular case: 2015MNRAS.451.4150K, having disentangled the β Per Aa1, Aa1, Ab spectra, determines their masses within plus-minus 2%, corroborating 2012ApJ...752...20B ¶ β Per Aa2 elemental abundances below corona and flare (investigated in 2015MNRAS.451.4150K) are of special

													interest, since mass transfer has stripped off Aa2 outer layers, opening the Aa2 interior to spectroscopic inspection ¶ 1983ApJ...273L..85K reports discovery of Chandrasekhar eclipse-induced stellar limb polarization from β Per Aa1, in a wide optical passband ¶ MK type K2 IV is assigned to Aa2 in at least 3 recent papers, whereas the older 1993ApJ...410..808L has the slightly hotter MK type K0 IV; what is essential here is the agreed “IV” (as opposed to “V”), indicating evolution of this (secondary) star off the MS ¶ β Per Ab, spectrally Am with some F1V characteristics, orbits the β Per Aa1,Aa2 binary with period ~680 d, without eclipsing ¶ 2012ApJ...752...20B presents CHARA interferometry (~0.5 mas, H (near-IR) band) of the β Per Aa1,Aa2,Ab system (finding orbital plane of Ab to be nearly perpendicular to Aa1,Aa2 orbital plane), and also summarizes earlier interferometry; an approx 55-frame “movie” from this paper can be conveniently viewed at https://en.wikipedia.org/wiki/Algol ¶ E(B-V)=+0.03 ¶ 2013ApJ...773....1J suggests β Per variability is documented in the “Cairo Calendar” papyrus (New Kingdom, dated to 1271–1163 BCE); al-Sufi (Persia, ca 964 CE) is, however, silent on question of β Per variability ¶ AAVSO has briefing notes, with some history, at www.aavso.org/vsots_betaper; 1910ApJ....32..185S is the discovery paper for β Per Aa1,Aa2 secondary minimum; 1998A&AT...15..357P analyzes “Algol paradox” history; https://arxiv.org/pdf/astro-ph/0611855.pdf, “Appendix B.” is a tabular history of β Per-pertinent investigations from antiquity to 1999; in this same K. Wecht 2006 Lehigh Univ PhD thesis, Table 2.5.1 summarizes 1966-through-1983 observational coverage, as tabulated in the less Web-accessible 1986 work of Budding	
α	Per A	3 25.8	+49 56	1.79	0.48	F5 Ib	~6.4	−4.2	510	0.035	138	−2 V	in open cluster near edge of HR diagram Instability Strip (slightly too hot to be a straightforward Cepheid)	**Mirfak**
δ	Eri	3 44.2	−9 42	3.52v	0.92	K0 IV	111	3.7	29.5	0.749	353	−6	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
δ	Per Aa,Ab	3 44.4	+47 51	3.01	−0.12	B5 IIIn	6	−3.0	500	0.050	149	+4 SB	variable in γ Cas class: 2.99–3.04 in V ¶ cluster affiliation is controverted ¶ E(B–V) =+0.04	
γ	Hyi	3 46.9	−74 11	3.26	1.59	M2 III	15.2	−0.8	~214	0.126	24	+16	evolutionary status is uncertain	
η	Tau Aa,Ab	3 48.7	+24 10	2.85	−0.09	B7 IIIn	8	−2.6	400	0.048	156	+10 V?	brightest member of Pleiades ¶ rapid rotator (BSC5: “rotationally unstable Be shell star”) ¶ 1972JBAA...82..431K describes the 18.6-year 1940-through-2050 cycle of lunar occultation possibilities ¶ significant dimming by ISM dust; E(B–V)=+0.03	Alcyone
ζ	Per A	3 55.4	+31 57	2.84	0.27	B1 Ib	4	−4.0	800	0.011	150	+20 SB	B: 9.16, B8 V, 12.9″, PA:205°→209°, 1824→2012 orbit ≥ 50,000 y ¶ significant dimming by ISM dust; E(B–V) =+0.33 (pronounced reddening)	
γ	Eri A	3 59.0	−13 27	2.97	1.59	M1 IIIb	16	−1.0	200	0.129	151	+62	Ca, Cr weak ¶ Kaler, at http://stars.astro.illinois.edu/, writes, “must be one of the least- studied of the cooler bright stars”	Zaurak
ε	Per A	3 59.2	+40 04	2.90v	−0.20	B0.5 IV	5	−3.6	600	0.028	149	+1 SB2	B: 7.39, B9.5 V, 8.7″, PA:10°→10°, 1821→2012 orbit ≥ 16,000 y ¶ variable possibly in the β Cep class (2.89–2.91 in V; one of the most extreme spectroscopic variables (periods 2.27 h and 8.46 h)) ¶ E(B–V) =+0.10	
λ	Tau	4 01.8	+12 33	3.41v	−0.10	B3 V	7	−2.4	480	0.017	209	+18 SB2	ecl.: 3.37–3.91, 4.0 d; secondary is A4 IV AAVSO(VSX) as at 2018 Dec. 26 gives period 3.9529478 d ¶ shape distortion (mutual tides), reflection effect, some evidence of mass transfer	
α	Ret A	4 14.7	−62 25	3.33	0.92	G8 II–III	20.2	−0.1	162	0.065	40	+36 SB?		

ε	Tau +1P	4 29.8	+19 13	3.53	1.01	K0 III	22.2	0.3	150	0.113	110	+39 V?	a “clump giant” in HR diagram, fusing He in Hyades; strictly ε Tau Aa,Ab ¶ metal-rich ¶ first known instance of a planet-host in an open cluster; unusually massive among the currently known planet-hosts	Ain
θ	Tau Aa,Ab	4 29.8	+15 55	3.40v	0.18	A7 III	22	0.1	150	0.112	104	+40 SB	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** in Hyades, system Aa-plus-Ab is a.k.a. θ^2 Tau companion in elongated orbit (0.23 AU min, 1.3 AU max) ¶ variable in the δ Sct class; 3.35–3.42 in V; 12 periods known, 1.64 h to 2.22 h, ranges 0.5 millimag to 30 millimag	Chamukuy
α	Dor AB	4 34.4	−55 00	3.30	−0.08	A0p V: (Si)	19	−0.3	169	~0.059	~79?	+26	A: 3.8; B: 4.3, B9 IV; 0.3″ (2016); orbit 12 y orbit very elongated: 1.9 AU min, 17.5 AU max	
α	Tau A	4 37.1	+16 33	0.87v	1.54	K5 III	49	−0.7	67	0.199	161	+54 SB	irregular var., 0.86–0.89 in V ¶ foreground star, not true Hyades member; among the nearest of the red giants; evolution has proceeded beyond the “FDU” stage which accompanies He-core contraction ¶ 49 lunar occultations occurred over the period 2015 Jan. 29/2018 Sep. 03 (and yet there is a surprisingly large scatter in the occultation determinations of α Tau angular diameter; 1972JBAA...82..431K describes the overall 18.6-year 1940-through-2050 cycle of lunar occultation possibilities) ¶ in contrast with its celestial-sphere neighbour α Ori, α Tau is of modest mass (with recent literature variously offering ~1.2 $M_\odot$, ~1.3 $M_\odot$, ~1.5 $M_\odot$): Appendix C of 2018ApJ...865L..20F tabulates values for mass, luminosity, radius, age, and several other parameters, on the strength of five separate 2008-through-2012 spectroscopy investigations ¶ 2013A&A...553A...3O reports “MOLsphere” (molecule-harbouring atmosphere) inhomogeneities, from VLTI/AMBER, thereby helping advance the still poorly understood topic of RGB mass loss (especially in a context in which dust condensation might appear not to play a significant role) ¶ recent literature proposes oscillations, and also proposes rotational modulation from modest photospheric-activity features (with possibly an activity cycle (2015A&A...580A..31H): the features could be (cool) starspots, but could alternatively be large convection cells; the general topic of activity in K giants is not yet well understood) ¶ 2019A&A...625A..22R casts doubt on 2018ApJ...865L..20F, 2015A&A...580A..31H exoplanet assertion	Aldebaran
π^3	Ori A	4 51.0	+7 00	3.19	0.48	F6 V	124	3.7	26.3	0.464	89	+24 SB2		Tabit
ι	Aur	4 58.3	+33 12	2.69v	1.49	K3 II	7	−3.2	500	0.016	155	+18V	var.: 2.63–2.78 in V; possibly 2 exoplanets ¶ X-ray “hybrid star” (unusual combination of (hot) corona, cool wind) ¶ dimming by ISM dust, ~0.6 mag.	Hassaleh
ε	Aur A	5 03.4	+43 51	3.03v	0.54	F0Iab? + ~B5V	~2	−8.0:	~1450	~0.003	n.a.	−3 SB	ecl.: 2.92–3.83, ~27.1 y (dim ~700 d) more formally, period is 9896.0 ± 1.6 d: as again discussed twice below, there are spectroscopic, as distinct from photometric, phenomena indicative of an eclipsing mass before the onset, and continuing after the end, of the photometric eclipse ¶ ε Aur ranks among the longest-period eclipsing binaries (exceeding even V383 Sco, with period 13.5 y; WW Vul, with period 13.9 y; and VV Cep, with period 20.3 y: the current long-period record is held by TYC 2505-672-1, at ~69.1 y (with dimming ~3.45 y)) ¶ determination of orbit elements has proven troublesome, with 2012A&A...544A..91M urging caution even in respect of recent careful studies ¶ it is remarkable that, even though the eclipsing entity is physically very extended (because the eclipse is protracted), and even though orbital dynamics indicates that the entity is quite massive, nevertheless no visible radiation from an eclipsing body is readily observable (i.e. it is remarkable that this SB is essentially a single-lined SB) ¶ although the (notably protracted) ε Aur eclipse is largely flat-bottomed, nevertheless even during eclipse the (dimmed) spectrum of the primary can be seen,	Almaaz

with no visible-wavelength colour
preference in the attenuation
(except that there are absorption
lines, as from a semi-transparent
atmosphere around the eclipsing mass,
at the start and the end of the dimming);
the 1937ApJ....86..570K explanation, postulating
a large semitransparent
totally eclipsing mass, with the non-selective
opacity due to scattering off free electrons,
is now universally abandoned in favour of the
1953AJ.....58..219K and 1965ApJ...141..976H
hypothesis of an almost edge-on (2010ApJ...714..549H)
cool opaque gas-dust low-mass
disk or disk-like entity (spiral
arm? cf 2013PASP..125..775G)
(rotating while orbiting, and several AU in diameter,
presenting a
temperature gradient ~550 K to ~1150 K (representing
the portions respectively
farthest from and closest to the primary star),
and in terms of its vertical
development not a (thick) hockey puck
but a (thin) wafer, of much larger
radius than the primary star;
2013PASJ...65L...1S gives
evidence for clumping in the disk;
2015ApJS..220...14K raises the
possibility that the disk is slightly tilted out of the
binary-system orbital plane, with consequent precession),
shrouding a B-type
star (B5V?) or star pair (the more dramatic
hypothesis of a shrouded black hole is not now
generally favoured: 2010AJ....140..595W, e.g. reports
null result from X-ray search), with the disk geometry
such as to render the eclipses of the primary star,
as observed from Earth, only partial;
the disk may have been formed
by mass transfer from the primary star,
and indeed 2013PASP..125..775G
and 2018MNRAS.479.2161G
report putative spectroscopic
detection of narrow mass-transfer stream;
the former paper stresses that the
detection of rare-earth elements
within the putative stream
spectrum (an indication that the primary
is highly evolved?) now poses a fresh puzzle,
in a system traditionally classed as puzzling
¶ 2012ApJ...748L..28H and
2012MNRAS.423.2075M discuss the question of gas-to-dust
ratio in the disk; 2015ApJ...798...11P,
2012MNRAS.423.2075M, and 2010ApJ...714..549H
suggest not-very-small values
in the distribution of dust-particle
diameters, with the first
two of these three papers
suggesting carbonaceous chemistry;
additionally, 2011AJ....142..174S
spectroscopy finds CO absorption bands,
symptomatic of sublimation, with indications that
large particles dominate
¶ 2013ARep...57..991P and 2013PASP..125..775G
document indications
that the structure of the disk does not greatly
change from one eclipse to the next
¶ the brightening around mid-eclipse has
in the post-1970 papers repeatedly been
attributed to a central opening in the postulated disk:
however, (*a*) dissenter 2011A&A...530A.146C
has instead suggested intrinsic variability in the primary
(which indeed has various quasi-periods or periods,
with 67 d and 123 d prominent,
with also variations
in radial velocity, and (unblended) spectral line width,
and other periodic or quasi-periodic behaviour, including
possible orbitally excited
non-radial pulsation; there seems as
yet, however, to be no extensive astroseismology),
and (*b*) dissenter 2011A&A...532L..12B
has instead suggested
forward scattering by disk dust (a line of thought now

supported by the key imaging-and-modelling paper
2015ApJS..220...14K)
¶ *HIPPARCOS* yields π possibly < 2 mas, distance ~2000 ly;
we now, however, choose to relinquish
the *HIPPARCOS* determination,
made at the limit of *HIPPARCOS* capabilities,
in favour of 2019IBVS.6258....1P,
which deduces from *Gaia* DR2
π =2.4144 ± 0.5119 mas, and goes
on to deduce from this, via supplementary (not
straightforward , Bailer-Jones et al. 2018AJ....156...58B)
considerations what we express here as "~1450 ly"
¶ section 1 of 2012A&A...546A.123G and section 1
of 2012A&A...544A..91M summarize past controversies
regarding mass of primary (low or high?),
stemming from the
difficulty in determining distance
(2012A&A...546A.123G assigns
a high distance,
~4900 ly, and consequently
favours a high mass value, ~20 M☉;
however, several post-2009 papers
instead assign a modest mass to the primary, suggesting
various values within the range ~2 M☉ – ~6 M☉:
2014MNRAS.445.2884M, e.g. suggests
2.5 M☉ for primary, 5.4 M☉ for
secondary (and suggests disk diameter 8.9 AU)):
evolutionary status of the
primary has been correspondingly controverted
(post-AGB star, now of modest mass, with much
past shedding of mass, and consequent
accumulation of the low-mass
opaque disk around the secondary
(a view taken by various papers, including recently
2019IBVS.6258....1P)
or, rather, an evolutionally earlier supergiant
(cf 2012JAVSO..40..647K), even
perhaps of high mass? – but it is clear
that the primary is at any rate sufficiently
evolved to have left the MS, and there are
indications that it is pulsating and a wind source;
angular diameter is 2.1 mas)
¶ most recent photometric eclipse started 2009 Aug. 12 ±15d,
ended 2011 Aug. 23 ±15 d;
next secondary (shallow, for the casual observer elusive)
eclipse is possibly 2025 Dec. 20 through 2028 Mar. 29;
next (deep, easy observable) primary
photometric eclipse starts in 2036;
monitoring even outside both the primary eclipse
and the secondary eclipse is useful,
in part because of intrinsic variations
in the primary star
(cf 2012JAVSO..40..647K); in part
because the postulated dense disk
has an extended "atmosphere"
yielding (e.g.) Hα absorption
even outside photometric eclipse
(2011A&A...530A.146C), with spectral
premonitions starting ~3 y before the onset
of the photometric eclipse; and in part
because the opaque primary-star-eclipsing
disk is potentially liable to thermal changes,
visible in mid-infrared outside primary and secondary
eclipse (2011AJ....142..174S)
¶ the Kloppenborg et al. CHARA interferometric imaging
of the eclipsing disk is perhaps
the single largest 21st-century advance
in ε Aur studies: 2010Natur.464..842G supplies
journalistic background, including a recapitulation
of 2010ApJ...714..549H modelling;
2010Natur.464..870K is the formal
Kloppenborg et al. discovery paper
(with the first spatially resolved image for
any eclipsing binary during eclipse); and
2015ApJS..220...14K is a Kloppenborg-et-al update,
with additional interferometry,
now including also PTI and NPOI
(and supplying also an overall history of ε Aur studies)
¶ news sources include
http://mysite.du.edu/~rstencel/epsaur.htm
(Prof. R. Stencel, Univ of Denver, on
the Kloppenborg-2010 team) and

													https://twitter.com/epsilon_Aurigae; 2012JAVSO..40..618S summarizes the 2009-2011 campaign from an AAVSO perspective; an 18-paper archive, of NSF-supported ~2009-through~2011 AAVSO eclipse campaign, is at www.aavso.org/citizen-sky-epsilon-aurigae-papers	
ε	Lep	5 06.3	−22 21	3.19	1.46	K4 III	15	−0.9	210	0.076	164	+1	evolutionary status is uncertain: in HR diagram first ascent, or second?	
η	Aur	5 08.0	+41 16	3.18v	−0.15	B3 V	13	−1.2	240	0.075	155	+7 V?	rotating ellipsoid var?: 3.16–3.18 in V, 2.5617 d spectral variations also suggested ¶ weak magnetic field detected, ~2× strength of Earth's dipole field	Haedus
β	Eri A	5 08.9	−5 04	2.78	0.16	A3 IVn	36	0.6	89	0.112	228	−9	unexplained brightening episode, over 2 h, by ~3 mag, in 1985 (recalling the 1972 unexplained brightening of ε Peg)	Cursa
μ	Lep	5 13.9	−16 11	3.29v?	−0.11	B9p IV: (HgMn)	18	−0.5	190	0.050	109	+28	var?.: 2.97–3.41 in V?, 2 d? variable in α^2 CVn class? (variability so far unconfirmed, and no CVn-class-appropriate magnetic field detected yet?) ¶ among the brightest of the Hg-Mn stars ¶ X-ray emission noted from putative companion, at angular distance 0.93″	
β	Ori A	5 15.5	−8 11	0.18	−0.03	B8 Ia	4	−6.9	900	0.001	69	+21 SB	B: 6.8, B5 V, 9.5″ (2014); C: 7.6; BC: 0.1″ A-BC orbit ≥ 25,000 y, BC orbit ~400 y ¶ variable in the α Cyg class (non-radial pulsator): 0.17–0.22 in Hp ¶ E(B–V) =+0.00	Rigel
α	Aur Aa,Ab	5 18.2	+46 01	0.08	0.80	G6:III + G2:III	76	−0.5	43	0.433	170	+30 SB2	composite; Aa: 0.7, Ab: 0.9 0.0–~0.1″ orbit 104.0 y; first binary with orbit studied interferometrically (Anderson-Pease, Mr Wilson, 1910); however, full system appears to be α Aur Aa+Ab+H+L, where H and L are red dwarfs sharing the proper motion of Aa+Ab and perhaps possessing further gravitationally bound companions (with α Aur B, C, D, E, F, G, I, J, K, however, being mere line-of-sight coincidences); more recent interferometry Mt Wilson "Mark III" 1994, Cambridge COAST 1995 ¶ α Aur Ab is in rapid evolutionary transition, currently crossing the Hertzsprung Gap ¶ system is among the brightest of X-ray sources	**Capella**
η	Ori AB	5 25.5	−2 23	3.35v	−0.24	B0.5 V + B	3	−4.0	1000	~0.004?	n.a.	+20 SB2	ecl.: 3.31–3.60 in V, 8.0 d; A: 3.6; B: 5.0, 1.8″ (2017) PA: 87°→77°, 1848→2017, orbit ≥ 2000 y; but strictly (WDS cataloguing) η Ori Aa,Ab,B ¶ system also possibly presents β Cep variability ¶ BSC5: "expanding circumstellar shell"	
γ	Ori A	5 26.2	+6 22	1.64	−0.22	B2 III	13	−2.8	250	0.015	212	+18 SB?	BSC5: "expanding circumstellar shell"	**Bellatrix**
β	Tau	5 27.6	+28 37	1.65	−0.13	B7 III	24	–1.4	130	0.175	173	+9 V	BSC5: "expanding circumstellar shell" ¶ lunar occultations possible as far N as southern California ¶ often, but not invariably, classified as Hg–Mn star: Mn 25× solar (and Ca, Mg only ~0.12× solar: radiative lofting, gravitational settling) ¶ E(B–V)=0.00	**Elnath**
β	Lep A	5 29.1	−20 45	2.81	0.81	G5 II	~20.3	−0.6	160	0.086	183	−14 V?	B: 7.5, 2.7″, PA:268°→8°, 1875→2015 ¶ β Lep B is possibly variable ¶ duplicity now suspected also in β Lep A, through 2002 adaptive-optics observation at Haleakala: separation 2.58″	Nihal
δ	Ori Aa,Ab	5 33.1	−0 17	2.25v	−0.18	O9.5 II	5	−4.4	700	0.001	137	+16 SB	ecl.: 2.14–2.26, 5.7 d but strictly (WDS cataloguing) δ Ori Aa1,Aa2,Ab ¶ yielded first detection of ISM (Hartmann, 1904, through SB's non-moving Ca line) ¶ E(B–V)=+0.07	Mintaka
α	Lep A	5 33.6	−17 49	2.58	0.21	F0 Ib	1.5	−6.6	2000	0.004	72	+24	evolutionary status unclear (has He fusion already started in core?); H-fusion past yields now abundances N 5× solar, Na 2× solar	Arneb
β	Dor	5 33.8	−62 29	3.76v	0.64	F7–G2 Ib	3.2	−3.7	1000	0.013	4	+7 V	Cepheid var.: 3.41–4.08 in V, 9.8 d period not quite constant; evolutionary status uncertain ¶ observed by *FUSE*, *XMM-Newton* missions	
λ	Ori A	5 36.3	+9 57	3.39	−0.16	O8 IIIf	3	−4.2	~1100	0.004	216	+34	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** B: 5.61, B0 V, 4.5″, PA:45°→45°, 1779→2017 ¶ the dominant member of Collinder 69 ¶ within gas ring 150 ly in diameter (possibly, but	Meissa

													not certainly, remnant from a Type II supernova) ¶ E(B–V)=+0.12	
ι	Ori Aa,Ab	5 36.4	−5 54	2.75	−0.21	O9 III	~1.4	−6.5	2000	0.001	108	+22 SB2	Aa,Ab 0.1″, mags 3.0, 6.3 B: 7.3, B7 IIIp (He wk), 11.6″, PA:134°→141°, 1779→2012, orbit ≥ 700,000 y; ι Ori A is itself a binary, 29 d, 0.11 AU min, 0.8 AU max; the elongated orbit, and the disparity in ages, suggest duplicity through many-body interaction-with-expulsion, rather than through cogenesis ¶ colliding winds make ι Ori A a strong X-ray source ¶ ι Ori B is variable ¶ brightest member of Sword asterism ¶ E(B–V)=+0.07	Hatysa
ε	Ori A	5 37.3	−1 11	1.69	−0.18	B0 Ia	2	−7.2	2000	0.002	118	+26 SB	luminosity (etc) controverted: Crowther (2006) 275,000 $L_\odot$, Searle (2008) 537,00 $L_\odot$, Puebla (2015) 832,000 $L_\odot$: at any rate a useful point for public-outreach talks is the disparity in distances between powerful ε Ori and the closer, and feebler, ζ Ori and δ Ori, our subjective visual impressions notwithstanding ¶ E(B–V)=+0.08	**Alnilam**
ζ	Tau	5 38.9	+21 09	2.97v	−0.15	B2 IIIpe (shell)	7	−2.7	400	0.020	175	+20 SB	2.80–3.17 in V, 133.0 d rapid rotator, and one of the best-known Be stars; GCVS assertion of variability (in γ Cas class) has been questioned, but is accepted by AAVSO(VSX); BSC5: “expanding circumstellar shell”; “shell-line velocities do not correspond to orbital elements; possible gaseous ring”; “unstable shell star with pseudo-periodic phenomena”; also BSC5: “widths H-lines vary in about 10-min polarization at Hβ changes in tens of minutes, probably due to circumstellar matter” ¶ nature of SB companion ζ Tau B is unknown (could even be neutron star); period is 133 d, and separation (with orbit nearly circular) is ~1.17 AU	Tianguan
α	Col A	5 40.4	−34 04	2.65	−0.12	B7 IV	12	−1.9	260	0.025	176	+35 V?	rapid rotator, with mass loss to disk; variability, in γ Cas class, has been suspected: BSC5: “expanding circumstellar shell”, and Hα is variable, and Hβ profile varies rapidly ¶ E(B–V) =0.00	Phact
ζ	Ori Aa.Ab	5 41.8	−1 56	1.74	−0.20	O9.5 Ib	4	−5.0	700	0.005	58	+18 SB	B: 4.2, B0 III, 2.4″, PA:152°→166°, 1822→2017 orbit ≥ 1500 y ¶ vigorous mass ejection ¶ the brightest of the (rare) MK O-type stars ¶ E(B–V) =+0.09	Alnitak
ζ	Lep	5 47.9	−14 49	3.55	0.10	A2 Vann	~46.3	1.9	~70.5	0.015	266	+20 SB?	rapid rotator (period ~0.2 d or ~0.3 d) ¶ has debris disk, has first known extrasolar asteroid belt ¶ approached to within ~4 ly or ~5 ly of Sun ~1 My ago **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
κ	Ori	5 48.7	−9 40	2.07	−0.17	B0.5 Ia	5	−4.4	600	0.002	131	+21 V?	evolutionary status unclear, high mass loss rate; slight variability (0.04 mag) ¶ carbon-deficient (with metallicity otherwise unremarkable) ¶ E(B–V) =+0.07	Saiph
β	Col	5 51.7	−35 46	3.12	1.15	K1.5 III	37.4	1.0	87	0.408	8	+89 V	high space velocity indicates that this is interloper from outside galactic thin disk, and yet it is richer than Sun in the elements beyond He	Wazn
α	Ori A	5 56.3	+7 25	0.45v	1.50	M2 Iab	7	−5.5	500	0.030	68	+21 SB	semireg., late-type supergiant var.: ~0–1.3 in V latest minimum ~2018 Dec. 01, 0.8 or 0.9 in V, rising to 0.5 or 0.4 in V ~2019-03-20 (but ~0.8 in V 2019 Nov. 13); has been visually fainter than even mag. 1.2 (1927, 1941) ¶ 2018A&A...615A.116M suggests on basis of magnetic variations a scenario on which evolution of giant photospheric convective cells, generating magnetism through local dynamos, is responsible for the observed long secondary ~2100-day photometric period; there are additionally ~200-~400-day photometric periodicities, plus a stochastic variation ascribed to photospheric granulation ¶ brightest star in IR sky, also brightest in bolometric sky ¶ nearest RSG (contrast with o Cet, as AGB); greatest angular diameter of almost any star other than Sun	**Betelgeuse**

													(near-IR limb-darkened disk ~42 mas; but R Dor, having approx 1/3 radius of α Ori, is less distant, and so attains still greater angular diameter); https://en.wikipedia.org/wiki/List_of_largest_stars supplies context, giving radii for many supergiants; reduction of α Ori angular diameter over period 1993/2009 has been asserted ¶ 2017AJ....154...11H reviews the longstanding α Ori distance problem: parallaxes, including *HIPPARCOS*, labour under the difficulty of accurately determining photocentre of visually extended object, awkwardly harbouring even plumes and hotspots; we now give in our table these authors' values for π (rounding from their 4.51 mas) and by implication for D (strictly 717 ly ± 20%) ¶ very slow rotator (true period difficult; 8.4 y has been suggested) ¶ 2019A&A...628A.101H announces dust halo with inner radius 1.5 R*; 2016A&A...585A..28K locates 3 R* as the interface between hot-gas and more outlying dust envelopes ¶ CO shells inner 50 to 150 R*, outer as far as 250 R* ¶ runaway star, exceeding local speed-of-sound in ISM: bow shock 6-7 arcmin, from stellar wind meeting ISM, plus linear bar at 9 arcmin (it has been suggested that the bar is a relic of collapsing wind from a previous BSG phase, and it also has been suggested that the bar is a feature intrinsic to the embedding ISM, unconnected with any α Ori wind) ¶ although RSG stars pose a more serious mass-loss problem for astrophysics than do the AGB stars, since it is not immediately clear what mechanism is lifting RSG stellar material above the photospheres (convection? pulsation? magnetics?), there is now a possible partial resolution in this particular case: 2018A&A...609A..67K, using ALMA, finds α Ori anisotropic mass loss, with plume of ejecta; the authors suggest that plume is associated with strong “rogue” convection cell, observable as photospheric hot spot (in contrast with the cool spots encountered on such MS stars as the Sun) ¶ progenitor mass possibly ~20 $M_\odot$ (making α Ori very massive), age since arrival on ZAMS possibly 8.0-8.5 My (making α Ori very young) ¶ present evolutionary status of α Ori uncertain: has this RSG previously been a BSG? (and 2017MNRAS.465.2654W suggests history may have been complicated by a stellar merger) ¶ α Ori is SN Type II-P progenitor, the core collapse being due within, (perhaps much within) 1 My: although SN will plateau for several months, yielding a star visible even in daytime, with the brilliance of a half-moon or full moon, the SN radiation from so distant a source will not constitute a terrestrial biohazard ¶ *Sky and Telescope.* feature article 2019-05 on α Ori can usefully be supplemented with Fig. 13 from 2018A&A...609A..67 (multi-wavelength composite, showing ejecta plume condensing to dust at a few R*, and showing also two areas of local photospheric magnetic activity): AAVSO has backgrounder at http://www.aavso.org/vsots_alphaori	
β	Aur Aa,Ab	6 01.0	+44 57	1.90v	0.08	A1 IV	~40.2	−0.1	81	0.056	269	−18 SB2	ecl.: 1.89–1.98, 3.96 d (mags. equal) dimming at eclipse is ~0.1 mag.	Menkalinan
θ	Aur A	6 01.1	+37 13	2.65	−0.08	A0p II: (Si)	~19.7	−0.9	166	~0.086	~149	+30 SB	B: 7.2, G2 V, 4.0″, PA:7°→304°, 1871→2014 orbit ≥ 1200 y, with separation ≥ 185 AU ¶ A is magnetic, and an oblique rotator; there are abundance anomalies in photospheric patches, with Si and Cr 10× and 100× solar, respectively	Mahasim
η	Gem A	6 16.1	+22 30	3.31v	1.60	M3 III	8	−2.0	400	~0.064	~259	+19 SB	var.: 3.15–3.9 in V, 233 d; B: 6.2, 1.8″ (2016) orbit ≥ 700 y ¶ variations in A have been variously ascribed either to	Propus

													binarity-eclipse or to Mira-like instability; A has finished core He fusion, and is beginning its ascent up the HR diagram AGB ¶ liable to lunar, and also to very rare planetary, occultations	
ζ	CMa A	6 21.1	−30 04	3.02	−0.16	B2.5 V	9.0	−2.2	360	0.008	61	+32 SB	variability has been claimed (with membership claimed in the β Cep pulsator class) ¶ SB orbit 675 d	Furud
β	CMa A	6 23.6	−17 58	1.98v	−0.24	B1 II–III	7	−3.9	~490	0.003	256	+34 SB	var. in β Cep class: 1.97–2.00 in V, 0.25130 d (we give here the AAVSO(VSX) period and V-mag. range, as at 2018 Dec. 27); the brightest of the β Cep pulsators; has multiple modes, with beat period 50 d; it is not known why ε CMa, while physically similar, is not a pulsator ¶ near the boundary of the "Local Bubble" ISM cavity ¶ E(B–V) =+0.01	Mirzam
μ	Gem A	6 24.2	+22 30	2.87v	1.62	M3 IIIab	14	−1.4	230	0.124	153	+55 V?	semiregular var.: 2.75–3.02 in V ¶ on HR diagram AGB ¶ subject to lunar occultations	Tejat
α	Car	6 24.4	−52 42	−0.62	0.16	A9 Ib	11	−5.5	~310	0.031	41	+21	visible both in X-ray (magnetically heated corona; also rapid rotator, strongly convective) and in radio ¶ evolutionary status not fully clear, and colour unusual in its luminosity class	**Canopus**
ν	Pup	6 38.4	−43 13	3.17	−0.10	B8 IIIn	9	−2.1	370	0.004	186	+28 SB	rapid rotator, with period < 1.7 d shell has been suggested, with "central quasi-emission peak" (cf Rivinius et al., 1999) ¶ distance was ~27 ly 3.6 My ago	
γ	Gem Aa,Ab	6 38.9	+16 23	1.93	0.00	A1 IVs	30	−0.7	110	0.057	166	−13 SB	SB in highly eccentric orbit, 12.6 y, average separation 8.5 AU ¶ the brightest star ever to be observed in an asteroid occultation (381 Myrrha, in 1991) ¶ E(B–V) =+0.03	Alhena
ε	Gem A	6 45.2	+25 07	3.06	1.38	G8 Ib	4	−4.0	800	0.014	204	+10 SB	unusually yellow in the general population of supergiants ¶ among the few supergiants liable to lunar and planetary occultations	Mebsuta
α	CMa A	6 46.0	−16 45	−1.44	0.01	A0mA1 Va	~379	1.5	8.6	~1.339	~204	−8 SB	B: 8.5, WDA; 10.7″ (2016); orbit 50.1 y separation 8.2 AU min (3″), 31.5 AU max (11″, in 2019) ¶ *IRAS* detected IR excess, a signature of dust (rather unexpected in a binary) ¶ Fe abundance of α CMa is ~2× or ~3× solar ¶ α CMa B is unusually massive for a WD (1.02 $M_\odot$; Chandrasekhar Limit is, however, 1.4 $M_\odot$; spectral type of α CMa B is DA (= hydrogen-only)) ¶ E(B–V) =-0.03	**Sirius**
ξ	Gem	6 46.4	+12 52	3.35	0.44	F5 IV	56	2.1	58.7	0.223	211	+25 V?	possibly SB, with components of ~equal mass ¶ rapid rotator (but just barely over the internal-structure boundary that causes some stars to rotate rapidly, others to experience braking through magnetics and winds) ¶ X-ray source (suggesting significant corona)	Alzirr
α	Pic	6 48.4	−61 58	3.24	0.22	A6 Vn	~34	0.9	100	0.252	345	+21	rapid rotator; shell, with time-varying spectral absorption features ¶ X-ray emission suggests a companion, otherwise undetected	
τ	Pup	6 50.4	−50 38	2.94	1.21	K1 III	18	−0.8	180	0.077	154	+36 SB	SB period 1066.0 d, separation ~3 AU, orbit of low eccentricity	
κ	CMa	6 50.6	−32 32	3.50v	−0.12	B1.5 IVne	4.9	−3.0	700	0.010	293	+14	var. in γ Cas class: 3.40–3.97 in V, now (2019) fading (was at faint end of its range before 1963)	
ε	CMa A	6 59.4	−29 00	1.50	−0.21	B2 II	8.0	−4.0	410	0.004	68	+27	binary (7.5″; B is mag. ~8 or ~9) separation 900 AU, period at least 7500 y brightest known source of extreme UV (~75 nm) in Earth's night sky; Lyman α (121.6 nm) observed by NASA *OAO-3* ¶ E(B–V) =+0.02	**Adhara**
σ	CMa A	7 02.5	−27 58	3.49v	1.73	K7 Ib	3	−4.2	1100	0.008	308	+22	irregular var.: 3.41–3.51 in V authorities are in some disagreement on MK type (possibly M, rather than K)	Unurgunite
o^2	CMa	7 03.9	−23 52	3.02	−0.08	B3 Ia	1	−6.6	3000	0.004	329	+48 SB	[THIS STAR ONLY IN ONLINE VERSION OF TABLE] var. in α Cyg class: 2.98–3.04 in Hp, 24.44 d the α Cyg vars. are non-radial pulsators ¶ E(B–V) =+0.03	
δ	CMa	7 09.2	−26 26	1.83	0.67	F8 Ia	2	−6.6	2000	0.005	317	+34 SB	¶ slow rotator (possibly ~1 y); N 2× solar, Na 6× solar	Wezen
L_2	Pup A	7 14.2	−44 40	4.42v	1.33	M5 IIIe	16	0.4	210	0.342	18	+53 V?	[THIS STAR ONLY IN ONLINE VERSION OF TABLE] semireg. late-type var., 2.6–8.0 in V, 140.6 d	HR2748

π	Pup Aa,Ab	7 17.9	−37 08	2.71v	1.62	K3 Ib	4	−4.3	800	0.012	303	+16	B: 7.9, 66”, PA nearly unchanged 1826→2009 ¶ semiregular var.: 2.70–2.85	
δ	Gem A	7 21.3	+21 57	3.50	0.37	F0 IV	54	2.2	60	0.018	237	+4 SB	B: 8.2, K3 V, 5.5″, PA: 198°→230°, 1822→2016 orbit 1200 y ¶ lunar occultations possible; planetary occultations possible-yet-rare ¶ in evolutionary transition, having completed stable core-hydrogen fusion **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	Wasat
η	CMa A	7 24.9	−29 21	2.45v	−0.08	B5 Ia	2	−6.5	2000	0.007	325	+41 V	B: 6.8, 178″ is mere optical companion ¶ variable in α Cyg class of non-radial pulsators; AAVSO(VSX) as at 2018 Dec. 28 gives mag. range 2.38–2.48 in Hp, period 4.70433 d ¶ strong wind; ejected circumstellar mass inferred from IR excess ¶ E(B–V) =+0.02	Aludra
β	CMi A	7 28.3	+8 15	2.89v	−0.10	B8 Ve	~20.2	−0.6	~162	0.064	234	+22 SB	rapid rotator, possibly ~1 d, with modest variability in the Balmer emission; disk of ejected matter has diameter ~4× diameter of β CMi itself (BSC5: “rotationally unstable”); although GCVS and AAVSO(VSX) assertion of γ Cas-type variability has not been corroborated, 2007ApJ...654..544S reports, using MOST, millimagnitude “slowly pulsating B-type” variability; AAVSO(VSX) as at 2012 Dec. 27 gives V-mag. range 2.84–2.92	Gomeisa
σ	Pup A	7 29.9	−43 21	3.25	1.51	K5 III	17	−0.6	190	0.198	342	+88 SB	B: 8.6, G5: V, 21.5″, PA:90°→73°, 1826→2011 orbit ≥ 27,000 y, separation ≥ 1300 AU; SB is eclipsing, of β Lyr type, with orbit 257.8 d, with very modest alternating primary (0.04 mag) and secondary (0.03 mag) minima; the SB primary component shows slow irregular variability ¶ system has high space velocity	
α	Gem A	7 35.9	+31 50	1.93	0.03	A1mA2 Va	63	0.9	52	~0.254	~234	+6 SB	orbit 445 y; max = 6.5″, in 1880;	
α	Gem B	7 35.9	+31 51	2.97	0.03	A2mA5 V:	63	2.0	52	~0.254	~234	−1 SB	min = 1.8″, in 1965; 5.2″ (2017); separation 71 AU min, 138 AU max; C mag. 9.8; AC PA: 162°→163°, 1822→2017, 70″, orbit ≥ 14,000 y; C has variable-star YY Gem (an eclipsing binary, and additionally a variable of the BY Dra class, with flaring); not only C, but also each of A, B is itself SB, making ABC a hierarchical 6-star system (Kaler at http://stars.astro.illinois.edu/sow/castor.html writes, “certainly the sky’s ranking sextuple”); https://en.wikipedia.org/wiki/Castor_(star) has a diagram summarizing this sextuple hierarchy, on the basis of 2012MNRAS.423..493H ¶ Castor-Pollux comparison is a helpful test of naked-eye night colour response	Castor
α	CMi A	7 40.4	+5 10	0.40	0.43	F5 IV–V	285	2.7	11.5	~1.259	~215	−3 SB	B: 10.3, WD; 3.8″ (2014); orbit 41 y separation 8.9 AU min, 21.0 AU max ¶ astroseismology of A is somewhat uncertain (*MOST* mission 2004 did not find pulsations, and yet *WIRE* mission 1999 and 2000 did) ¶ the WD Procyon B is physically unlike the WD Sirius B, attaining only ~0.2 of the Sirius B density, and being of rare spectral type DQZ	Procyon
β	Gem A+1P	7 46.6	+27 58	1.16	0.99	K0 IIIb	97	1.1	33.8	0.628	266	+3 V	the nearest of the giants; unusual in being a giant known to harbour an exoplanet (and the brightest known exoplanet host in Earth’s sky); as of 2015, exoplanet is IAU-named “Thestias” ¶ subject to rare lunar occultations, for observers S of Earth’s equator ¶ Castor-Pollux comparison is a helpful test of naked-eye night colour response	Pollux
ξ	Pup A	7 50.2	−24 55	3.34	1.22	G6 Iab–Ib	3	−4.5	1200	0.005	260	+3 SB	full system is SB with B (mag. 13, ~5″, orbit ≥ 26,000 y) ¶ SB primary has high metallicity, with exact evolutionary status uncertain ¶ SB primary is near, but is a little too cool to lie within the HR diagram Instability Strip	Azmidi
χ	Car	7 57.3	−53 02	3.46	−0.18	B3 IV(p?)	7	−2.3	500	0.035	304	+19 V	Si II anomalous strength now discounted ¶ suggestion of variability now discounted, via *HIPPARCOS* ¶ the MK luminosity class “IV” (phenomenologically “giant”) notwithstanding, χ Car is in astrophysical terms in the last part of its stable core-hydrogen-fusion phase	

ζ	Pup	8 04.3	−40 04	2.21	−0.27	O5 Iafn	3.0	−5.4	1080	0.034	299	−24 V?	blue supergiant ¶ rapid rotator (1.78 d), despite ~2300 km/s stellar wind (in which spiral structure was announced in 2017 by *BRITE* mission team), with mass loss rate > 1e-6 $M_\odot$ /y ¶ high space velocity (impelled by past nearby supernova? or, rather, impelled by multibody gravitational interactions in its stellar birth family?); possibly ejected from Trumpler 10 OB association ¶ distance has been controverted ¶ He, N overabundant ¶ has been suspected of being a variable in the α Cyg class ¶ E(B–V) =+0.04	Naos
ρ	Pup A	8 08.4	−24 22	2.83v	0.46	F2mF5 II: (var)	51.3	1.4	64	0.095	299	+46 SB	var.: 2.68–2.87 in V, 0.14 d prototype of the “ρ Pup stars” (these combine δ Sct variability with Am-like abundance anomalies); main period is ~3.3 h (0.15 mag.); photosphere temperature is notably low in the overall population of stars presenting δ Sct variability ¶ IR excess (circumstellar ring, at separation 50 AU?)	Tureis
γ	Vel Aa,Ab	8 10.2	−47 24	1.75v	−0.14	O7.5 III-I + WC8	3	−5.9	~1100	0.012	330	+35 SB2	eruptive var.: 1.81–1.87 in V; Aa,Ab system is a.k.a. γ^2 Vel ¶ strictly a quadruple system, comprising the SB Aa,Ab pair (period 78.5 d) and the tighter SB Ba,Bb pair (a.k.a. γ^1 Vel, period 1.48d); separation of these two pairs, i.e. of “AB”, 42.9″→41.2″, 1826→2017; PA: 222°→221°, 1826→2017 ¶ the (carbon-rich) WR component γ Vel Ab is the nearest and visually brightest of all WR stars, and is an exceptionally massive WR (9.0 $M_\odot$; but at birth, > 30 $M_\odot$); the Aa,Ab pair is the best studied of all O-WR binaries: in the SB γ Vel Aa,Ab pair (orbit 78.5 d, separation 0.8 AU min? 1.6 AU max), γ Vel Ab dominates spectrally, making the γ Vel Aa,Ab SB the “Spectral Gem of the Southern Skies,” and a notable sight within the broader “Vela complex” (dominated by the the Gum Nebula, within which lie the Vela SNR, the *IRAS* Vela shell, and the Vela pulsar: some literature, including 2011A&A...525A.154S, indeed proposes intersection between the Vela SNR and a γ Vel SWB, taking the *IRAS* Vela shell as marking the meeting of SNR and SWB); nevertheless, the V-band light is overwhelmingly from the more massive (28.5 $M_\odot$) O-type component γ Vel Aa ¶ like η Car (bright to mag. ~0 for several years after 1837, but now too faint, and now too lacking in firm future-outburst prognoses, to qualify for the RASC “Brightest Stars” list), γ Vel Aa,Ab is a colliding-wind pair (2017MNRAS.468.2655L Fig. 1 sketches the collision geometry), and in consequence is a UV and X-ray source (and in consequence may also possibly resemble η Car in being a γ-ray source (cf 2017ApJ...847...40R9; as of at any rate 2017, it seems that no other colliding-winds-binary stellar γ-ray sources are known); it is the wind from Ab that dominates, with mass-loss rate at least 100× greater than for Aa; the Ab wind may feature some clumping, but is to a good approximation spherically symmetric until it encounters the γ Vel Aa wind; orbital motion of Aa,Ab around centre of mass yields a spiral structure in the wind-collision area, particularly salient during periastron ¶ 2017ApJ...847...40R summarizes recent observations of Aa,Ab Vel, in radio and IR and optical, including interferometry, noting inter alia discrepancies in the available determinations of mass-loss rates from Ab (a copious 3e-6 $M_\odot$ /y? or a still more copious 8e-5 $M_\odot$ /y?) ¶ notable among recent observational studies are 2017MNRAS.468.2655L (VLTI/AMBER near-IR spectro-interferometry, with also 3-D hydrodynamic modelling)	

													and 2012MNRAS.427..581R ¶ likely destiny of γ Vel Ab is as (exotic) stripped-core SN (same prognosis as for η Car; this contrasts with α Ori, which will for its part instead explode as a (not exotic) hydrogen-spectrum SN) ¶ dust emission is absent (even though formation of circumstellar dust is common in stars which, like γ Vel Ab, undergo copious mass outflow) ¶ distance ~1200 ly, in contrast with our ~1100 ly, has also been recently asserted, on basis of VLTI/AMBER ¶ we take MK type for γ Vel Aa from 1999A&A...345..163D (as what must be considered an emendation of our (slightly cooler) Garrison-approved MK type from earlier editions of this table; admittedly, MK determination of γ Vel Aa is still difficult, because the raw spectrum is a composite comprising not only the two stars Aa, Ab, but also emission from the wind-collision zone) ¶ neither the traditional Suhail al-Muhlif nor the modern Regor (devised within NASA, to commemorate 1967 fire victim Roger Chaffee) is presently IAU-approved name for any of the four stars γ Vel Aa, Ab, Ba, Bb	
β	Cnc A+1P	8 17.6	+9 07	3.53	1.48	K4 III	11	−1.3	300	0.068	224	+22 V?	"barium star," with Ba abundance ~6× solar, presumably as contamination from defunct companion (but no companion remnant has been found) **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	Tarf
ε	Car AB	8 22.9	−59 35	1.86v?	1.20	K3:III + B2:V	5	−4.5	600	0.034	311	+2	ecl.?: 1.82–1.94? asserted to be variable 785 d, but not in AAVSO(VSX) database as of 2019 Jan. 05 (if ecl., then separation ~4 AU, precluding mass transfer)	**Avior**
o	UMa A+1P	8 32.0	+60 39	3.35v?	0.86	G5 III	~18.2	−0.3	~179	0.172	231	+20	var.?: 3.30?–3.36 in V? ¶ currently in rapid evolutionary transition, crossing the Hertzsprung Gap ¶ despite high space velocity, a member of the galaxy thin disk	Muscida
δ	Vel AB	8 45.3	−54 47	1.93	0.04	A1 Va	40	0.0	81	~0.107	~164	+ 2 V?	B: 5.0, 0.5″, PA:177°→209°, 1894→2017 orbit 142 y (min angular separation was in 2000) ¶ strictly (WDS cataloguing) δ Vel Aa,Ab,B; Aa, Ab resolved both interferometrically and with VLT adaptive optics; orbit 45.15 d, average separation 90.61 AU, dimming ~0.4 mag: the brightest known eclipsing binary	Alsephina
ε	Hya AB	8 47.9	+6 21	3.38	0.68	G5:III + A:	25	0.4	130	~0.232	259	+36 SB	composite A: 3.8; B: 4.7, 0.3″ (2014); C: 7.8, 2.8″ (2016) AB orbit 15.09 y, AB+C orbit 590 y ¶ C is SB, orbit 9.9 d	Ashlesha
ζ	Hya	8 56.5	+5 52	3.11	0.98	G9 II–III	~19.5	−0.4	~167	0.101	279	+23		
ι	UMa A	9 00.6	+47 58	3.12	0.22	A7 IVn	~68.9	2.3	47.3	~0.491	~244	+9 SB	A+BC 2.4″, PA: 349°→82°, 1831→2012 A+BC orbit 818 y; BC 0.7″, period ~39 y; A is itself SB, orbit 4028 d, making this a quadruple system; the system is not, as in many cases of multiplicity, hierarchical and stable, but kinematically unstable (disruption in ~0.1 My?) B mag. 9.9 M1 V, C mag. 10.1 M1 V	Talitha
λ	Vel A	9 08.8	−43 31	2.23v	1.66	K4 Ib–IIa	6.0	−3.9	540	0.028	299	+18	semireg. var.: 2.14–2.30 in V ¶ probably on or approaching HR diagram AGB, but could still be on RGB ¶ has slow wind, whose origins are said to be poorly understood	**Suhail**
a	Car	9 11.5	−59 03	3.43v	−0.19	B2 IV–V	7	−2.3	500	0.022	312	+23 SB2	ecl.?: 3.41–3.44 ¶ orbit 6.74 d, with light curve indicating tidal distortion ¶ there is some uncertainty whether observable light is solely from primary, or whether primary and secondary make approximately equal contributions ¶ not to be confused with α Car	HR 3659
β	Car	9 13.4	−69 48	1.67	0.07	A1 III	28.8	−1.0	113	0.191	305	−5 V?	rapid rotator (< 2.1 d), despite having finished stable core hydrogen fusion ¶ quasi-periodic variation, ~0.5 h, in Balmer lines	**Miaplacidus**
ι	Car	9 17.6	−59 22	2.21v	0.19	A7 Ib	4.3	−4.6	800	0.022	302	+13	var.: 2.23–2.28 in V ¶ despite being slow rotator, has magnetic activity (as inferred from X-rays) ¶ not to be confused with l (letter el) Car	Aspidiske
α	Lyn A	9 22.3	+34 18	3.14	1.55	K7 IIIab	16	−0.8	~203	0.224	274	+38	B: 8.8, 223″, PA: 33°→43°, 1823→2016	

													suspected var., mag. 3.12–3.17 (beginning to evolve into a Mira?)	
κ	Vel	9 22.8	−55 06	2.47	−0.14	B2 IV–V	6	−3.8	600	0.016	315	+22 SB	orbit 116.65 d, average separation possibly ~1.1 AU ¶ mass loss rate ~1e-9 $M_\odot$/y ¶ system is X-ray source ¶ ISM absorption has varied over the years (ISM cloud in transit?)	Markeb
α	Hya A	9 28.6	−8 45	1.99	1.44	K3 II–III	18	−1.7	180	0.038	336	−4 V?	slow rotator (possibly 2.4 y), with Ba mildly overabundant ¶ astroseismology has been studied ¶ α Hya B (mag. 9.7; 282″, PA 154°, both measures almost unchanged since 1833) might be a true binary companion (with orbit ≥ 870,000 y, separation ≥ 15,700 AU)	Alphard
N	Vel	9 31.8	−57 08	3.16	1.54	K5 III	13.6	−1.2	240	0.033	280	−14	semireg. var., 3.12–3.18 in V, 82.0 d ¶ evolutionary status uncertain (He core fusion impending, or already ended?)	HR 3803
θ	Uma A	9 34.2	+51 35	3.17	0.48	F6 IV	74.2	2.5	44.0	1.088	241	+15 SB	luminosity class, and also SB status, have been controverted, with postulated SB companion remaining undetected in speckle interferometry	
ο	Leo Aa.Ab	9 42.2	+9 48	3.52v	0.52	F5 II + A5?	25	0.5	130	0.148	255	+27 SB	A: occ. bin. (mags equal) orbit 14.5 d, separation 0.165 AU (interferometrically resolvable) ¶ ο Leo A is a rare instance of a star that has ended core hydrogen fusion, and yet in which the convection typical of an evolved star has not yet removed the chemical peculiarities possible in a core-hydrogen fuser (where still-quiet atmosphere facilitates radiative lofting and gravitational settling)	Subra
l	Car	9 45.8	−62 36	3.69v	1.01	F9–G5 Ib	2	−4.7	2000	0.015	302	+3 V	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** Cepheid var.: 3.28–4.18, 36 d AAVSO(VSX) as at 2018 Dec. 27 gives period 35.551609 d; an exceptionally luminous, and consequently exceptionally slow, Cepheid (compare both the visual brightness and the intrinsic luminosity with less dramatic δ Cep, ζ Gem, η Aql: Kaler remarks that "if Carina had been in the northern hemisphere, the collection of these variables might well have been called the 'Carinids'"; radius, in its pulsation cycle, has been measured as 160 $R_\odot$ min, 194 $R_\odot$ max ¶ circumstellar envelope of ejected matter, radius 10 AU–100 AU ¶ lower-case ell Car; not to be confused with i (lower-case i) Car (HR 3663), ι Car (HR 3699), L Car (HR 4089), I (upper-case i) Car (HR 4102) (and note additionally that Bayer nomenclature does not use the label "λ Car")	HR 3884
ε	Leo	9 47.0	+23 41	2.97	0.81	G1 II	13.2	−1.4	250	0.047	259	+4 V?	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** slow rotator, period possibly as long as 200 d ¶ currently crossing the Hertzsprung Gap? ¶ variability has been studied (cf Andrievsky 1998; pulsation as in Cepheids?) ¶ the Arabic or quasi-Arabic name Algenubi (more classically, al Ras al Asad al Janubiyyah et al.) is not presently IAU-official	
υ	Car A	9 47.6	−65 10	2.92	0.29	A6 II	2.3	−5.3	~1400	0.028	307	+14	A: 3.01; B: 5.99, B7 III, 5.0″, PA:126°→126°, 1836→2010 orbit ≥ 19,500 y, separation ~2000 AU ¶ the duplicity causes parallax to be poorly known	
φ	Vel A	9 57.6	−54 40	3.52	−0.07	B5 Ib	2.0	−4.9	1600	0.014	285	+14		
η	Leo AB	10 08.4	+16 40	3.48	−0.03	A0 Ib	3	−4.5	1300	~0.003	n.a.	+3 V	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** B: 4.5, 0.1″, PA:84°→309°, 1937→1993 mass-loss rate ~5e-8 $M_\odot$/y (> 10,000× solar mass-loss rate); BSC5: "chromospheric shell" ¶ a lunar occultation has suggested duplicity, but this is unconfirmed	
α	Leo A	10 09.5	+11 52	1.36	−0.09	B8 IVn	41	−0.6	79	0.249	271	+6 SB	α Leo A is SB orbit 40.11 d, with the secondary in the pair which is α Leo A not yet detected (2011IBVS.5987....1R reports null photometry result from *MOST*, at the high accuracy of ~0.5 millimag) ¶ the primary in α Leo A, being an exceptionally rapid rotator, is an extreme star in respect of one of the three fundamental stellar properties (mass, metallicity, equatorial rotation speed; section 1 of 2011ApJ...732...68C supplies a general current-astrophysics briefing on stellar rotation, including the problem of deviations from the von Zeipel 1925 gravity-darkening law for oblate-spheroid stars): period is 15.9 h, rendering this star an oblate spheroid,	**Regulus**

													(Rpol ~3.14 $R_\odot$, but Req ~4.16 $R_\odot$), and rendering the photosphere equator ~3000 K cooler than the photosphere poles (and possibly inducing meridional flow in the envelope); in contrast with pole-on rapid rotator α Lyr, the α Leo A primary is seen nearly equator-on; the aperture-synthesis imaging of 2017NatAs...1..690C Fig. 5 displays the photosphere temperature variation (a joint consequence of limb darkening and oblateness), along with oblateness and axis orientation; according to 2017NatAs...1..690C, the α Leo A primary (*i*) has attained 96.5% of its breakup speed (earlier literature had suggested 86%), and (*ii*) is the first rapid rotator found to exhibit Chandrasekhar rotation-induced stellar limb polarization (the related phenomenon of eclipse-induced stellar limb polarization was admittedly detected earlier, with β Per, as reported in 1983ApJ...273L..85K) ¶ 2011ApJ...732...68C discusses the subtleties involved in placing a rapid rotator, whether seen equator-on or seen pole-on, onto a luminosity-temperature HR plot, in efforts at deducing mass and age, and additionally notes the difficulty in constructing an evolutionary model for the interior of a rapid rotator ¶ 2011ApJ...732...68C revises the mass of the primary upward, offering 4.15 $M_\odot$ in place of the 2005ApJ...628..439M determination of ~3.5 $M_\odot$ ¶ 2008ApJ...682L.117G suggests the possibility that the secondary in the α Leo A SB pair is a WD of exceptionally low mass, while noting that FUV observations would be appropriate in an attempt at confirming this suggestion; in making the suggestion, 2008ApJ...682L.117G raises the possibility that the secondary is the remnant of an erstwhile mass donor, with the donor conferring on the primary its presently observed, and in the absence of a donor puzzling, high spin angular momentum: α Leo B, C are for their part too far away to be implicated in past processes of mass transfer ¶ A+BC almost unchanged since 1779 (175.5″ in 2016); separation ≥ 4200 AU, orbit ≥ 125,000 y; BC combined light is mag. ~8.2; BC is no longer underobserved (PA: 89°→95°, 4.0″→2.10″, 1867→2015, with orbit ≥ 880 y) ¶ we adopt here the MK classification of 2003AJ....126.2048G, while recalling that earlier editions of our RASC brightest-stars table used instead B7 Vn, essentially in accordance with 1953ApJ...117..313J ¶ the α Leo system is occasionally occulted by Mercury, Venus (e.g. 1959 Jul. 07, 2044 Oct. 01), Moon (e.g. 2017 Sep. 18; 1972JBAA...82..431K describes the 18.6-year 1940-through-2050 cycle of possibilities), and asteroids (e.g. 166 Rhodope 2005 Oct. 19 (2008mgm..conf.2594S reports GTR effect of light bending, not only from general solar gravitational field but also from Rhodope field), 163 Erigone 2014 Mar. 20 (cloud-defeated 2014 Erigone campaign is documented at https://occultations.org/regulus2014) ¶ E(B–V) =+0.01	
ω	Car	10 14.2	−70 08	3.29	−0.07	B8 IIIn	9.5	−1.8	340	0.037	281	+7 V	or "IIIne"; shell star; rapid rotator (< 1.2 d, ~85% of breakup speed); photometric variation (cp γ Cas, δ Sco, …) might be expected, and yet seems undocumented; BSC5 does report variable Hα	
q	Car A	10 17.8	−61 26	3.39	1.54	K3 IIa	5.0	−3.1	660	0.026	286	+8	irregular var.: 3.36–3.44 in V classified "LC" by AAVSO(VSX) as at 2019 Jan. 05 ¶ metallicity is uncertain ¶ evolutionary state is uncertain (has core already	HR 4050

													started He fusion?)	
ζ	Leo A	10 17.8	+23 19	3.43	0.31	F0 IIIa	12	−1.2	270	0.020	110	−16 SB	in rapid evolutionary transition, currently crossing Hertzsprung Gap	Adhafera
λ	UMa	10 18.3	+42 49	3.45	0.03	A1 IV	24	0.3	140	0.186	256	+18 V	despite MK luminosity class "IV", has not yet finished core hydrogen fusion ¶ mildly metallic, being insufficient metallic to warrant MK "Am" ¶ seems mild IR excess (indicating circumstellar debris)	Tania Borealis
γ	Leo A +1P	10 21.1	+19 44	2.61	1.13	K1 IIIb Fe–0.5	26	−0.3	130	~0.333	~118	−37 SB	4.8″ (2017), PA:99° →126°, 1820→ 2017 (510.3 y);	
γ	Leo B	10 21.1	+19 44	3.16	1.42	G7 III Fe–1	26	0.2	130	~0.346	~118	−36 V	max = ~5″, around 2100 separation ≥ 170 AU, orbit > 500 y, orbital parameters not yet well known ¶ A, B are of mildly unequal masses, and therefore are of mildly disparate evolutionary stage (Kaler http://stars.astro.illinois.ed/: "best understood as being in different stages of gianthood"; cf this same source for further discussion of the uncertainties in various γ Leo parameters, including the respective mags of A and B) ¶ γ Leo A "+ 1P" is an exception to the tendency for exoplanets to be found around the more metallic stars (but the "+1 P" could be modelled as a brown dwarf); and indeed even "+2P" is now considered possible ¶ high space velocity of the γ Leo AB pair, plus their low metallicity, suggests system is interloper from more remote galactic region ¶ γ Leo AB, and indeed also the next "Sickle" star ζ Leo, serve to mark the radiant of the Leonids meteor shower	Algieba
μ	UMa	10 23.5	+41 24	3.06v?	1.60	M0 IIIp	14	−1.2	230	0.089	293	−21 SB	Ca II emission ¶ SB period 230 d ¶ variability suspected (suggested range 2.99–3.33; but AAVSO(VSX) database as of 2019 Jan. 05 has no entry) ¶ Kaler (http://stars.astro.illinois.edu-sow-taniaas.html) terms this "a rare 'hybrid star'" (in the sense of blowing both a fast-and-thin wind and a slower-and-dense wind), and additionally notes the puzzle posed by X-ray emission in the presence of cool photosphere	Tania Australis
p	Car	10 32.8	−61 47	3.30v	−0.09	B4 Vne	7	−2.6	500	0.021	304	+26	var. in γ Cas class: 3.22–3.55 in V ¶ fast rotator; BSC5: shell; variable Balmer-line profiles	HR 4140
θ	Car	10 43.7	−64 30	2.74	−0.22	B0.5 Vp	7	−3.0	460	0.022	303	+24 SB	chemically anomalous SB period 2.2 d is unusually short, suggesting that mass transfer could be the culprit in the anomalies ¶ the primary is the brightest of the "blue stragglers"; at http://stars.astro.illinois.edu/sow/thetacar.html, Kaler discusses difficulties in determination of the primary's temperature and of its (short) rotation period ¶ E(B–V) =+0.06	
μ	Vel A	10 47.7	−49 32	2.69	1.07	G5 III + F8:V	28	−0.1	~117	0.083	131	+6 SB	A: 2.72; B: 5.92, 2.3″, PA:55°→57°, 1880→2016 period variously given as 116.24 y (Hoffleit) and 138 y (Heintz); separation possibly 8 AU min, 93 AU max, 51 AU average ¶ A is in rapid evolutionary transition, having recently finished core hydrogen fusion ¶ A is magnetic, and an X-ray emitter, with hot corona, and with violent 2-day X-ray flare detected in 1998 by IUE	
ν	Hya	10 50.6	−16 18	3.11	1.23	K2 III	23	−0.1	144	0.220	25	−1	slow rotator (but ≤ 619 d) ¶ low metallicity and high space velocity suggest interloper, born outside Sun's neighbourhood	
β	UMa	11 03.1	+56 16	2.34	0.03	A0mA1 IV–V	~40.9	0.4	80	0.088	68	−12 SB	debris disk first detected via IR excess, now marginally resolved by *Herschel Space Observatory* (Matthews et al. 2010)	Merak
α	UMa AB	11 05.0	+61 38	1.81	1.06	K0 IIIa	27	−1.1	120	0.139	255	−9 SB	A: 1.86; B: 5.0, A8 V, 0.8″ (2017) orbit 44 y ¶ the first cool star found to have multimodal oscillations (*WIRE* camera; Buzasi, et al, 2000, suggest fundamental mode 6.35 d) ¶ the most distant of the seven Big Dipper stars (and, like η at the other extreme of the Big Dipper, not a member of the UMa Moving Group)	**Dubhe**
ψ	UMa	11 10.8	+44 23	3.00	1.14	K1 III	22.6	−0.2	145	0.068	246	−4 V?	slow rotator (but ≤ 2.6 y)	
δ	Leo A	11 15.2	+20 25	2.56	0.13	A4 IV	56	1.3	58	0.193	132	−20 V	rapid rotator (< 0.5 d) ¶ suspected δ Sct variable	Zosma
θ	Leo	11 15.3	+15 19	3.33	0.00	A2 IV	~19.8	−0.2	165	0.099	217	+8 V	(K-line var.)	Chertan

													rotation rather slow for MK type A (but < 9 d); quiet atmosphere renders Ca, Sc underabundant, and Fe, Sr, Ba overabundant ¶ IR excess (debris disk?)	
ν	Uma A	11 19.6	+32 59	3.49	1.40	K3 III Ba0.3	~8.2	−1.9	400	0.039	317	−9 SB	B: ~10, 7.8″, PA:145°→145°, 1827→2015 orbit ≥ 12,000 y; separation ≥ 950 AU	Alula Borealis
ξ	Hya Aa,Ab	11 34.0	−31 58	3.54	0.95	G7 III	~25.2	0.5	130	0.214	259	−5 V	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** La Silla CORALIE ~2001 detected multimodal oscillations, not all radial, with periods ~3 h	
λ	Cen Aa,Ab	11 36.7	−63 08	3.11	−0.04	B9.5 IIn	8	−2.4	400	0.034	258	−1 V	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** despite possible fast rotation (< 2.7 d?), Fe is overabundant, with Si and C mildly underabundant ¶ at http://stars.astro.illinois.edu/sow/lambdacen.html, Kaler discusses questions of visual binarity (λ Cen Aa, Ab, B)	
β	Leo A	11 50.1	+14 27	2.14	0.09	A3 Va	91	1.9	36	0.511	257	0 V	rapid rotator (< 0.65 d) ¶ debris disk resolved by *Herschel Space Observatory* (Matthews et al. 2010), disk structures differentiated with ground-based interferometry (Stock et al. 2010) ¶ assertion of δ Sct variability now seems erroneous	**Denebola**
γ	Uma A	11 54.9	+53 35	2.41	0.04	A0 Van	39	0.4	83	0.108	84	−13 SB	rapid rotator: MK type Ae has been asserted (Ae is rare, Be common) ¶ E(B–V) =0.00	Phecda
δ	Cen Aa,Ab	12 09.4	−50 50	2.58v	−0.13	B2 IVne	8	−2.9	400	0.050	262	+11 V	var. in γ Cas class: 2.51–2.65 in V ¶ rapid rotator (< 1.3 d), with shell 2008A&A...488L..67M summarizes recent research, and as part of a wider VLTI investigation into the "Be phenomenon" not only discusses the circumstellar envelope, but also reports discovery of binarity (secondary at angular distance 68.7 mas)	
ε	Crv	12 11.2	−22 44	3.02	1.33	K2 III	~10.3	−1.9	320	0.072	278	+5	slow rotator (but ≤ 3.9 y) ¶ metals somewhat overabundant ¶ evolutionary status uncertain (core He fusion starting, in progress, or finished?) ¶ the etymologically Arab name "Minkar" is of merely modern origin, and is not currently IAU-official	
δ	Cru	12 16.2	−58 52	2.79v	−0.19	B2 IV	9.4	−2.3	350	0.037	254	+22 V?	var. in β Cep class: 2.78–2.84 in V, 0.15 d ¶ rapid rotator (<1.3 d; BSC5: "expanding circumstellar shell")	Imai
δ	UMa A	12 16.4	+56 55	3.32	0.08	A2 Van	40.5	1.4	81	0.104	86	−13 V	possesses debris disk, of unusually low radius (Wyatt et al. 2007; Poynting-Robertson drag?)	Megrez
γ	Crv	12 16.9	−17 39	2.58	−0.11	B8 III	21	−0.8	154	0.160	278	−4 SB	sp. var.? rather rapid rotation notwithstanding (BSC5: "expanding circumstellar shell"), Hg and Mn are overabundant, with some other elements underabundant (but rotational line broadening makes abundance determinations difficult)	**Gienah**
α	Cru A	12 27.8	−63 13	1.25	−0.20	B0.5 IV	10	−3.7	~320	0.037	251	−11 SB	5.4″ (1826); 4.2″ (2016)	**Acrux**
α	Cru B	12 27.8	−63 13	1.64	−0.18	B1 Vn	10	−3.3	~320	0.037?	251?	−1	PA: 114°→112°, 1826→2016 orbit ≥ 1300 y, separation ~430 AU; A is SB pair Aa, Ab (75.78 d, separation ~0.5 AU min, ~1.5 AU max); C (itself an SB pair) at ~90″ from AB, imperfectly sharing the AB proper motion, is possibly (not assuredly) gravitationally bound with AB (if bound, then > 130,000 y, with separation ≥ 9,000 AU); WDS additionally documents D, E, F, G, H, I, J, K ¶ duplicity makes individual magnitude determinations for A, B somewhat controverted	
δ	Crv A	12 30.9	−16 38	2.94	−0.01	B9.5 IVn	~37.6	0.8	87	0.252	237	+9 V	B:8.26, K2 V, 24.6″, PA: 216°→213°, 1782→2012 orbit ≥ 9400 y; although A, B have common proper motion, disparity in age estimates has caused binarity to be questioned ¶ Kaler suggests B is young post-T-Tauri star, with surrounding dust as yet uncleared	Algorab
γ	Cru A	12 32.3	−57 14	1.59v	1.60	M3.5 III	37	−0.6	89	0.267	174	+21	semireg. var.: 1.60–1.67 in V although has been classified as semiregular var., at least 6 pulsation periods have been documented ¶ the nearest of the M giants, radius > 0.5 AU; evolutionary status uncertain (is core He fusion now finished?) ¶ cause of the observed Ba overabundance is unknown (undetected evolved companion?)	**Gacrux**
β	Crv	12 35.5	−23 31	2.65	0.89	G5 II	22	−0.6	146	0.057	179	−8 V	slight variability has been reported (2.60–2.66) ¶ slow rotator (but ≤ 180 d) ¶ possibly in evolutionary transition (He core about to ignite?)	Kraz

													¶ assertion of weak Ba-star status is perhaps erroneous	
α	Mus Aa,Ab	12 38.4	−69 15	2.69	−0.18	B2 IV–V	10.3	−2.2	320	0.042	252	+13 V	var. in β Cep class: 2.68–2.73 in V, 0.090 d classification of the low-amplitude variability as β Cep has been questioned ¶ rapid rotator (< 2 d)	
γ	Cen A	12 42.7	−49 04	2.95	−0.02	A1 IV	25	−0.1	130	~0.194	~267	−6	orbit 84 y; 0.4″ (2010),	
γ	Cen B	12 42.7	−49 04	2.85	−0.02	A0 IV	25	−0.2	130	~0.194	~267	−6	0.1″ (2017); max = 1.7″; separation 8 AU min, 67 AU max, 37 AU average ¶ Arabic name Muhlifain is not currently IAU-official	
γ	Vir AB	12 42.7	−1 34	2.74	0.37	F1 V + F0mF2 V	85	2.4	39	~0.619	~276	−20	A: 3.48; B: 3.50; 0.8″ (2007); 2.5″ (2016) orbit 169 y; separation 5 AU min (most recently 1836 and 2005), 81 AU max, 43 AU average, with plane of orbit inclined 31° to plane of sky; for discussion of orbit, with observations plot showing error bars (binary astrometry being now old enough to archive data for one full orbit), cf Kaler at http://stars.astro.illinois.edu/sow/porrima.html ¶ lunar occultations possible, planetary occultations possible-yet-rare	Porrima
β	Mus Aa,Ab	12 47.6	−68 13	3.04	−0.18	B2 V + B2.5 V	~9.6	−2.1	340	~0.043	~258	+42 V	A: 3.51; B: 4.00, 1.1″, PA:317°→53°, 1880→2016 orbit 194 y; average separation uncertain (101 AU, or only ~80 AU?); orbit map, showing error bars, given by Kaler at http://stars.astro.illinois.edu/sow/betamus.html, with Kaler's accompanying discussion of orbit- modelling problems, underscores limitations in current β Mus AB knowledge ¶ β Mus A is rapid rotator (< 1 d) ¶ a runaway system, in the sense of presenting a high velocity relative to the general galactic rotation	
β	Cru A	12 48.9	−59 48	1.25v	−0.24	B0.5 III	12	−3.4	300	0.046	249	+16 SB	var.in β Cep class: 1.23–1.31 in V, 0.24 d SB period 5 y, separation 5.4 AU min, 12.0 AU max; Kaler at http://stars.astro.illinois.edu/sow/mimosa.html discusses other possible companions, including an X-ray visible, and yet optically invisible, object interpreted as a pre-MS star ¶ β Cru A is believed to be a rapid rotator (possible ~3.6 d) ¶ β Cru A is a multiperiodic β Cep variable ¶ β Cru A, its MK luminosity class "III" notwithstanding, is only about halfway through its career of stable-core hydrogen fusing	Mimosa
ε	UMa AB	12 54.9	+55 51	1.76v	−0.02	A0p IV: (CrEu)	~39.5	−0.3	83	0.112	94	−9 SB?	var. in α^2 CVn class: 1.76–1.78 in V, 5.1 d the brightest of the Ap stars, and a variable in the α^2 CVn class (in the specific case of ε Uma, the magnetic-dipole axis is believed to be nearly perpendicular to rotation axis, yielding Cr bands nearly perpendicular to equator; dipole strength is unusually low) (but it has also been suggested that a substellar companion of mass ~14.7× Jupiter, at average separation 0.055 AU, orbit 5.1 d, rather than a 5.1-d stellar rotation, is the source of the observed variability period)	**Alioth**
δ	Vir A	12 56.6	+3 17	3.39	1.57	M3 III	16	−0.5	~198	0.473	264	−18 V?	semireg. var. (multiperiod pulsator), mag. 3.32–3.40 ¶ high space velocity relative to galactic neighbours ¶ evolutionary status uncertain (He fusion recently started, or already finished?)	Minelauva
α	CVn A	12 57.0	+38 12	2.85	−0.06	A0p (SiEu)	28	0.1	110	0.241	283	−3 V	B:5.6, F0 V, 19.3″, PA:234°→230°, 1777→2017 orbit ≥ 8300 y (common proper motion indicates true binarity); separation ≥ 675 AU; prototype for the α^2 CVn var. class (chemically anomalous photospheric regions yielding spectroscopic variability, and with magnetism yielding large spots; in the particular case of α^2 CVn, rotation period is 5.46939 d, with consequent spot-driven magnitude range 2.84–2.98) ¶ two correct, potentially confusing, designations are α CVn A (signalling that this is the brighter of the binary pair) and α^2 CVn (signalling that α^1 crosses the local meridian before α^2, lying further W); the Latin "heart-of-Charles" designation, official at IAU as of 2016, honours the "martyr king" Charles I (although Charles II is sometimes cited in error)	Cor Caroli
ε	Vir A	13 03.2	+10 51	2.85	0.93	G9 IIIab	29.8	0.2	110	0.275	274	−14 V?	one of the most notable X-ray sources in our table (X-ray luminosity, although far below α Aur, is nevertheless almost 300× solar)	Vindemiatrix
γ	Hya A	13 20.0	−23 17	2.99	0.92	G8 IIIa	~24.4	−0.1	134	0.081	121	−5 V?	slow rotator (but ≤ 240 d) evolutionary state uncertain (core He fusion impending, or already in progress?)	
ι	Cen	13 21.8	−36 49	2.75	0.07	A2 Va	55	1.5	59	0.352	256	0		

													rapid rotator (< 2d) ¶ low metallicity ¶ debris disk (unusually luminous, given evolutionary state of ι Cen)	
ζ	UMa Aa,Ab	13 24.7	+54 49	2.23	0.06	A1 Va	40	0.1	90	0.123	100	−6 SB2	B:3.94, A1mA7 IV–V, 14.4″; period >5000 y? not only are A+B a true binary; it is now additionally argued (controversy possibly continues) that Alcor is gravitationally bound to A+B (Bob King, *Sky & Tel* .2015-03-25); although ζ Uma A and ζ Uma B (both chemically anomalous) are universally accepted as themselves individually SB (yielding quartet ζ UMa Aa, Ab, 20.538 d (cf NPOI trial, 1997AJ….114.1221B), ζ UMa Ba, Bb, 175.6 d; both SB orbits are highly elliptical), the old, widely repeated claim that Alcor is itself SB requires scrutiny (pro, F. Heard ApJ 1949; contra, www.leosondra.cz/en/mizar, specifically rebutting Heard; once again pro, but now on new basis (discovering elusive red-dwarf companion), 2010ApJ…709..733Z; this Leos Ondra web source should be consulted also *(a)* for details on Mizar-Alcor multiplicity-studies history, including Galileo and Michelson (Ondra, citing inter alia Fedele 1949, seems to establish that it was Galileo pupil Castelli, rather than (as widely asserted) Riccioli, who discovered Mizar's visual duplicity) and *(b)* for a 15′ map documenting around 20 of the field stars, including mag. 7.58 "Stella Luoviciana" ("Sidus Ludovicianum"))	Mizar
α	Vir Aa,Ab,Ac	13 26.3	−11 16	0.98v	−0.24	B1 V	13	−3.4	250	0.052	234	+1 SB2	var.: 0.96–1.00 in V, 4.0 d; mags 3.1, 4.5, 7.5 ¶ this SB (separation 0.12 AU, 4.0145 d; the geometry is close to achieving a grazing eclipse) is the brightest of the rotating ellipsoid variables (by definition no eclipse, and by definition with the SB's total presented luminous area varying, through geometrical asymmetry, as the orbital motion proceeds); the Aa,Ab orbit is highly eccentric; Aa (a rapid rotator, at ~0.3 breakup speed) is itself a pulsating variable of the β Cep type (0.1738 d; shortly after the ~1970 discovery of the β Cep variability, photometric and spectroscopic variations were present; the photospheric variations soon ceased, but the spectroscopic (radial-velocity, i.e. pulsational) variations continued; 2016MNRAS.458.1964T, incorporating precision *MOST* photometry, reports for Aa one radial and two non-radial pulsation modes, with one of the non-radial modes tidally induced) ¶ in an early application of interferometry, 1971MNRAS.151..161H argues with the example of α Vir Aa,Ab that given supporting spectroscopy and photometry, orbit and distance of a double-lined SB can be deduced (the SB distance notably without recourse to parallax measurements and without recourse to spectroscopic determination of luminosity classes) ¶ the tidal-interactions studies 2016A&A...590A..54H and 2013A&A...556A..49P stress the importance of the α Vir Aa,Ab double-lined SB for critically testing the (astrophysically foundational) assumption that the individual components *x*, *y* of a binary, of determined masses, rotation periods, and chemical compositions, resemble in their photospheres, and even in their interiors, solitary stars *x′*, *y′* possessing the same masses, rotation periods, and chemical compositions (could tidal effects, e.g. change internal temperature structure?); additionally, the tidal effects in the α Vir Aa,Ab SB	**Spica**

														are judged in 2009ApJ...704..813H to be responsible for large-scale shearing horizontal photospheric motions, spectroscopically observable as modifiers of line profiles (but 2016MNRAS.458.1964T questions the judgement) ¶ assignment of individual MK types to Aa, Ab is challenging: the rather-unevolved-B MK types (1971MNRAS.151..161H B1.5 IV-V + B3V, 2007AAS...211.6301A B0.5 III-IV + B2.5-B3V) are in any case consistent with rather high masses (10.9 $M_\odot$ + 6.8 $M_\odot$, 10.25 $M_\odot$ + 6.97 $M_\odot$, for these two respective papers) ¶ as is to be expected from the failure of Aa,Ab to be tidally locked, the system is young (with 2016MNRAS.458.1964T assigning as age 12.5 ± 1 My) ¶ the Aa,Ab binary is a polarimetric variable (ISM material entrained?), and a strong X-ray source (colliding winds?) ¶ α Vir Ab is one of the few stars known to exhibit Struve-Sahade variation (https://en.wikipedia.org/wiki/Struve%E2%80%93Sahade_effect) in its spectral line strengths ¶ 1972JBAA...82..431K describes the 18.6-year 1940-through-2050 cycle of lunar occultation possibilities ¶ Aa was measured in 1975 to lie 0.50″ from the tight Aa,Ab pair ¶ E(B-V)=+0.03
ζ	Vir AB	13 35.7	−0 42	3.38	0.11	A2 IV	44	1.6	74	0.285	280	−13	Heze	rapid rotator (< 0.5 d; this renders puzzling the possible evidence for chemical anomalies, which would presuppose a quiet atmosphere) ¶ now strictly ζ Vir A; elusive red-dwarf companion B is reported in 2010ApJ…712..421H (0.168 $M_\odot$, possibly accounting for the X-ray emission observed by *ROSAT*: as a star of a spectral type lacking strong winds and lacking convection at photosphere, ζ Vir A would not itself be expected to emit X-rays) ¶ a good marker of celestial equator (precession placed ζ Vir exactly onto equator in February 1883)
ε	Cen Aa,Ab	13 41.2	−53 34	2.29	−0.17	B1 III	8	−3.3	400	0.019	233	+3		slight variability (mag. 2.29─2.31; multiperiodic; in β Cep class) ¶ rapid rotator (< 2.7 d) ¶ metals underabundant ¶ although we here assign MK luminosity class “III”, Kaler at http://stars.astro.illinois.edu/sow/epscen.html discusses uncertainty
η	UMa	13 48.3	+49 13	1.85	−0.10	B3 V	31	−0.7	104	0.122	263	−11 SB?	**Alkaid**	resembles α Uma, at the other extreme of the Big Dipper, in not belonging to UMa Moving Group; 1921LicOB..10..110T asserts Pleiades Group ¶ rapid rotator (< 21 h), with some line variability (circumstellar ejecta disk?) ¶ X-ray source ¶ colour and mean temperature are anomalous for the MK type ¶ unusually young in our Sample S (< 15 My) ¶ E(B–V)=+0.02
ν	Cen	13 50.7	−41 47	3.41	−0.22	B2 IV	~7.5	−2.2	440	0.034	233	+9 SB		SB period is 2.622 d; system is rotating ellipsoidal variable (not eclipsing, but varying in light as the presented surface area changes); additionally, the primary is a pulsator in the β Cep class (mag. 3.38─3.41) ¶ MK luminosity class “IV” notwithstanding, primary is still a stable fuser of core hydrogen ¶ possible weak Be, the (possible) emission coming (possible; and possibly intermittent?) circumstellar disk
μ	Cen Aa,Ab	13 50.9	−42 34	3.47v	−0.17	B2 IV–V pne	~6.4	−2.5	510	0.031	232	+9 SB		var. in γ Cas class: 2.92–3.47 in V rapid rotator (consistently with the γ Cas behaviour); additionally said to be a multiperiodic non-radial pulsator; BSC5: “line profiles of MgII 4481 change in period 0.505 d, about five times the period of weaker absorption”; variable Hα; “variable line profiles”
η	Boo A	13 55.7	+18 18	2.68	0.58	G0 IV	88	2.4	37	0.361	190	0 SB	Muphrid	

													unusually metal-rich ¶ an X-ray source (hot corona) ¶ 2007ApJ…657.1058V discusses recent work (*MOST* helioseismology, PTI interferometry)	
ζ	Cen	13 56.8	−47 23	2.55	−0.18	B2.5 IV	8.5	−2.8	380	0.073	232	+7 SB2	SB period 8.02 d ¶ primary is a rapid rotator (<1.5 d) (BSC5: “expanding circumstellar disk”) ¶ MK luminosity class “IV” notwithstanding, primary is possibly only halfway through its core hydrogen fusing ¶ E(B–V) =–0.02	
β	Cen Aa,Ab	14 05.3	−60 28	0.58v	−0.23	B1 III	8	−4.8	400	0.041	235	+6 SB	B:3.94, A1mA7 IV–V, 0.3″ (2017) entire (triple) system comprises SB Aa+Ab (357 d, separation 0.53 AU min, 5.5 AU max, 4 AU average) with B; at least one, and perhaps both, of Aa, Ab multiperiod variables in the β Cep class; Kaler discusses uncertainty in distance (etc) of the triple at http://stars.astro.illinois.edu/sow/hadar.html ¶ E(B–V) =+0.02	**Hadar**
π	Hya	14 07.5	−26 47	3.25	1.09	K2 IIIb	~32.3	0.8	101	0.148	163	+27 V	negative cyanide ion lines are anomalously weak relative to metal lines, consistent with this star’s anomalously high velocity relative to Sun (suggesting interloper in our own galactic region; however, π Hya is more metal-rich than the celebrated interloper α Boo) ¶ in the HR-diagram “clump” of core-He fusers (but uncertain whether recent arrival in clump or longtime denizen)	
θ	Cen A	14 07.9	−36 28	2.06	1.01	K0 IIIb	55	0.8	59	0.734	225	+1	high velocity with respect to Sun suggests interloper status (and yet metallicity is approximately solar)	**Menkent**
α	Boo	14 16.6	+19 05	−0.05	1.24	K1.5 III Fe–0.5	89	−0.3	37	2.279	209	−5 V	high space velocity a metal-poor interloper (from galactic thick disk? but galaxy-merger scenario has also been suggested), and member of Arcturus Moving Group (2009IAUS..254..139W) ¶ a magnetic cycle (< 14 y?) has been detected ¶ still ascending HR diagram RGB, with He flash impending? (but a later evolutionary stage has also been suggested) ¶ publication of α Boo line atlas 1968pmas.book…..G (R.Griffin) was a major event in postwar spectroscopy ¶ α Boo has been studied in recent astroseismology ¶ there may be a companion, at margin of *HIPPARCOS* detectability	**Arcturus**
ι	Lup	14 20.7	−46 09	3.55	−0.18	B2.5 IVn	~9.6	−1.5	340	0.013	249	+22	rapid rotator (possibly ~0.9 d), and yet no evidence of circumstellar disk, and in particular no Be spectral features ¶ the MK luminosity class “IV” notwithstanding, still performing stable core-hydrogen fusion	
γ	Boo Aa,Ab	14 32.9	+38 13	3.04v	0.19	A7 IV+	37.6	0.9	87	0.190	323	−37 V	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** variable in the δ Sct class ¶ IR excess (from circumstellar debris, so far unexplained) ¶ Aa,Ab resolved in speckle interferometry as 70 mas	Seginus
η	Cen	14 36.8	−42 15	2.33v	−0.16	B1.5 IV pne	11	−2.5	310	0.048	227	0 SB	γ Cas and λ Eri var.: 2.29–2.47 in V, multiperiodic BSC5: Hα variable, Hβ “sometimes bright, sometimes dark and double or multiple”; consistently with γ Cas variability, a rapid rotator (< 1 d)	
α	Cen B	14 41.0	−60 55	1.35	0.9	K1 V	750	5.7	4.3	~3.703	~283	−21 V?	AB 4.1″ (2016) orbit 79.9y min = 2″ (1955); max 22″ separation 11.2 AU min, 35.6 AU max; Kaler at http://stars.astro.illinois.edu/sow/rigil-kent.html has map of AB orbit (note further here that green, violet, blue denote micrometry, photography, interferometry, respectively: as the error bars suggest, the AB orbit is one of the most precisely known in visual-binary astrometry; Kaler also discusses some uncertainties in the ABC physical properties) ¶ magnetic activity of α Cen A is in deep decline since 2005 ¶ 2005A&A...442…315R reports a flare on magnetically active α Cen B ¶ 2012 B-exoplanet claim now discounted, and yet an exoplanet Bc now considered possible in 2015MNRAS.450.2043D	Toliman

													¶ Einstein-ring event expected with 45% probability in 2028, early in May
α	Cen A	14 41.0	−60 55	−0.01	0.71	G2 V	750	4.4	4.3	~3.710	~277	−22 SB	Ca (Proxima), 12.4, M5e, 212°, Cb (exopl) Rigil Kentaurus gravitational binding of AB+C was finally established with high probability in 2017A&A…598L…7K (~550,000 y: min > 4300 AU, max 13,000 AU) ¶ 2016Natur.536..437A announces an approx. Earth-mass exoplanet (mass < ~3× Earth?) around α Cen C (unfortunately, however, for exobiology, α Cen C suffers superflares); https://en.wikipedia.org/wiki/Proxima_Centauri_b discusses astrobiology pros and cons; http://breakthroughinitiatives.org/initiative/3 advocates nanocraft exploration ¶ all of A, B, C are metals-rich
α	Lup A	14 43.3	−47 28	2.30	−0.15	B1.5 III	7	−3.5	460	0.032	221	+5 SB	var. in β Cep class: 2.29–2.34, 0.26 d actually multiperiodic, with primary period (unusually long) 0.2598466 d given by AAVSO(VSX) as at 2019 Jan. 02
α	Cir	14 44.2	−65 04	3.18	0.26	A7p (Sr)	60.4	2.1	54.1	0.303	220	+7 SB?	B: 8.6, K5 V, 15.7″, PA:263°→224°, 1826→2017 AB probably true binary, with orbit ≥ 2600 y ¶ the brightest variable of the AAVSO “rapidly oscillating Ap” class (features of the type include rapid non-radial pulsation with a stellar-rotation signal), with V mag. range 3.17–3.19; magnetically an oblique rotator (4.4790 d, with field strength ~500× solar); 2009MNRAS.396.1189B discusses the rotation, two notably stable putative equatorial chemical- anomaly regions, and astroseismology, with history and fresh *WIRE*+*SAAO* observations
ε	Boo AB	14 45.9	+26 59	2.35	1.34	K0 II–III+A0 V	16	−1.6	200	0.044	288	−17 V	A:2.50; B:4.66, 2.9″, PA:318°→345°,1822→2015 Izar orbit well over 1000 y ¶ ε Boo B is a rapid rotator ¶ http://stars.astro.illinois.edu/sow/izar.html discusses difficulties in determination of the individual magnitudes and of the binary system’s distance ¶ F.G.W. von Struve: “pulcherrima” (“the loveliest”)
β	UMi A+1P	14 50.7	+74 04	2.07	1.46	K4 III	24.9	−0.9	131	0.035	289	+17 V	**Kochab** a guide for the aligning of a small telescope with equatorial mount (since NCP, although not quite coincident with α UMi, does lie near the great-circle arc linking β UMi with α UMi: http://arksky.org/Kochab.htm) ¶ Fe underabundant, Ba possibly slightly overabundant ¶ 2008A&A...483L..43T suggests (via *CORIOLIS*-SMEI) two short-lived radial-pulsation mods ¶ 2014A&A...566A..67L announces exoplanet
α	Lib Aa,Ab	14 52.0	−16 08	2.75	0.15	A3 III–IV	43	0.9	76	0.126	237	−10 SB	B. 5.2, 231″ **Zubenelgenubi** angular distance from α Lib B, which shares the proper motion of α Lib A, is 231″, with separation ≥ 5500 AU; if B and A are gravitationally bound, then their period is ≥ 200,000 y; alternative names for the α Lib Aa,Ab pairing and the single star α Lib B are α^2 Lib and α^1 Lib, respectively, with “1” signalling the fact that α^1 Lib, lying to W of α^2 Lib, although fainter than “2”, is the earlier of the two in its crossing of the local meridian ¶ one of α Lib Aa, α Lib Ab is overabundant in some metals, perhaps due to influence of its very close SB companion (angular distance ~10 mas, separation a few tenths of 1 AU) ¶ lunar occultations are possible, planetary occultations possible-yet-rare
β	Lup	14 59.9	−43 13	2.68	−0.18	B2 IV	9	−2.7	380	0.054	222	0 SB	has been claimed to be low-amplitude (β Cep) var.: dominant period 0.232 d ¶ fast rotator (< 3.4 d) ¶ low metallicity
κ	Cen Aa,Ab	15 00.5	−42 11	3.13	−0.21	B2 V	9	−2.2	400	0.029	218	+8 SB	strictly a triple system, Aa+Ab+B; B mag. 11.5; AB 4″, PA: 84°→83°, 1926→2000, separation ≥ 470 AU; ≥ 3000 y; Aa+Ab separation possibly ~10 AU, period possibly ~10 y (http://stars.astro.illinois.edu/sow/kappacen.html discusses various physical uncertainties) ¶ line profiles vary; although the Aa+Ab binarity has made variability classification difficult, κ Cen Aa is classified by AAVSO(VSX) as a variable of the β Cep class (3.13−3.14 in V, 0.095325 d)
β	Boo	15 02.7	+40 19	3.49	0.96	G8 IIIa	14.5	−0.7	230	0.049	234	−20 V?	Ba 0.4, Fe −0.5 Nekkar 1995A&A...296..509H discusses the puzzling flare seen by *ROSAT* 1993 Aug. 08 (unusual for a lone M giant; it is possible, but seems unlikely, that flare came instead from an undetected M-dwarf companion; the mild

													Ba enhancement is, admittedly, consistent with presence of such a companion); slow rotator (~200 d)	
σ	Lib	15 05.3	−25 22	3.25v	1.67	M2.5 III	11	−1.5	290	0.083	239	−4	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** semireg. var.: 3.20–3.46 in V, mean period 20 d there is also rapid microvariability ¶ highly evolved (on HR diagram AGB, with dead carbon-oxygen core)	Brachium
ζ	Lup A	15 13.8	−52 11	3.50	0.92	G8 III	~27.8	0.6	117	0.133	238	−10	B: 6.74; 71.60″ at most scant PA change over the period 1826–2016; separation ≥ 2600 AU; shared proper motion suggests true binary (period possibly ≥ 68,000 y) ¶ A is an HR diagram “red clump” star (originally Sun-like, but He flash now finished, core He fusion now underway)	
δ	Boo A	15 16.3	+33 14	3.46	0.96	G8 III Fe–1	~26.8	0.6	122	0.140	143	−12 SB	a very wide double: B is mag. 7.89, 105″ PA: 84°→78°, 1780→2017, separation ≥ 3800 AU, period 120,000 y (with shared proper motion indicating true binarity) ¶ δ Boo A is CN weak; δ Boo B could be a subdwarf, consistently with the observed low metallicity of δ Boo A ¶ δ Boo A is an HR diagram “clump” star (core He fusion now underway)	
β	Lib	15 18.1	−9 27	2.61	−0.07	B8 IIIn	~17.6	−1.2	190	0.100	259	−35 SB	flagged by AAVSO(VSX) as “suspected variable lacking deeper studies,” with V mag. 2.60–2.62 (and yet Eratosthenes, resp. Ptolemy, asserted β Lib to be brighter than, resp. equal to, α Sco) ¶ rapid rotator ¶ E(B–V) =–0.02	Zubeneschamali
γ	UMi	15 20.7	+71 46	3.00	0.06	A3 III	6.7	−2.9	490	0.025	315	−4 V	a rapid rotator, and (despite being in MK type A, not B) said to be a variable shell star (cf 2000A&A...354..157H; BSC5: “shell possibly variable,” H and CaII variable); AAVSO(VSX), however, classified this as a variable in the δ Sct class	Pherkad
γ	TrA	15 20.9	−68 45	2.87	0.01	A1 IIIn	17.7	−0.9	184	0.074	244	−3 V	has been asserted to be chemically anomalous (Eu overabundance), and also, not quite consistently, has been classed as a rapid rotator (< 1.2 d) ¶ although we here give MK luminosity class III, class V has also been asserted ¶ IR excess has been asserted (circumstellar disk?)	
δ	Lup	15 22.7	−40 43	3.22	−0.23	B1.5 IVn	4	−3.9	900	0.032	218	0 V?	rapid rotator (< 2.4 d) ¶ a (low-amplitude) variable in the β Cep class, with a single period known, 0.1655 d (cf 2007MNRAS.377..645S)	
ε	Lup Aa,Ab,B	15 24.1	−44 46	3.37	−0.19	B2 IV–V	6	−2.6	500	~0.030	~230	+8 SB2	A: 3.56; B: 5.04, 0.2″, PA:285°→70°, 1883→2017 orbit 737 y: in more detail, a (probable) hierarchical quadruple; although B experiences A as essentially a point mass, in fact A is SB, for which 2005A&A...440..249U gives SB period 4.55970 d (classifying primary as a suspect β Cep variable and secondary as a new β Cep variable), experiencing AB, on the other hand, as essentially a point mass is the (probably) gravitationally bound C (lying at angular distance 26.1″ in 2016; separation ≥ 4100 AU; if gravitationally bound, then period ≥ 60,000 y); in its stable kinematics, this putative hierarchical quadruple may be contrasted with the unstable, nonhierarchical θ Ori system, and in its detailed organization with the stable, hierarchical, but mere “double-double” ε Lyr system	
ι	Dra A+1P	15 25.4	+58 54	3.29	1.17	K2 III	32.2	0.8	101	0.019	334	−11	2002ApJ...576..478F announces substellar-mass companion and discusses possibility of transits; this is the first discovery of a planet or brown dwarf (IAU name: Hypatia) orbiting a star that has finished stable core-hydrogen fusion; http://exoplanet.eu/catalog/HIP%2075458_b/ may from time to time have updates; its substellar companion notwithstanding, ι Dra has metallicity only slightly greater than solar	Edasich
α	CrB	15 35.6	+26 39	2.22v	0.03	A0 IV (composite)	43	0.4	75	0.150	127	+2 SB	ecl.: 2.21–2.32, 17 d (more precisely, from AAVSO(VSX) as at 2019 Jan. 02, 3.59907 d): a detached binary, with neither component filling its Roche lobe; separation 0.13 AU min; as with β Per, so also with α CrB, instrumental photometry reveals both the primary and the secondary eclipse ¶ individual MK types are difficult: primary possibly	**Alphecca**

													A0 V, secondary possibly G5 ¶ primary has IR excess (debris disk?) ¶ secondary is X-ray visible and is a rather rapid rotator (~9 d or ~7 d or less, so not tidally locked) ¶ non-IAU name Gemma denotes α CrB as "gem of the Northern Crown"	
γ	Lup AB	15 36.5	−41 14	2.80	−0.22	B2 IVn	8	−2.8	400	~0.030	~212	+2 V	A: 3.5; B: 3.6; similar spectra 0.8″ (2017) PA: 94°→275°, 1835→2017; max angular separation 1980, min ang. dist. 2075; orbit 190 y: γ Lup AB orbit is seen nearly edge-on; separation 41 AU min, 128 AU max, 84.5 AU average; http://stars.astro.illinois.edu/sow/gammalup.html has an orbit map, showing that observational coverage is imperfect (green for micrometry (with large error bars), violet for photography, blue for interferometry); γ Lup A is itself SB (2.8081 d), making this a hierarchical triple system, with the primary in the γ Lup A pairing a fast rotator (< 1 d, so not tidally locked) ¶ BSC5 asserts expanding circumstellar shell, and (citing 1987 Vainu Bappu spectra) notes emission peaks in Hα profiles, says possibly in transition from B to Be	
α	Ser A	15 45.3	+6 22	2.63v?	1.17	K2 IIIb CN1	44	0.9	74	0.141	71	+3 V?	var.? not in AAVSO(VSX) variability database as at 2019 Jan. 02 ¶ a "strong-lined giant" (although [Fe/H] metallicity is not very much above solar) ¶ a modest X-ray source ¶ has borne also the (not IAU-official) name Cor Serpentis ("Heart of the Serpent"), despite being the principal luminary of Serpens Caput ("Serpent Head")	Unukalhai
μ	Ser AB	15 50.7	−3 30	3.54	−0.04	A0 III	19	0.0	170	0.104	255	−9 SB	announced in 2010NewA...15..324G as astrometric binary, 36 y	
													[THIS STAR ONLY IN ONLINE VERSION OF TABLE]	
β	TrA A	15 57.0	−63 30	2.83	0.32	F0 IV	~80.8	2.4	40.4	0.444	205	0	*Spitzer Space Telescope* finds IR excess (debris disk?) ¶ rapid rotator (slightly < 1 d), with detectable magnetic field ¶ metals vary widely (some overabundant, some underabundant)	
π	Sco A	16 00.1	−26 10	2.89	−0.18	B1 V + B2 V	6	−3.4	600	0.029	203	−3 SB2	A: occ. bin.: 3.4 + 4.5, 1.57 d (more precisely, from AAVSO(VSX) as at 2019 Jan. 02, 1.570103 d), circular orbit, possibly tidally locked, separation possibly ~0.07 AU; although system has been said to be of β Lyr type, the AAVSO(VSX) classification is, rather, "rotating ellipsoidal variable" (the stars so close as to be gravitationally distorted into ellipsoids, but neither star deformed into the teardrop shape possible in one β Lyr scenario (the β-Lyr variability-type scenario, namely, in which a component becomes so grossly distended as to fill its Roche lobe; in any β Lyr variable, the shape distortion is by definition so severe as to leave no constant-light segments in the light curve)); V-mag. range 2.88–2.91; inspection of AAVSO(VSX) suggests a present paucity in photometry (and Kaler at http://stars.astro.illinois.edu/sow/pisco.html additionally discusses some difficulties in astrophysical modelling)) ¶ E(B–V) =+0.08	Fang
T	CrB	16 00.4	+25 52	9.8v	1.34	gM3: + Bep	—	0.6	2500?	0.011	329	−29 SB	recurrent nova 1866&1946 mags 3&2; mag. ~9.8 2019 Aug. 14 only ten galactic recurrent novae are currently known (2010ApJS..187..275S; these are by definition novae known to recur, and yet lacking the short periods of dwarf novae) ¶ long documented here as mag. 10.08, T CrB brightened from February 2015, attaining ~9.2 in April 2015 (with mag. 9.8, on the other hand, reported on 2018 Nov. 15); Bob King in *Sky and Tel.* 2016 Apr. 20 gives recent history, and AAVSO has a backgrounder at https://www.aavso.org/t-crb; next eruption 2026, or earlier? ¶ nova phenomenon is due to WD companion, orbit 227 d	
η	Lup A	16 01.5	−38 27	3.42	−0.21	B2.5 IVn	7	−2.2	440	0.033	211	+8 V	A: 3.47; B: 7.70, 15.0″, PA:22°→19°, 1834→2016 orbit ≥ 26,000 y: a hierarchical system, with remote outlier D at angular distance 135″ (separation ≥ 18,000 AU, period	

													≥ 750,000 y), with D experiencing the AB pair as essentially a point mass; η Lup C is not part of this (triple) system, C’s angular proximity to AB being a mere line-of-sight coincidence ¶ although η Lup A is a rapid rotator (< 1.1 d), there is no evidence of a circumstellar disk, and in particular there seems to be no documentation of Be phenomenology ¶ η Lup B is chemically peculiar	
δ	Sco AB	16 01.6	−22 41	2.29	−0.12	B0.3 IVe + B3V	7	−3.6	500	~0.037	~196	−7 SB	periastron outbursts 2000, 2011 https://www.aavso.org/delta-scorpi has recent forum discussion, notably on choice of comparison stars for the visual observer; a typical recent AAVSO V-filter photometry report is 2018-07-19, mag. 1.713: classified at AAVSO(VSX) as a variable of the γ Cas type; consistently with this classification, the primary is a rapid rotator; www.aavso.org/vsots_delsco covers 2000–2011 ¶ AB: 10.8 y, 0.2″ (2016); http://stars.astro.illinois.edu/sow/dschubba.html discusses multiplicity (in all, possibly quadruple, with hierarchical organization; AB period is 20 d, separation ~0.4 AU) ¶ E(B–V)=+0.16	Dschubba
β	Sco AB	16 06.6	−19 52	2.56	−0.06	B0.5 V	8	−2.9	400	0.025	192	−1 SB	A: 2.78; B: 5.04, 0.3″ (2017); C: 4.93, 14″ in gross terms a visual binary, with separation ≥ 2200 AU, period > 16,000 y; but in fact putatively a sextuplet; https://en.wikipedia.org/wiki/Beta_Scorpii summarizes the sextuplet’s hierarchy in a diagram (Aa with Ab (6.82 d), and B experiencing Aa+Ab as essentially a point mass (610 y); Ea with Eb (10.7 d), and C experiencing Ea+Eb as essentially a point mass (39 y); the B+AaAb triple is in a wide, > 16,000-y orbit with the C+EaEb triple, around the centre of mass shared by this pair of triples, thereby delivering the gross visual-binary phenomenology) ¶ lunar occultations possible, planetary occultations Possible yet rare (1971 May 14 occultation by Jovian satellite Io) ¶ the name Graffias is not IAU-official	Acrab
δ	Oph A	16 15.4	−3 45	2.73	1.58	M1 III	~19.1	−0.9	171	0.150	198	−20 V	slow rotator ¶ high metallicity ¶ although δ Oph has finished core hydrogen fusion, its exact evolutionary state is uncertain (cf http://stars.astro.illinois.edu/sow/yedprior.html) ¶ naked-eye neighbour Yed Posterior is a mere optical companion, too greatly separated in space for true binarity; the “prior” and “posterior” in the traditional, and as of 2016 IAU-official, names denote the order in which these two (physically unrelated) stars cross the local meridian ¶ listed in NSV as a suspected variable; 1992IBVS.3792....1P finds no variability, but says that since NSV V-amplitude is just 0.03 mag., variability cannot be excluded	Yed Prior
ε	Oph A	16 19.4	−4 44	3.23	0.97	G9.5 IIIb	31	0.7	106	0.093	64	−10 V	CN and C notably underabundant, suggesting that ε Oph is an interloper from outside the galactic thin disk	Yed Posterior
σ	Sco Aa,Ab	16 22.4	−25 38	2.91v	0.13	B1 III	5	−3.7	700	0.019	213	+3 SB	var.: 2.86–2.94, 0.25 d; B: 8.3, B9 V, 20.3″ (2016) recent studies, including lunar occultation measures, show σ Sco to be a quadruple system, with σ Sco A in fact a spectroscopic binary (33.0 d) in orbit with a B7 star at angular distance 9.4″ (period > 100 y); 2007MNRAS.380.1276N announces interferometric solution for the SB orbit, proposing for primary and secondary the respective MK types B1 III, B1 V; in the SB pair, the primary is a variable of the β Cep type (in November 2018, AAVSO(VSX) gives V-mag. range 2.86–2.94, period 0.246839 d; 1992A&A...261..203P discusses period changes) ¶ photography shows σ Sco to be embedded in diffuse nebula ¶ E(B–V) =+0.4 (pronounced reddening)	Alniyat
η	Dra A	16 24.3	+61 28	2.73	0.91	G8 IIIab	35.4	0.5	92	0.059	343	-14 SB?	B: 8.7, 4.4″, PA: 150°→143°, 1843→2015 orbit ≥ 1000 y, separation ≥ 140 AU	Athebyne

¶ η Dra A is a “clump star” in HR diagram (evolved, now stable, performing core He fusion)
¶ η Dra A is believed to be a slow rotator (~400 d)
¶ η Dra A is a modest X-ray source
¶ η Dra A is listed by NSV (Kukarkin et al.) as a suspected variable
¶ near the radiant of the η Draconids meteor shower

α **Antares**	Sco A	16 30.7 -26 29	1.06v	1.86	M1.5 Iab	6	-5.1	600	0.026	207	-26 SB	semireg. var.: 0.75–1.21, 5.97 y; B: 5.37, 3.2″(2016)

PA: 273°→276°, 1847→2016; orbit 2500 y?
AAVSO(VSX): semireg. (with some discussion of period; cf also 2013AJ....145...38P, where a true period is found for radial-velocity variations, and the detected variation is judged to be more likely of pulsational than of orbital origin), V mag. 0.75–1.21 (but the variability has also been called irregular); 2018AuJAn..29...89H reports that variability was observed by, and incorporated into the oral tradition of, aboriginals in southern Australia; asserted by Eratosthenes to be fainter than β Lib, and by Ptolemy to equal β Lib
¶ radius has been studied interferometrically and via lunar occultations (up to 3.4 AU; however, even apart from the problem of pulsation, radius determination of highly evolved red stars is wavelength-dependent);
one of the two first-magnitude supergiants (the other being α Ori)
¶ significant stellar wind, with mass loss almost 1e-6 $M_\odot$/y, within which α Sco B has created a locally ionized region
¶ the most massive member of the Sco-Cen Association (the nearest OB association)
¶ B shares in the proper motion of A, indicating true binarity: AB separation is ≥ 530 AU, period possibly ~1200 y
¶ location (within zodiac) makes the classical Greek name for “rival of Mars” appropriate not only as regards apparent colour but also as regards sky geometry
¶ 1972JBAA...82..431K describes the 18.6-year 1940-through-2050 cycle of lunar occultation possibilities

β	Her Aa,Ab	16 31.1 +21 27	2.78	0.95	G7 IIIa	23	-0.4	140	0.100	261	-26 SB	Kornephoros

SB period computed 1908, and again 2008, in both cases ~410 d; 1977ApJ...214L..79B announces speckle-interferometry resolution of the SB, with angular distance 43 mas
¶ suspected variable (NSV (Kukarkin, et al., online) suggests V-mag. range 2.76–2.81)
¶ X-ray emission from the SB primary indicates magnetic activity
¶ Kaler, noting that primary has N enhanced relative to C, says in his overall summation “a very normal star for its state of age”
¶ “Kornephoros” = Gk “club-bearer,” in reference to the weapon of Hercules (compare α Her, which in the pictorial-atlas tradition, marks the hero’s head)

τ	Sco	16 37.2 -28 15	2.82	-0.21	B0 V	7	-3.0	500	0.025	203	+2 V	Paikauhale

intrinsically more luminous than σ Sco, but more heavily obscured by ISM
¶ anomalous in its UV lines (P Cyg profile)
¶ O and Fe are underabundant
¶ 2006MNRAS.370..629D discusses τ Sco magnetic topology (poloidal, with also a warped toroidal component of modest strength), including both its origin (more likely a fossil field form the star’s (recent) birth than a dynamo effect) and its connection with winds and with the observed hard X-ray emission; the authors note that the topology is stable over the 1.5-y period of their observations (in contrast with a strongly differential-rotation star, such as Sun); in additionally announcing a (refined) rotation period of 41.033 d, the authors comment, “the second-slowest rotator so far known among high-mass stars”
¶ Kaler: “among the most-observed stars in the sky”
¶ E(B-V)=+0.06
¶ the τ Sco name Paikauhale was IAU-approved in 2018 Aug. 10;
the not-IAU-official “Al Niyat,” or “the arteries of the Heart,” on the other hand,

												denotes σ Sco and τ Sco jointly, as flanking α Sco	
ζ	Oph	16 38.3 -10 36	2.54	0.04	O9.5 Vn	9	-2.7	370	0.029	32	-15 V	the nearest O-type star (and consistently with this extreme temperature, resident in an H II region) ¶ “runaway star” (consistently with this extreme speed-relative-to-LSR, forming bow shock in ISM), perhaps formerly the secondary in a binary pair whose primary perished in a supernova; 2011AN....332..147H confirms magnetic field, discusses X-ray properties, suggests PSR B1919+10 as remnant of the hypothesized defunct companion ¶ line of sight to ζ Oph is one of the most used in spectroscopic studies of ISM ¶ 2014MNRAS.440.1674H is a recent discussion of variability, from radial and non-radial pulsation modes; AAVSO(VSX), assigning mag. range 2.56–2.58 in V, follows GCVS in treating ζ Oph as a variable with Be behaviour, and yet lacking the history of outbursts founds in the γ Cas class; ζ Oph is, on the other hand, classified as γ Cas-variable (and is termed a shell star) in BSC5; still elsewhere, ζ Oph has been treated as a prototype for the “ζ Oph variables” ¶ E(B-V)=+0.32 (pronounced reddening; if ISM were not present, ζ Oph would reach nearly first magnitude) ¶ recapitulations of recent ζ Oph studies include 2012MNRAS.427L..50G (MK classification problem, also mass-loss rate in context of “weak-wind problem”), 2014MNRAS.440.1674H (rotation, pulsation, Hα emission episodes, inferred circumstellar decretion disk, satellite-based photometry), 2015ApJ...800..132C (distance, age, mass, effective temperature, bow shock in ISM, ...); additionally, 2012A&A...543A..56D is among the papers describing not only the specific interaction of ζ Oph with ISM, but also the quite general ISM bow-shock topic (noting inter alia that not all runaway stars produce bow shocks)	
ζ	Her AB	16 42.1 +31 34	2.81	0.65	G1 IV	93	2.7	35	~0.575	~307	−70 SB	A: 2.90; B: 5.53, G7 V, 1.3″ (2016), orbit 34.45 y orbit well studied since F.G.W. von Struve 1826 micrometry (however, it was Herschel, not von Struve, who discovered the binarity); separation 8 AU min, 21 AU max, 15 AU average, 34.45 y; one of the few binaries in which ratio of B mass to sum of A and B masses can be studied both astrometrically and spectroscopically ¶ ζ Her A is unusual in its evolutionary phase, being in the Hertzsprung Gap (and so in rapid evolutionary transition) ¶ 2001A&A...379..245M summarizes previous work, presents detailed physical modelling for A and B, and discusses astroseismology of A, remarking in conclusion that “among the binaries to be calibrated with some confidence, ζ Herculis is one of the most interesting owing to the difference of evolutionary state of components” ¶ high velocity relative to Sun	
η	Her A	16 43.6 +38 53	3.48	0.92	G7.5 IIIb Fe–1	30.0	0.9	109	0.092	157	+8 V?	on HR diagram a “clump star” ¶ Fe is notably underabundant	
α	TrA A	16 50.9 −69 04	1.91	1.45	K2 IIb–IIIa	~8.4	−3.5	390	0.036	150	−3	anomalous for its MK type, with flares and X-ray	**Atria**

													emission, perhaps from as-yet-undetected magnetically active companion (a companion would indeed be indicated by the claimed “barium star” status of α TrA; http://stars.astro.illinois.edu/sow/atria.html, in discussing the possibility of a companion, also remarks, however, “the classic ‘hybrid star’, a giant that shows evidence for blowing a cool wind from its surface, yet having a hot surrounding magnetic corona at the same time”; https://ntrs.nasa.gov/archi ve/nasa/casi.ntrs.nasa.gov/20040086627.pdf further discusses both α TrA and β Dra, as (solitary) stars, which are in this particular posited sense “hybrid”	
ε	Sco	16 51.5	−34 20	2.29	1.14	K2 III	51	0.8	64	0.666	247	−3	slow rotator (possibly even 1.3 y) ¶ evolved, and yet not a clump star; http://stars.astro.illinois.edu/sow/epssco.html discusses the uncertainty in evolutionary stage (brightening, with He core as yet awaiting ignition? dimming, with He core fusion in progress? or brightening, with dead C-and-O core, He-core fusion now over?) ¶ high velocity relative to Sun indicates origin outside the galactic thin disk (and metal underabundances are consistent with such an origin)	Larawag
μ^1	Sco A	16 53.3	−38 05	3.00v	−0.20	B1.5 IVn	7	−2.9	500	0.024	206	−25 SB2	ecl.: 2.94–3.22, 1.4 d (more precisely, in AAVSO(VSX) as at 2019 Jan. 02, 1.44626907 d); semidetached, partially eclipsing, binary system, with mass transfer, resembling β Lyr in its never-constant light and in exhibiting both primary and secondary minima; 1948MNRAS.108..398S gives the light curve, and also discusses early observational history (this is the third SB discovery in astronomy (made by Bailey, 1896)); separation is ~0.07 AU ¶ μ^1 Sco and μ^2 Sco are not gravitationally bound, although both belong to the (gravitationally unbound) “Upper Sco” subgroup of the Sco-Cen Association	Xamidimura
κ	Oph	16 58.6	+9 21	3.19	1.16	K2 III	36	1.0	91	0.292	268	−56 V	slow rotator (possibly as slow as 1.6 y) ¶ historical assertion of variability may be due to a confusion between κ Oph and χ Oph; completely apart from this historical problem, however, 2001BaltA..10..593A discusses the possible variability both of κ Oph and of other HR diagram red-clump giants ¶ high velocity relative to Sun suggests origin outside the galactic thin disk	
ζ	Ara	17 00.3	−56 01	3.12	1.55	K4 III	7	−2.7	490	0.041	206	−6	one of the rather rare instances of a giant excessively bright in far IR (1997A&A...323..513P suggests that such giants are more likely to be radiating their IR excess from circumstellar debris disks than from winds, and so are to be considered evolved-star analogues of the unevolved (and IR-bright) α Lyr)	
ζ	Dra AB	17 08.8	+65 41	3.17	−0.12	B6 III	10	−1.8	330	0.028	314	−17 V	A,B: mags 3.2, 4.2, respectively; 0.10″ (1994) ¶ given the recent formation of the ζ Dra system, Fe is anomalously underabundant ¶ E(B–V) =+0.03	Aldhibah
η	Oph AB	17 11.6	−15 45	2.43	0.06	A2.5 Va	37	0.3	90	~0.107	~22	−1 SB	A: 3.0; B: 3.5, A3 V, 0.5″ (2017), orbit 87.6 y highly eccentric orbit: separation 2 AU min, 65 AU max ¶ it is possible that A, or B, or both A and B, are superabundant in metals	**Sabik**
η	Sco	17 13.6	−43 16	3.32	0.44	F2 V:p (Cr)	~44.4	1.6	73	0.290	175	−28	although we are constrained by 2018-2019 Handbook printed-edition workflow to display the Garrison legacy dwarf MK type “F2 V:p(Cr)” here (complexity of the legacy type hints at difficulties in classification; even “dwarf barium star” has been asserted elsewhere), it is also the case that NASA NStars assigns, in work summarized at 2006AJ....132..161G (with Garrison the third author) subgiant MK type F5 IV ¶ rapid rotator (< 1 d); the observed X-ray emission is consistent with magnetic effects (including coronal heating?) stemming from rapid rotation	
α	Her Aa,Ab	17 15.6	+14 22	2.78v	1.16	M5 Ib–II	9	−2.4	400	0.032	347	−33 V	semireg. var.: 2.73–3.60 in V; B: 5.4, 4.8″ (2017) PA: 117°→104°, 1777→2017; orbit > 3000 y;	Rasalgethi

													α Her A is strictly SB Aa+Ab (~10 y), and α Her B also strictly SB Ba+Bb (51.578 d, separation 0.4 AU), making α Her at least a (kinematically stable, hierarchically organized) quadruplet; more distant α Her C and α Her D are not necessarily gravitationally bound to the quadruplet; separation of Aa+Ab and Ba+Bb (each of these binaries experiencing its distant companion binary as essentially a point mass) is > 500 AU ¶ 1956ApJ...123..210D discusses mass loss from (in 21st-century nomenclature) α Her Aa, and the consequent circumstellar material (so copious as to encompass even Ba+Bb) ¶ https://en.wikipedia.org/wiki/List_of_largest_stars shows ranking of α Her Aa (radius ~1.5 AU, or more) in the overall known cosmic population of giants, supergiants, and hypergiants ¶ in classification of AAVSO(VSX), α Her Aa is a “semi-regular late-type giant”, with V-mag. range 2.73–3.60; 2001PASP..113..983P reports timescales both of 80–140 d and of 1000–3000 d, while underscoring the complexity of the variation (in their Figure 5, authors show light curve) ¶ in the pictorial-atlas tradition, α Her marks the head of hero Hercules (with β Her marking his club; for summer-evening observers in the northern hemisphere, the hero is to be visualized inverted, with feet high in the sky, club and head lower)	
π	Her	17 15.8	+36 47	3.16	1.44	K3 IIab	8.7	−2.2	380	0.027	276	−26 V?	MK classification K3 has also been asserted ¶ low-amplitude photometric variations with low-amplitude radial-velocity variations, 613 d, perhaps favour the hypothesis of non-radial pulsation over the competing hypotheses of an undetected low-mass companion and of rotation with starspots	
δ	Her Aa,Ab	17 15.9	+24 49	3.12	0.08	A1 Vann	43.4	1.3	75	~0.158	~188	−40 SB	B: 8.8, 12.7″ (2013) is mere optical companion δ Her A, being SB (and also resolved as a binary in interferometry, with angular distance 60 mas; separation ≥ 1.45 AU, period ≥ 335 d), is strictly δ Her Aa,Ab ¶ δ Her Aa is a fast rotator (< 9 h) ¶ as with δ Her B, so also δ Her C and δ Her D, at respective angular distances 174″ (2013) and 192″ (2009), are most likely mere optical companions	Sarin
θ	Oph AB	17 23.3	−25 01	3.27v	−0.19	B2 IV	~7.5	−2.4	440	0.025	197	−2 SB	vaiable. in β Cep class: 3.25–3.31 in V, 0.14 d http://stars.astro.illinois.edu/sow/thetaoph.html discusses uncertainties in multiplicity: perhaps SB with outlying, gravitationally bound, companion at angular distance 0.15″; the primary in the putative SB is a β Cep variable, 0.140531 d ¶ occasional lunar occultations	
β	Ara	17 27.0	−55 33	2.84	1.48	K3 Ib–IIa	5	−3.6	600	0.027	199	0	slow rotator (possibly as much as 2.33 y) ¶ high metallicity ¶ not gravitationally bound to γ Ara AB	
γ	Ara A	17 27.1	−56 24	3.31	−0.15	B1 Ib	~2.9	−4.4	1100	0.016	182	−3 V	broad lines for Ib ¶ γ Ara A is rapid rotator (both “~4.8 d” and “< 2.5 d” have been asserted, and yet rapid rotation is unusual for the (evolved) γ Ara A luminosity class) ¶ 1997A&A...318..157P finds via *IUE* spectroscopy that, consistently with this rapid rotation, the stellar wind of γ Ara A may be equatorially enhanced (and more generally, that the wind is variable, and is structured with two components, its structure being not typical of stars in this portion of the HR diagram) ¶ γ Ara AB is not gravitationally bound to β Ara ¶ E(B–V) =+0.08	
β	Dra A	17 30.9	+52 17	2.79	0.95	G2 Ib–IIa	8.6	−2.5	380	0.020	308	−20 V	in evolutionary terms, β Dra A is somewhat unusual, as a yellow more-than-giant (having been a stable core-hydrogen fuser just 0.5 My ago, the star is in transition to being redder, and of still larger radius ¶ it is also odd that β Dra A, while lying in the HR diagram Instability Strip, has not been observed to pulsate	Rastaban
υ	Sco	17 32.2	−37 19	2.70	−0.18	B2 IV	6	−3.5	600	0.030	185	+8 SB		Lesath

													although we here give spectral type B, type Be has also been asserted ¶ υ Sco and λ Sco are not gravitationally bound (although both belong to the (gravitationally unbound) Sco-Cen OB association, and have as an optical double been called the "Cat's Eyes") ¶ E(B–V) =+0.02	
α	Ara A	17 33.4	−49 53	2.84	−0.14	B2 Vne	12	−1.7	300	0.075	206	0 SB	spectrally not only emission but shell-absorption (emission is from equatorial ejecta; but since the ejecta are rather dense, with the line of sight rather close to equator-on, the star-occulting portion of the ejected mass, as distinct from the two portions flanking the stellar disk, is seen in absorption); consistent with shell-star. 2007A&A...464...59M says, "For the first time, we obtain the clear evidence that the [equatorial ejecta] disk is in Keplerian rotation, closing a debate that has continued since the discovery of the first Be star γ Cas by Father Secchi"; on the authors' modelling, α Ara is rotating near breakup speed (and consequently is oblate), with an enhanced wind from its poles; the authors assert the possibility that equatorial ejecta disk is truncated by an unseen companion at 32 stellar radii ¶ IR excess is unusually high for a Be star ¶ for problem of distance (the *HIPPARCOS* distance given here may be too high) cf 2005A&A...435..275C and 2007A&A...464...59M	
λ	Sco Aa,Ab	17 35.0	−37 07	1.62v	−0.23	B1.5 IV	>6	−4.6	400	0.032	195	−3 SB2	ecl.?, var: 1.62−1.68, 0.21 d strictly a hierarchical triple system, with orbits studied interferometrically in 2006MNRAS.370..884T: the narrow λ Sco Aa,Ab pair has period 5.9525 d, with eclipsing, and the wider λ Sco AB pairing has period ~1000 d (B is elusive, at mag. ~15) ¶ although *HIPPARCOS* parallax entails distance (to one significant figure) 600 ly, 2006MNRAS.370..884T entails instead (to one significant figure) 400 ly: generally speaking, *HIPPARCOS*, like other fine-grained parallax measures of distance, risks degradation if a star has a stellar-mass gravitationally bound companion ¶ λ Sco Aa is a β Cep variable; since full orbital coverage is available in this case (as also with β Cep itself; in most or all other β Cep-class cases, full orbital coverage is presently unavailable), mass determination becomes feasible, making the λ Sco Aa,Ab binary important in β Cep-variable research; λ Sco Ab is itself of interest, as a possible pre-main sequence star (this would be consistent with the observed X-ray emission) ¶ 1975MNRAS.173..709L gives some photometry ¶ a flare was observed in vicinity of λ Sco on 1975 Jun. 01 ¶ 2004A&A...427..581U summarizes previous work on λ Sco, discusses masses, discusses tidal effect on β Cep pulsation ¶ λ Sco and υ Sco are not gravitationally bound (although both belong to the (gravitationally unbound) Sco-Cen OB association, and have as an optical double been jointly called the "Cat's Eyes") ¶ E(B–V) =+0.03	**Shaula**
α	Oph AB	17 35.9	+12 33	2.08	0.16	A5 Vnn	67	1.2	49	0.247	154	+13 SB?	α Oph A is a fast rotator (oblateness has been imaged interferometrically); the binary system has become better understood with the recent, 2011ApJ...726..104H, determination of masses and orbit geometry, through coronagraph and adoptive optics (period 3148.4 d, angular distance at periastron passage ~50 mas; the now-achieved determination of masses in this particular system has implications for astrophysics generally, since it potentially facilitates the refining of numerical models for rapidly rotating hot stars) ¶ astroseismology mission *MOST* has identified ~50 pulsational modes in α Oph A	**Rasalhague**
ξ	Ser Aa,Ab	17 38.8	−15 25	3.54	0.26	F0 IIIb	31	1.0	105	0.073	215	−43 SB		

													hierarchically organized triple system, comprising ξ Ser Aa and ξ Ser Ab, experienced as essentially a point mass by the outlying ξ Ser B; period of single-lined SB Aa+Ab is 2.29 d, with angular distance (in 1987) 0.30″; B is mag. 13.0, at angular distance 24.9″ (2012), with PA: 81°→78°, 1943→2012, and period possibly ~15,000 y ¶ although in our printed Handbook edition we give a Garrison-determined MK type without discussion of multiplicity, ξ Ser Aa has been asserted to be very slightly hotter than Garrison's "F0 IIIb", and moreover to be chemically peculiar, being on this (more recent?) determination of MK type A9 IIIp Sr; additionally, somewhere in the literature, δ Sct variability has been asserted or conjectured (Kaler comments at http://stars.astro.illinois.edu/sow/xiser.html: "the star /…/ remains cryptic") **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
θ	Sco AB	17 38.8	−43 01	1.86	0.41	F1 III	~11	−3.0	300	0.006	119	+1	rapid rotator, in the sense that *v* sin *i* is (according to 2005yCat.3244....0G) 125.0 km/s; since, however, θ Sco is a (rapidly evolving) giant, its high *v* sin *i* may correspond to a not-spectacularly short rotation period, of up to 10 d ¶ optical companion, mag. 5.36, 6.50″; PA: 322°→315°, 1896→1991 ¶ although it is the Sumerian name Sargas that is IAU-official as of 2016 Aug. 21, θ Sco, like κ Sco, has also been known under the different, not IAU-official, name Girtab (originally applied by the Sumerians to an entire asterism)	Sargas
κ	Sco	17 43.9	−39 02	2.39	−0.17	B1.5 III	7	−3.5	480	0.026	193	−14 SB	κ Sco AB has orbital period 195.65 d, with separation 1.7 AU ¶ κ Sco A is a rapid rotator (1.9 d), and additionally is a variable of β Cep type (0.1998303 d, V mag. 2.41-2.42; 1975MNRAS.173..709L gives some photometry, confirming a beat period) ¶ κ Sco, as a single naked-eye object, has (like θ Sco) been known under the different, not IAU-official, name Girtab (originally applied by the Sumerians to an entire asterism)	
β	Oph	17 44.5	+4 34	2.76	1.17	K2 III	~39.8	0.8	82	0.165	345	−12 V	1996ApJ...468..391H finds multiple pulsation periods, in behaviour parallelling α Boo ("it may well be that these [two] stars represent a new class of radially and unradially pulsating stars"), and also a possible long period of 142.3 d; the authors suggest that if the latter is real, then although the more likely explanation is a 142.3-d rotation, nevertheless gravitational pull from an unknown exoplanet is conceivable	Cebalrai
μ	Her Aa,Ab	17 47.3	+27 43	3.42	0.75	G5 IV	~120.3	3.8	27.1	0.804	201	−16 V	BC: 9.78, 35.5″, PA:240°→249°, 1781→2015 orbit ≥ 3700 y: stable quadruple system, in fact the third-closest quadruple star system to the Sun; system is organized as a "double double," being one of the best-studied such systems (2016AJ....151..169R consequently says μ Her "serves as an archetype for understanding stellar system formation"): μ Her Aa,Ab is in tight orbit, and μ Her BC is in tight orbit, with each of these two pairs experiencing the other as essentially a point mass; 2016AJ....151..169R gives Aa,Ab a period of ~100 y, with wide uncertainties, concluding also that Ab is an M-dwarf (as opposed to a mere substellar object); BC has period 43.127 y, separation 1.5 AU min, 3.6 AU max, 2.2 AU average; the separation of the Aa,Ab centre of mass from the BC centre of mass is ≥ 300 AU, with orbital period ≥ 3700 y ¶ despite having finished core-hydrogen fusion, μ Her Aa is a fast rotator, and is consequently magnetically active and an X-ray source	
ι^1	Sco Aa,Ab	17 49.0	−40 08	2.99	0.51	F2 Ia	2	−5.9	2000	0.006	180	−28 SB		

													a rare instance of a yellow supergiant (dead He core; the star is now cooling, and is now in transition to the less exotic status of red supergiant) ¶ radius estimates vary; CADARS (2001A&A...367..521P) value is ~1.9 AU ¶ mass loss ~1e–7 $M_\odot$/y ¶ slow rotator (≥ 0.5 y) ¶ distance and mass are rather uncertain ¶ the modest angular distance of ι^1 Sco from ι^2 Sco is the result of a mere line-of-sight coincidence (with ι^2 ~2 times as distant as ι^1; again by coincidence, not ι^1 alone, but also ι^2, is a supergiant)
G	Sco A	17 51.3	−37 03	3.19	1.19	K2 III	25.9	0.3	126	0.049	56	+25	HR6630, Fuyue although masses of K giants are in general uncertain, in this particular case the mass is known via WIRE salvage-mission astroseismology (being determined in 2008ApJ...674L..53S as 1.44 $M_\odot$, with just a 15% uncertainty)
γ	Dra A	17 57.1	+51 29	2.24	1.52	K5 III	21.1	−1.1	154	0.024	200	−28	**Eltanin** in 1728, James Bradley used γ Dra to demonstrate aberration of light (“velocity aberration”); his demonstration strongly confirmed the heliocentric (and thus non-Ptolemaic) kinematics of Solar System ¶ Fe is slightly underabundant
ν	Oph +2P	18 00.2	−9 46	3.32	0.99	G9.5 IIIa	22	0.0	150	0.117	185	+13	brown-dwarf companions, with masses ≤ 24× Jupiter and ≤ 27× Jupiter (deuterium fusion begins at a lower mass, 13× Jupiter), periods 530.3 d and 3190 d (Quirrenbach et al. 2011, and additionally 2012PASJ...64..135S; the latter paper suggests formation in circumstellar disk, with subsequent migration, in a scenario reminiscent of planet and exoplanet formation): this is the third star found to be hosting two brown dwarfs ¶ slow rotator (≤ 234 d) ¶ far-IR variability has been suspected ¶ CN underabundant, Fe overabundant
γ^2	Sgr	18 07.1	−30 25	2.98	0.98	K0 III	34	0.6	97	0.189	197	+22 SB	Alnasl metals underabundant ¶ ε Sgr and the γ^2–γ^1 Sgr pair serve as pointers to Baade’s Window ¶ angular proximity of γ^1 Sgr (= W Sgr; ~50 arcmin, to ~N of γ^2 Sgr) is a mere line-of-sight coincidence
η	Sgr A	18 19.0	−36 45	3.10v	1.5	M3.5 IIIab	22	−0.2	~146	0.211	218	+1 V?	irreg. var.: 3.05–3.12; B: 8.33, G8: IV:, 3.5″ (2016) PA:100°→110°, 1879→2016; orbit ≥ 1270 y, separation ≥ 165 AU ¶ η Sgr A is variously asserted to be on the (very highly evolved) HR diagram AGB or at the tip of the RGB ¶ η Sgr A is in the AAVSO(VSX) classification an “LB,” i.e. a slow irregular variable ¶ temperature of η Sgr A not yet well determined?
δ	Sgr	18 22.3	−29 49	2.72	1.38	K2.5 IIIa	9	−2.4	350	0.041	128	−20 V?	Kaus Media possibly a weak barium (Ba) star, δ Sgr A possesses (as expected for a Ba star) a WD companion ¶ temperature of δ Sgr A not yet well determined? ¶ “Kaus” is Arabic “bow,” with Kaus Borealis (λ Sgr), Kaus Media (δ Sgr), and Kaus Australis (ε Sgr) the three delineating stars of the archer’s bow; by coincidence, the archer turns out to be aiming rather close both to Baade’s Window and (prolonging the line of firing) to the Sgr A black hole at the galaxy’s centre
η	Ser A	18 22.4	−2 54	3.23	0.94	K0 III–IV	54	1.9	~60.5	0.890	218	+9 V?	slow rotator (but ≤ 1.9 y) ¶ high velocity relative to Sun suggests that η Ser is an interloper (born outside the galactic thin disk? consistently with this conjecture, Fe is underabundant)
ε	Sgr	18 25.5	−34 22	1.79	−0.03	A0 IIn (shell?)	23	−1.4	~143	0.130	198	−15	**Kaus Australis** fast rotator (consistent with shell-star classification); as might be predicted for a fast rotator, a magnetic field, and also X-ray emission, have been detected ¶ has been classified as a λ Boo star, apparently in error ¶ IR excess indicates debris disk (possibly also detected in polarimetry), at average separation 155 AU; and yet a companion is also asserted, surprisingly present within this radius
α	Tel	18 28.5	−45 57	3.49	−0.18	B3 IV	12	−1.2	280	0.056	198	0 V?	

													http://stars.astro.illinois.edu/sow/alphatel.html remarks that MK luminosity class IV notwithstanding, α Tel is still on the astrophysical (as opposed to the MK-phenomenological) main sequence (in other words, is still fusing core hydrogen) ¶ said in 2005ApJS..158..193S to be among the (rare) He-rich stars; these authors list α Tel as a candidate-and-unconfirmed β Cep variable, and say they suspect it is a variable in the slowly pulsating B-star class; although α Tel has *HIPPARCOS* microvariability (0.909 d), it is absent from the AAVSO(VSX) database **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
λ	Sgr A	18 29.2	−25 25	2.82	1.02	K1 IIIb	~41.7	0.9	78	0.191	194	−43 V?	modest X-ray emission indicates some magnetic activity (not usual in a duly evolved, stable core-He-fusing, HR diagram “clump star” ¶ lunar occultations are possible, planetary occultations possible yet rare; most recent planetary occultation was by Venus, on 1984 Nov. 19 ¶ unusual in occupying fully three roles in the Western pictorial traditions: as northernmost star of the Archer’s Bow, as westernmost (handle-tip) star of the Little Milk Dipper, and as uppermost (lid-knob) star in the Teapot	Kaus Borealis
α	Lyr A	18 37.6	+38 48	0.03	0.00	A0 Va	130	0.6	25.0	0.350	35	−14 V	pole-on rapid rotator with circumstellar disk ¶ pole-on rotators are useful for astroseismology, since all but the axisymmetric modes (whether radially symmetric or radially not symmetric) are helpfully rendered invisible to photometry; α Lyr pole-on orientation represents an extreme on a continuum whose other extreme is represented by the equator-on rapid rotator α Leo; the α Lyr rapid rotation (2015A&A...577A..64B now confidently asserts 0.68 d) yields oblate spheroid shape (here as with α Leo); it is this, with consequent latitude-varying photosphere (severe temperature and luminosity gradients along the arcs of photospheric longitude, with equator coolest and darkest), rather than any evolution beyond core-hydrogen-fusion stage, that explains the anomalously high luminosity (α Lyr is in MK luminosity class Va, rather than in the slightly dimmer V class that would be observed if its orientation was equator-on) ¶ α Lyr is now known to harbour all three of the classical circumstellar-dust regimes (~1500 K, near-IR; ~120-170 K, mid-IR, as an analogue of our own zodiacal dust; and ~50 K, far-IR, as an analogue of our own Kuiper Belt: for regimes overview without specific reference to α Lyr, cf 2013ApJ...763..118S, section 1): 2013ApJ...763..118S is the paper announcing discovery of the second of these around α Lyr (with sections 5.1 and 5.2, respectively, summarizing previous α Lyr work on the first and third of the three regimes): a question of recent interest is the origin of the α Lyr exozodiacal (warm-regime, mid-IR) dust (episode analogous to our own planetary system's Late Heavy Bombardment? or, rather, some steady-state replenishment mechanism?); efforts at detecting exoplanet(s)	**Vega**

													to account for the complex inferred, and indeed in some wavelengths also now directly imaged, disk structure have not yet succeeded ¶ 2007ASPC..364...305G, reviewing the history of α Lyr photometry, considers modest variability likely, the historical use of α Lyr as a photometric standard notwithstanding (and indeed α Lyr is described at AAVSO(VSX) as a low-amplitude δ Sct variable, in the now-obsolete AAVSO(VSX) “DSCTC” classification bin, with range -0.02-0.07 in V, with period 0.19 d) ¶ 2010A&A...523A..41P, with 2014A&A...568C...2P corrigendum, is a recent discussion of α Lyr magnetism (the authors note that α Lyr “may well be the first confirmed member of a much larger, as yet unexplored, class of weakly-magnetic stars now investigatable with the current generation of stellar spectropolarimeters”; for origin, they somewhat favour dynamo over fossil, and radiative dynamo over core dynamo): consistently with magnetism, 2015A&A...577A..64B finds, via line-profile variations, multiple (bright, not dark) star spots, in some undetermined complex pattern (authors comment that this is “first strong evidence that standard A-type stars can show surface structure”); 2015A&A...577A..64B is additionally one of several papers summarizing recent work on an interrelated complex of α Lyr themes, comprising (in addition to magnetism) rotation, spots, photovariability, and pulsation ¶ in 2010ApJ...725.2401F, Fig. 8 with its accompanying discussion summarizes studies on elemental abundances (important because α Lyr, as a rather “normal” A star, might serve as a benchmark for appraising chemically peculiar A stars) ¶ E(B–V) =0.00	
φ	Sgr	18 46.9	−26 58	3.17	−0.11	B8 III	14	−1.2	240	0.051	89	+22	apparent duplicity now discounted (erroneous lunar-occultation observation) ¶ http://stars.astro.illinois.edu/sow/phisgr.html discusses some difficulties in physical modelling (if pole-on rotator, then there will be troublesome temperature and luminosity gradients along the arcs of photospheric longitude)	
β	Lyr Aa,Ab	18 50.8	+33 23	3.52v	0.00	B7 Vpe (shell)	~3.4	−3.8	~960	0.004	152	−19 SB	ecl.: 3.30–4.35, 13 d period is increasing at constant rate of ~19 s/y; orbit is seen nearly edge-on; prototype of the β Lyr class of eclipsing systems (but has also been assigned to the new class of “W Ser stars”: 1980IAUS...88..251P); AAVSO supplies information both via VSX database (showing, e.g. the high-precision recent determinations of period) and via https://www.aavso.org/vsots_betalyr (a detailed astrophysics discussion, with bibliography): alternating deep and shallow visible-light minima, with the object eclipsed in the deep minima (the “donor”) a Roche-lobe-filling giant, currently ~3 $M_\odot$ and diminishing, and the object eclipsed in the shallow minima (the “gainer”) embedded in a thick accretion disk, currently ~13 $M_\odot$ and increasing; mass transfer is copious (~2e–5 $M_\odot$/y); this disk renders the gainer dim, and its eclipses consequently shallow, even though the (presently dim) gainer is (now, at this rather late stage in mass transfer) already ~4 times more massive than the (bright) donor (cf 1963ApJ...138..342H); further, instabilities in the accretion disk, from which ~20% of the light comes, make the light	Sheliak

													curve liable to vary slightly from cycle to cycle; the presently dim gainer is destined to be first (1) brightening, and spun up by conservation of angular momentum, as its obscuring accretion disk disappears by being dumped down into photosphere, and then (2) to become a slower rotator, tidally locked with the secondary; at stage “(1)”, the system will be a so-called “Rapidly Rotating Algol,” at stage “(2)”, on the other hand, the system will be simply a “classical Algol” ¶ 2008ApJ...684L..95Z presents the first (CHARA-interferometric) binary-resolving imaging, achieving resolution ~0.5 mas or ~0.7 mas (and for the first time in astrophysics deduces a β Lyr astrometric orbit); the bright low-mass donor, and the presently dim high-mass gainer, are evident, corroborating t the overall conception of 1963ApJ...138..342H ; 2008ApJ...684L..95Z discusses also polar outflow jets on the gainer (these do not alter the essential situation: for the gainer, equatorial gain exceeds polar loss), and deduces a distance to ±15% (a distance consistent-to-within- uncertainties with the *HIPPARCOS* distance) ¶ 2012ApJ...750...59L discusses possible hot spot at edge of accretion disk, on the basis of spectropolarimetry (and 2013MNRAS.432..799M has modelling that provides for hot spot, and additionally for a bright spot, on the accretion disk) ¶ some observations have been made in radio and (a regime especially relevant to hot-spot studies) X-ray ¶ strictly speaking, this is a hierarchical system, with the just-discussed pair becoming, in the updated nomenclature now canonical in multiplicity studies, “β Lyr Aa1” and “β Lyr Aa2”; for the Aa+Ab pairing, and for possibility of further pairings (AB, AC, … , Be, …), cf WDS and (a source which reports inter alia *Gaia*) https://en.wikipedia.org/wiki/Beta_Lyrae ¶ although we here, following Garrison, assign a rather straightforward spectral type, this should be taken only as a starting point: cf, eg., 2000A&A...353.1009B, which lists six systems of spectral lines, while repeating an old O.Struve warning that spectrum involves circumstellar matter ¶ Kaler comments in http://stars.astro.illinois.edu/sow/sheliak.html “one of the most confusing, heavily studied, and important stars of the nighttime sky” ¶ the rather long period, with the large magnitude swing, and the readily discoverable difference in depths of the alternating minima, make this object a suitable binoculars-or-naked-eye photometry project (using γ Lyr as a comparison) even from locations suffering rather frequent cloud **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**
σ	Sgr Aa,Ab	18 56.5	−26 16	2.05	−0.13	B3 IV	14	−2.2	230	0.056	164	−11V	**Nunki** fast rotator ¶ lunar occultations are possible, and planetary occultation possible-yet-rare (most recently Venus, 1981 Nov. 17) ¶ E(B–V) =+0.02
ξ²	Sgr	18 59.0	−21 05	3.52	1.15	K1 III	9	−1.7	400	0.034	113	−20	occultations (at any rate lunar) are possible ¶ the angular proximity of ξ¹ Sgr is a mere line-of-sight coincidence **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**
γ	Lyr	18 59.7	+32 43	3.25	−0.05	B9 II	5	−3.1	600	0.003	290	−21 V	Sulafat has been both asserted and denied to be SB ¶ 2001A&A...371.1078A reports many metals underabundant
ζ	Sgr AB	19 03.9	−29 51	2.60	0.06	A2 IV–V + A4:V:	37	0.4	90	n.a.	n.a.	+22 SB	Ascella A: 3.2; B: 3.5, 0.6″ (2017), orbit 21.1 y separation 10.6 AU min, 16.1 AU max, average 13.4 AU ¶ http://stars.astro.illinois.edu/sow/ascella.html discusses uncertainty in masses, remarks that temperatures are not yet directly measured ¶ Sgr C (17.6″ in 2013) is probably a mere optical companion
ζ	Aql A	19 06.4	+13 54	2.99	0.01	A0 Vann	~39.3	1.0	83	0.096	184	−25 SB	Okab among the most rapidly rotating stars known (period 16 h) ¶ in the angular-proximity grouping ζ Aql A, B, C, D, E, B is considered a gravitationally bound companion of A (mag. 12; angular distance 7.20″ in 2009; separation ≥ 125 AU, period ≥ 800 y); additionally, faint (mag. 16.20) E shares in the AB

													proper motion, and so is likely gravitationally bound ¶ 2008A&A...487.1041A reports near-IR excess around ζ Aql A, and suggests that an unseen close companion is a more likely source than a close-in hot debris disk	
λ	Aql	19 07.3	−4 51	3.43	−0.10	B9 Vnp (kB7HeA0)	26	0.5	120	0.093	192	−12 V	rapid rotator (< 21h) ¶ possibly SB ¶ suspected chemically anomalous (metals-weak, in λ Boo class)	
τ	Sgr	19 08.2	−27 38	3.32	1.17	K1.5 IIIb	27	0.5	120	0.255	191	+45 SB	high velocity relative to Sun suggests origin outside galactic thin disk; underabundance of metals is consistent with this conjecture ¶ slow rotator (≤ 270 d) ¶ possibly SB	
π	Sgr ABC	19 11.0	−20 59	2.88	0.38	F2 II–III	6	−3.1	500	0.036	182	−10	triple system, with AB–C poorly measured B is at angular distance 0.10″ (1989) from A: PA: 152°→179°, 1936→1989; separation ≥ 13 AU, orbit ≥ 15 y; C (mag. 6) was observed in 1936 and 1939 to be at angular distance ~0.3″ from AB (separation ≥ 40 AU, orbit ≥ 100 y), but seems not to have been more recently measured ¶ in HR-diagram terms, π Sgr A lies on blue edge of IS, without being presently observed to pulsate ¶ lunar occultations of ABC are possible, planetary occultations possible-yet-rare (next by Venus, 2035 Feb. 17)	Albaldah
δ	Dra A	19 12.6	+67 42	3.07	0.99	G9 III	33.5	0.7	97	0.133	46	+25 V		Altais
δ	Aql Aa,Ab	19 26.5	+3 09	3.36	0.32	F2 IV	64	2.4	51	0.268	72	−30 SB	fast rotator (> 0.9 d) ¶ binary; 1989AJ.....98..686K, addressing the difficulty posed by fast-rotator line broadening, refines previously computed orbital elements spectroscopically, finding period 3.426 d ¶ http://stars.astro.illinois.edu/sow/deltaaql.html discusses points of uncertainty (incl. the just-mentioned binarity, and possible δ Sct variability; δ Aql is not presently (2018) in the AAVSO(VSX) database	
β	Cyg Aa,AbAc	19 31.5	+28 00	3.36	1.09	K3 II + B9.5 Ve	10	−2.3	330	0.009	229	−24 V	B: 5.11, 35″; Aa, Ab, Ac ≤ 0.4″ (2008) if AB is true binary, orbit is possibly ≥ 100 000 y; the competing mere-optical-companions thesis is argued by Bob King in *Sky & Tel* 2016 Sep. 21; same conclusion is reached in 2018 by P. Plait at www.syfy.com/syfywire/long-standing-as tronomical-mystery-solved-albireo-is-not-a-binary-star, on strength of fresh *Gaia* data (which yield for β Cyg B **π** = 8.4 mas ±2%, implying distance for β Cyg B, to two significant figures, 390 ly; however, further analysis is needed, since astrometry of β Cyg A is potentially perturbed by the multiplicity of A (https://en.wikipedia.org/wiki/Albireo recaps literature, with some reference to recent interferometry)) ¶ our values, for β Cyg A, of **π** = 10 mas (strictly, 9.5 mas ± 6.0%), with D consequently computed to two significant figures as 330 ly, are taken uncritically from *Gaia* ~2018, rather than (as in our previous Handbook editions) from *HIPPARCOS*; we do not here attempt a critical investigation of uncertainties ¶ β Cyg B is a fast rotator (< 0.6 d), and consistently with this is in emission (as “Be”, rather than plain “B”) ¶ β Cyg B is a close binary (companion of mag. 9.2, at angular distance 0.4″; high eccentricity, with average separation ~40 AU, period almost 100 y)	Albireo
δ	Cyg AB	19 45.6	+45 11	2.86	0.00	B9.5 III	20	−0.7	160	~0.066	~42	−20 SB	B: 6.4, F1 V; 2.7″, PA:41°→217°, 1826→2016 orbit 780 y; separation 84 AU min, 230 AU max, 157 AU average, period 780 y ¶ δ Cyg A is a rapid rotator ¶ δ Cyg C is gravitationally bound to the AB pair: mag. 12, angular distance (2017) 62.5″, PA only slightly changed over the interval 1913–2017 ¶ variability has been suspected both in A and in B ¶ E(B–V)=+0.05	Fawaris
γ	Aql A	19 47.2	+10 40	2.72	1.51	K3 II	~8.3	−2.7	390	0.017	100	−2 V	radius ~0.5 AU ¶ variability has been asserted ¶ a rare instance of a “hybrid” star (possessing a	Tarazed

													(hot) corona, like our Sun’s, and yet also emitting the cool high-mass wind typical in an evolved star	
α	Aql A	19 51.8	+8 55	0.76	0.22	A7 Vnn	195	2.2	16.7	0.660	54	−26	rapid rotator (~9 h): 2007Sci...317..342M announces CHARA imaging with angular resolution ~0.65 mas (the first direct imaging of any main-sequence star other than the Sun; http://news.bbc.co.uk/2/hi/science/nature/6709345.stm is a news writeup); 2007Sci...317..342M shows oblate rotation-flattened photosphere, brighter at pole than at equator; the authors argue that a new, improved generation of rapid-rotator models is now needed, going beyond traditional von Zeipel (with, they suggest, successful future modelling of their imaging result *(a)* possibly requiring convection at low latitudes, and *(b)* possibly requiring higher photosphere rotation rate at low than at high latitudes, and *(c)* possibly requiring a more refined treatment of opacities ¶ found in 2005ApJ...619.1072B, via *WIRE* salvage mission, to be δ Sct variable (making it the brightest δ Sct variable, a classification now followed by AAVSO(VSX)); the 2005ApJ...619.1072B authors suggest that many δ Sct variables in the HR diagram Instability Strip may be oscillating at such low amplitudes as to evade detection except by such specially sensitive facilities as *WIRE* (their suggestion helps relieve a longstanding astrophysical bafflement over IS stars which seem inexplicably non-pulsating) ¶ low latitudes of α Aql are source of weak X-rays: 2009A&A...497..511R says they may therefore harbour localized dynamo activity and localized corona (a conjecture consistent with the above-noted 2007Sci...317..342M suggestion of photosphere convection at low latitudes)	**Altair**
η	Aql	19 53.5	+1 04	3.87v	0.63	F6–G1 Ib	2	−4.3	1000	0.011	140	−15 SB	Cepheid var.: 3.49–4.30, 7.2 d more precisely, AAVSO(VSX) as at 2019 Jan. 03 gives 7.17679 d, adding also that BSC5 asserts 7.176641 d with period changes; 2002ApJS..140..465B (in centre panel of the author’s Fig 1) gives (1990s?) photometry (to tighter than ±10 millimag), colour, and radial-velocity curves ¶ hot companion resolved with *HST* WFC3 (cf 2013AJ....146...93E: the authors, combining this WFC3 work with other work, conclude that η Aql is a triple; their hot-companion binarity result is astrophysically important, as supporting the quest for Cepheid masses, and so ultimately supporting the study of the (astrophysically crucial) Cepheid period-luminosity relation ¶ in the case of novice Northern Hemisphere observers troubled by frequent cloud, its rather long period makes η Aql a better high-amplitude Cepheid demonstration than the more celebrated δ Cep **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
γ	Sge	19 59.7	+19 33	3.51	1.57	M0 III	13	−1.0	260	0.070	71	−33 V?	radius 0.26 AU (from interferometry; the disk subtends an angle of 6.18 mas) ¶ slightly variable; already has a dead carbon core, is not yet a Mira **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
θ	Aql Aa,Ab,Ac	20 12.4	−0 46	3.24	−0.07	B9.5 III	11	−1.5	290	0.036	81	−27 SB2	SB 17.1 d, separation ~0.26 AU; 1995AJ....110..376H gives orbital parameters, from interferometry ¶ θ Aql A is metal-rich	
β	Cap Aa,Ab	20 22.2	−14 43	3.05	0.79	K0: II: + A5: V:n	10	−2.0	300	0.046	81	−19 SB	hierarchical quintuplet (or greater) https://en.wikipedia.org/wiki/Beta_Capricorni has a diagram summarizing the known gravitationally bound hierarchy: Aa, Ab1 (seen), Ab2 (unseen), Ba, Bb, where Aa is mag. 3.1, Ab1Ab2 is mag. 4.9, Ba is mag. 6.2, Bb is mag. 9.1; WDS also lists, as nearby in angular distance, C (mag. 8.8, 226″), D (mag. 13.0, 116″),	Dabih

													and E (mag. 14.4, 3.9 ″ from D): Ab1, Ab2 period is 8.7 d; Aa experiences Ab1Ab2 as essentially a point mass, recently at angular distance 50 mas (period 3.77 y, separation ~4 AU); Ba, Bb 0.5″, according to WDS (and yet https://en.wikipedia.org/wiki/Beta_Capricorni states 3″), PA: 106°→57°, 1884→2017; AB 205″, PA: 268°→267°, 1800→2012; each of AaAb, BaBb experiences the other as essentially a point mass, at separation ≥ 0.34 ly, with the AaAb+BaBb orbit ≥ 700,000 y ¶ spectral type of β Cap A is controverted ¶ β Cap A is overabundant in Hg, Mn, and several other heavy elements ¶ lunar occultations are possible, planetary occultations possible-yet-rare	
γ	Cyg A	20 23.0	+40 19	2.23	0.67	F8 Ib	2	−6.5	2000	0.003	111	−8 V	BC combined light is mag. 11, with B, C mags 10.0, 11.0, respectively; A, BC angular distance 147″ in 2010, with PA unchanged since 1877; however, http://stars.astro.illinois.edu/sow/sadr.html considers the A+BC pairing to be a mere line-of-sight coincidence (and WDS gives the following for BC: 1.9″ in 2015, PA: 305°→302°, 1878→2015) ¶ unusual in being not only a supergiant, but a supergiant in MK type F (among supergiants, it is the hotter and the cooler types that are more usually encountered); γ Cyg A is near the HR diagram Instability Strip: 2010AJ....140.1329G first surveys the observational literature, then discusses spectral variations (possibly pulsation-style oscillation, or alternatively large convection cells are possible; and indeed convection cells can be a driver of oscillation) ¶ radius ~1 AU (http://stars.astro.illinois.edu/sow/sadr.html discusses uncertainty) ¶ BSC5: “no demonstrable connection” between γ Cyg and the so-called γ Cyg supernova remnant	Sadr
α	Pav A	20 27.3	−56 40	1.94	−0.12	B2.5 V	18	−1.8	180	0.086	175	+2 SB	SB 11.753 d, separation 0.21 AU ¶ 1988A&A...201..273V discusses galactic-astronomy implications of this star’s puzzling deuterium paucity ¶ E(B–V)=+0.02 ¶ the name, although anomalously English, is nevertheless IAU-official: its origins lie in 1930’s RAF Air Almanac project, which directed HM Nautical Almanac Office that no air-navigation star was to be left nameless	**Peacock**
α	Ind A	20 39.0	−47 13	3.11	1.00	K0 III CN–1	33	0.7	98	0.083	37	−1	Fe overabundant (α Ind born in metal-rich ISM cloud?)	
α	Cyg A	20 42.1	+45 21	1.25	0.09	A2 Ia	2	−6.9	~1400	0.003	47	−5 SB	blue supergiant (BSG), of radius ~0.5 AU or ~1 AU; for context pertaining to this particular BSG in the general population of hypergiants and supergiants, cf https://en.wikipedia.org/wiki/List_of_largest_stars (which adopts “~1 AU”); for current state of theoretical investigations into BSG populations (crossing Hertsprung-Russell diagram for the first time, redward? or, rather, after an RGB episode of mass loss, crossing for the second time, blueward?) cf, e.g. 2014MNRAS.439L...6G ¶ the prototype of the α Cyg variables: AAVSO(VSX) gives V ranges 1.21–1.29; seemingly irregular (in the α Cyg variables, many short-period oscillations are superimposed); 2011AJ....141...17R discusses α Cyg, reporting a 1977-through-2001 campaign in both photometric and spectroscopic variability ¶ α Cyg core hydrogen-fusion career started in MK spectral type B, or possibly even in the rare MK spectral type O ¶ present mass loss rate is ~8e-7 M☉/y ¶ slow rotator (period possibly as long as 0.5 y, consistently with its large radius and its ongoing mass loss) ¶ public-outreach astro audiences enjoy comparing	**Deneb**

													and contrasting distance, and therefore intrinsic luminosity, of α Cyg with distance, and therefore intrinsic luminosity, of the other two Summer Triangle stars (nearby α Lyr, nearby α Aql; all three are similar not only in their apparent magnitudes, but also in falling within MK type A, and consequently in lacking tint, even through binoculars); it is perhaps worth stressing in such lectures that the α Cyg distance, although large (1500 ly? more?), is nevertheless not yet well known; Kaler in http://stars.astro.illinois.edu/sow/deneb.html, accepting ~1500 ly, writes that if placed at distance of α Lyr, α Cyg “would /…/ be as bright as a well-developed crescent Moon, cast shadows on the ground, and easily be visible in broad daylight”	
η	Cep A	20 45.7	+61 55	3.41	0.91	K0 IV	70.1	2.6	46.5	0.823	6	−87	high velocity relative to Sun indicates interloper status in galactic thin disk (and observed underabundance of Fe is consistent with interloper status)	
β	Pav	20 46.8	−66 08	3.42	0.16	A6 IV	~24.1	0.3	135	0.044	283	+10	still a fast rotator (≤ 2.3 d), although core hydrogen fusion is ended or is close to ending	
ε	Cyg Aa,Ab	20 47.0	+34 03	2.48	1.02	K0 III	44.9	0.7	73	0.486	47	−11 SB	C: common proper motion, 79″ (2017) AC PA: 266°→269°, 1959 →2017; AC orbit ≥ 50,000 y, separation ≥ 1700 AU (where C is a red dwarf, mag. 13.4); the SB pairing (with just one set of lines visible) ε Cyg Aa+Ab has period ≥ 15 y ¶ velocity of AaAb+C relative to Sun is high	Aljanah
ζ	Cyg Aa,Ab	21 13.8	+30 19	3.21	0.99	G8 IIIa Ba 0.5	23	0.0	140	0.069	175	+17 SB	in evolutionary terms, possibly a “clump giant” (with stable He fusion in core); but it might also be the case that core He fusion has yet to begin ¶ chemically a mild Ba star (1992Obs...112..168G discusses spectroscopy, reviewing history at a level of detail so instructive as to make this a case study for spectroscopy technique more generally, even outside the particular domain of ζ Cyg); consistently with this chemical anomaly, ζ Cyg A has WD companion ζ Cyg B (before becoming a WD, this close companion deposited Ba onto ζ Cyg A as it shed mass: WD orbit 17.8 y, separation 8 AU min, 13 AU max, 11 AU average; 2001MNRAS.322..891B announces direct imaging with *HST* WFPC2 (elongated smear, WD partly resolved, possibly 36 mas))	
α	Cep A	21 19.1	+62 40	2.45	0.26	A7 Van	66.5	1.6	49.1	0.158	72	−10 V	fast rotator (< 12h) ¶ listed by AAVSO(VSX) as δ Sct variable, with V mag. range 2.41–2.47 ¶ several factors, including X-ray emission, indicate magnetic activity	Alderamin
β	Cep Aa,Ab	21 28.9	+70 39	3.23v	−0.20	B1 III	5	−3.4	700	0.015	56	−8 SB	var.: 3.16–3.27, 0.19 d; B: 7.8; 13.5″ (2016) PA: 255°→251°, 1779 →2016; orbit ≥ 40,000 y ¶ the archetype of the β Cep variables (although this same class is sometimes called the “β CMa variables”), and (as is typical in the class) known to be multiperiodic: AAVSO supplies a 2010 Apr. 13 backgrounder at www.aavso.org/vsots_betacep; AAVSO archives a notice for a August 2009 β Cep campaign (coordinated photometry, spectroscopy, CHARA) at www.aavso.org/aavso-special-notice-162 ¶ system comprises at least (the much-studied variable) and Ab (mag. 6.6, probably an emission (Be) star, and the origin of the Be behaviour observed in AaAb); Aa+Ab period 85 y (when resolved with speckle interferometry in 1972, angular distance was 250 mas); β Cep B is mag. 8.6, at angular distance 13.5″ in 2016; if B is gravitationally bound to AaAb, then period is ≥ 40,000 y, with separation 3,000 AU ¶ MK luminosity class III (“giant”) notwithstanding, β Cep Aa is still fusing hydrogen in its core	Alfirk
β	Aqr A	21 32.6	−5 29	2.9	0.83	G0 Ib	6	−3.2	500	0.020	114	+7 V?		Sadalsuud

													a rare instance of a yellow supergiant; possibly now evolving blueward in a second crossing of the HR diagram ¶ spectroscopically a “hybrid” star, combining signature of hot corona with signature of cool massive wind; 2005ApJ...627L..53A, in a study jointly covering β Aqr and the astrophysically similar hypergiant (likewise a hybrid) α Aqr reports *Chandra* observation of coronal X-rays (first X-ray detection from a hybrid G supergiant; such supergiants are X-ray deficient, their coronae notwithstanding) ¶ β Aqr lies in the HR diagram Instability Strip, and yet is not known to be a pulsator	
ε	Peg A	21 45.2	+9 58	2.38v	1.52	K2 Ib	5	−4.2	700	0.027	89	+5 V	irregular var.: 2.37–2.45 (flare in 1972) 1972IAUC.2392....1W reports extreme flare-like brightening, ~10 minutes, to V mag. 0.7 ¶ orange-class supergiant ¶ 1987MNRAS.226..563S discusses abundances, finding that, earlier literature notwithstanding, ε Peg is unremarkable in its Ba (and unremarkable in its Sr), and therefore discounting an earlier suggestion that ε Peg outer layers have hosted nucleosynthesis in slow-neutron capture ¶ BSC5 suggests “cooler shell surrounding”	**Enif**
δ	Cap Aa,Ab	21 48.2	−16 02	2.85v	0.18	A3mF2 IV:	84	2.5	38.7	0.396	139	−6 SB	occ. bin.: 2.81–3.05, 1.0 d, 3.2 + 5.2 δ Cap Aa+Ab classified at AAVSO(VSX) as Algol-type eclipsing binary, 1.0227688 d (period current as of 2018 Dec. 21; the AAVSO(VSX) lookup also yields O-C, i.e. period-monitoring, plotting from 2016); Ab is ~3 mag. fainter than Aa, and is judged in 1992MNRAS.259..251W to be mildly active, possibly tidally locked, with large spot: Aa+Ab is known to be SB since 1906 (Slipher), and yet is known to be eclipsing only as of 1956PASP...68..541E ¶ lunar occultations are possible, planetary occultations possible-yet-rare ¶ 1994MNRAS.266L..13L rebuts earlier assertion of δ Sct variability, and remarks that “given the brightness of the system, δ Cap is poorly observed,” with period awkward for any one solitary observatory (an implication of this remark is that coordinated intercontinental photometry would now be helpful)	Deneb Algedi
γ	Gru	21 55.2	−37 16	3.00	−0.08	B8 IV–Vs	15	−1.1	210	0.099	98	−2 V?		Aldhanab
α	Aqr A	22 06.8	−0 13	2.95	0.97	G2 Ib	6	−3.1	~520	0.021	117	+8 V?	a rare instance of a yellow supergiant; possibly now evolving blueward in a second crossing of the HR diagram ¶ spectroscopically a “hybrid star”, combining signature of hot corona with signature of cool massive wind; 2005ApJ...627L..53A, in a study jointly covering α Aqr and the astrophysically similar supergiant (likewise a hybrid star) β Aqr reports *Chandra* observation of coronal X-rays (first X-ray detection from a hybrid G supergiant; such supergiants are X-ray deficient, their coronae notwithstanding) ¶ in HR-diagram terms, α Aqr lies in the HR diagram Instability Strip (under at least one definition of the Strip) and yet is nonpulsating (cf further 2017AstL...43..265U)	Sadalmelik
α	Gru A	22 09.5	−46 52	1.73	−0.07	B7 Vn	32	−0.7	101	0.194	139	+12	rapid rotator (< 1d) ¶ E(B–V)=–0.02	**Alnair**
θ	Peg	22 11.2	+6 18	3.52	0.09	A2mA1 IV–V	35	1.3	90	0.284	84	−6 SB2	rapid rotator (< 20 h); consistently with rapid rotation, and therefore with a stirred atmosphere, elemental abundances are unremarkable ¶ earlier assertion of δ Sct variability is now discounted **[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	Biham
ζ	Cep	22 11.6	+58 18	3.39	1.56	K1.5 Ib	3.9	−3.7	800	0.014	69	−18 SB	orange supergiant, either approaching core He fusion or already in core He fusion ¶ an eclipsing companion has been suggested, with suggestion later questioned ¶ metals somewhat overabundant	
α	Tuc	22 19.9	−60 09	2.87	1.39	K3 III	16	−1.1	200	0.081	241	+42 SB	SB 11.5 y, separation possibly 11.5 AU ¶ primary in the SB is a giant, with C underabundant,	

													N overabundant ¶ http://stars.astro.illinois.edu/sow/alphatuc.html discusses uncertainties in the evolutionary stage of this giant, offering three scenarios	
δ	Cep A	22 29.9	+58 31	4.07v	0.78	F5–G2 Ib	4	−3.0	900	0.016	77	−15 SB	prototype Cepheid var.: 3.49–4.36, 5.4 d second-nearest Cepheid (α UMi is still nearer) ¶ AAVSO offers a tutorial at www.eso.org/public/outre_ach/eduoff/aol/market/collaboration/varstar/pg2.html and an initial backgrounder at www.aavso.org/vsots_delcep; the first three sections of a paper directed inter alia to AAVSO observers, 2016JAVSO..44..179N, constitute a deeper backgrounder on the Cepheids ¶ AAVSO(VSX) has, from 2013 Sep. 24, period 5.366266 d; although Cepheids experience both period jitter and (monotonic) period slide, with a slide of even 200 s/y possible, 2014ApJ...794...80E finds δ Cep period sliding slowly, at just -0.1 s/y (period decrease-increase is a signature of evolution, specifically of density increase-decrease, as a Cepheid passes across the HR diagram (δ Cep is now making its second such passage, moving blueward)) ¶ 2015ApJ...804..144A announces that δ Cep is SB, with period 2201 d ¶ accurate distances to Cepheids are foundational in cosmology, which needs independently known (galactic) Cepheid distances before embarking on its external-galaxy distance deductions through applications of the Cepheid Period-Luminosity (PL) Law; it is reassuring that the 2007 *HIPPARCOS* distance and the distance implied by the usual PL calculation agree to within uncertainties; although we have here stated the 2007 *HIPPARCOS* parallax, on which distance of δ Cep depends, as 4 mas, our cited 2007 *HIPPARCOS* determination is more formally, with decimal fractions and the uncertainty made explicit, 3.77±0.16 mas; 2015ApJ...804..144A proposes instead 4.09±0.16 mas, with the remark that impending *Gaia* may be expected, in part in the light of these authors' SB announcement, to secure an authoritative parallax; an already reassuring state of affairs may thus be expected to improve further ¶ mass loss ~1e–6 $M_{\odot}$/y; bow shock in ISM has now been detected ¶ C: 6.1, 41″ (2017), has period ≥ 300,000, separation ≥ 11,000 AU	
ζ	Peg A	22 42.5	+10 56	3.41	−0.09	B8.5 III	16	−0.6	210	0.078	98	+7 V?	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** our (Garrison) MK type notwithstanding, B8 V has been suggested ¶ fast rotator (< 1.4 d) ¶ microvariable (2007PASP..119..483G discusses satellite detection of amplitude ~0.5 millimag); assigned by AAVSO(VSX) to the class of "slowly pulsating B stars"	Homam
β	Gru	22 43.9	−46 47	2.07v	1.61	M5 III	18	−1.6	180	0.135	92	+2	irregular var.: 2.0–2.3 among the rather uncommon cool red giants, with radius slightly > 0.8 AU ¶ classified at AAVSO(VSX) as semiregular late-type giant, perhaps on the basis of 2006JAVSO..34..156O (this paper might serve as a case study for effective amateur-budget intercontinental photometry collaboration)	Tiaki
η	Peg Aa,Ab	22 44.0	+30 20	2.93	0.85	G8 II + F0 V	15	−1.2	210	0.029	153	+4 SB	η Peg Aa+Ab period 813 d ¶ slow rotator (818 d?) ¶ system is possibly more than a binary: cf WDS, which lists, apart from Aa and Ab, also celestial-sphere neighbours B, C, D, E, F, G, H, I	Matar
ε	Gru	22 49.8	−51 13	3.49	0.08	A2 Va	25	0.5	130	0.126	121	0 V	rapid rotator (< 0.65 d)	
ι	Cep	22 50.4	+66 19	3.50	1.05	K0 III	28.3	0.8	115	0.141	208	−12	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	
μ	Peg	22 51.0	+24 43	3.51	0.93	G8 III	31	0.9	106	0.151	106	+14	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]**	Sadalbari
δ	Aqr	22 55.7	−15 43	3.27	0.07	A3 IV–V	20	−0.2	160	0.051	237	+18 V	**[THIS STAR ONLY IN ONLINE VERSION OF TABLE]** (weak λ4481) ¶ rapid rotator (< 3.0 d)	Skat
α	PsA A+1P	22 58.8	−29 31	1.17	0.14	A3 Va	130	1.7	25.1	0.368	1 17	+7	2008 exoplanet image (*HST*)	**Fomalhaut**

													HST shows exoplanet Dagon (so named at IAU after a Semitic deity) at ~125 AU, in the outermost of the debris rings; Dagon is in always-wide (albeit eccentric) orbit, making direct imaging, as opposed both to spectroscopy (for star Doppler wobble) and astrometry (for star transverse wobble) the tool of choice: 32 AU min, 320 AU max; period ~1700 y ¶ in recent years, it has been suggested that Dagon could be a mere dust cloud, or an aggregation of rubble, or a single rocky body (with the first possibility more recently disfavoured?); an explanation is needed for the fact that Dagon proves so readily HST-visible (e.g. visibility enhanced by circumplanetary dust sphere, or by circumplanetary ring system?); Dagon mass is uncertain (< 2× Jupiter, perhaps even ~Earth) ¶ the nested circumstellar dust rings extend as far as radius ~150 AU (a distance recalling the Solar System Kuiper Belt); 2017ApJ...842....8M reports complete outer debris-ring mapping, via ALMA (223 GHz radio), finding ring mass of 0.015 Earths, eccentric, with α PsA A offset from the ring centroid ¶ α PsA A is a fast rotator (< 1d) ¶ in evolutionary terms, α PsA A is sufficiently young to be undergoing an analogue of the Solar System's Late Heavy Bombardment (and consistently with this, 2017ApJ...842....9M says exocometary gas is detected, by ALMA 230 GHz radio) ¶ 2017ApJ...842....8M comments that "given its unique characteristics and architecture, the Fomalhaut system is a Rosetta stone for understanding the interaction between planetary systems and debris disks" ¶ α PsA A has low metallicity ¶ 2013AJ....146..154M, working both from proper motion (across the celestial sphere) and from velocities along the line of sight, concludes that α PsA, B, and C belong to the same system: B (a flare star) is V mag. 7.1, at angular distance almost 2° (period ≥ 7.6 My), while C is V mag. 13.2, at enormous angular distance 5.7° (and yet at a sufficiently low separation from AB to have the AB gravitational field dominate the general external gravitational field at its location; period ≥ 35 My) ¶ β Peg, α Peg serve as pointers: since α PsA lies a couple of arcminutes N of DEC=-30°, α PsA rises (if briefly) above the horizon even for such Canadian subarctic communities as Churchill, and for such Scandinavian communities as Stavanger	
β	Peg A	23 04.8	+28 12	2.44v	1.66	M2 II–III	16.6	−1.5	~196	0.232	54	+9 V	irregular var.: 2.31–2.74 classified by AAVSO(VSX) as semireg. variable, with period 43.3 d ¶ an intermediary between straightforward red giant and red bright giant (radius ~0.5 AU); mass loss rate is notably low for such a star (≤ 1e-8 $M_\odot$/y; i.e. ~100× lower than mass loss rate of α Ori; IRAS detected no IR excess)	Scheat
α	Peg A	23 05.8	+15 19	2.49	0.00	A0 III–IV	24	−0.6	133	0.073	124	−4 SB	rapid rotator (1.5 d)	**Markab**
γ	Cep AB+1P	23 40.2	+77 45	3.21	1.03	K1 III–IV	71	2.5	46	0.135	339	−42 V?	a tight double (angular distance 0.9″ in 2006, separation 12 AU min, 25 AU max, period 66 y or 67 y; 2007A&A...462..777N reports the first direct imaging of γ Cep B, by Subaru) ¶ γ Cep A possible rotation period 781 d (making this star a slow rotator) ¶ exoplanet orbiting γ Cep A (IAU-named Tadmor) is among the few discovered in a binary system; it is circumstellar without being circumbinary: period 2.47 y, average separation 2.05 AU, mass between 3× Jupiter and 16× Jupiter	Errai