TOP ARGELANDER STARS: PEDAGOGY & PRIZE
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ABSTRACT

Stellar astronomy, fueled by massive capital investments, advances in numerical modeling and theory, is resurgent and arguably is on the verge of a magnificent renaissance. Powerful time domain optical surveys, both on ground and in space, are producing data on variable stars on an unprecedented industrial scale. Those with deep knowledge of variable stars will stand to benefit from this resurgence. Notwithstanding these developments, in some astronomical communities, classical stellar astronomy has been in the doldrums. I offer a modest proposal to establish a basic level of familiarity with variable stellar phenomenology and an attractive scheme to make research in variable star astronomy visible, alluring and fashionable.

1. A RESURGENCE IN STELLAR ASTRONOMY

Stellar astronomy is now on the rise. Kepler with its exquisite photometric precision has revolutionized the field of extra-solar planets and additionally has kick-started the rich field of asteroseismology. The Gaia mission is poised to initiate a revolution in astrometry on a scale that astronomers have not seen for nearly a century. This grand expectation is grounded in the large number of stars for which precision astrometric measurements will be obtained by Gaia. Pan-STARSS has laid down a deep multi-band photometric grid over three quarters of the sky. Next year, the Zwicky Transient Facility (ZTF) will begin a 3-year survey of the Northern sky, sharply focused on the dynamic optical sky (that is, variable stars, transients and moving objects). In 2018 the TESS mission is expected to start routine observations. TESS will focus on precision photometry of stars brighter than 12 mag. However, full frame images will allow observations of fainter stars over substantial areas of the sky.

One should not discount smaller and nimble investments such as ASAS, ASAS-SN and Evryscope. Many such projects are trail blazers. Finally, it is both gratifying and astonishing, despite the massive capital investment by professional astronomers, that amateur astronomers continue to make serious contributions to stellar and supernova research.

While above we have focused on astrometry and photometry there has been good progress in spectroscopic surveys (e.g. RAVE and the ultra-low resolution spectroscopy of Gaia). There is now a (timely) movement to repurpose the massively-multiplexed spectrographs of the Sloan Digital Sky Survey (SDSS) for stellar astronomy.

As can be deduced from the above summary the capital investment in stellar astronomy has been substantial. However, stellar astronomy is a fairly mature field. Thus merely obtaining large volumes of superior data without corresponding superior theoretical framework will not result in realization of the full gains of the capital investments. Fortunately, there has been good progress on the theoretical and modeling fronts. Nowadays, on a routine basis, astronomers undertake multi-dimensional, if not three-dimensional, modeling of stars and related phenomena. Tools such as MESA allow observers and modelers to compare theory to observations at the few percent (or even lower) level.

The future landscape in stellar astronomy is extremely promising. I justify this statement with just three examples. First is the implication to stellar astronomy arising from the recent findings by LIGO (Abbott et al. 2016) — not only are stellar black hole binaries rare but the masses of the black holes was surprisingly higher than expected. These two findings are motivating astronomers to explore entirely new paths of stellar evolution in which not only low metal abundance but rapid rotation is expected to strongly influence the evolution of stars. Second, several findings over the last few years, from time domain surveys — wild diversity in pre-supernova mass loss, new types of super-luminous supernova — clearly show that massive stars have multifarious evolutionary paths and multifaceted deaths. These advances are still being digested. It is now clear that future textbooks on stellar astronomy will have not one but several chapters on the evolution and endings of massive stars. Finally, it is becoming clear that massive stars in binary systems may play a major role in the ionization history of the early Universe (z ~ 6; Ma et al. 2015).

2. F. W. ARGELANDER

With the modern background laid out I now arrive at the primary goal of this writeup — the anticipated resurgence of variable star astronomy. It is by now well known that forecasting the future is difficult. Furthermore, it is almost always wrong. However, it is said that a knowledge of the past helps understand the future better. In that spirit our journey begins with Friedrich Wilhelm Argelander (1799–1875) who is considered as the founding astronomer of the modern era of variable stars.

Argelander was born in what is now Lithuania. He undertook his PhD under the famous German astronomer Friedrich Bessel at the University of Königsberg located in what is now called Kalingrad. Following his PhD, in 1823, he moved to the Turku Observatory. In 1832 he...
moved to Helsinki where he supervised the construction of the then new Helsinki observatory. His primary accomplishment, up until this point, was the investigation of the Sun’s motion with respect to other stars. In 1837 he moved to Germany and took up the Directorship of the Observatory of the University of Bonn (which was, at the time, one of the best funded observatories). It was in Bonn, in 1844, he began studies of variable stars. Separately, since 1826, he was a corresponding member of the St. Petersburg Academy of Sciences. Clearly, Argelander was not only energetic but also a pan-European astronomer.

Argelander was an expert in astrometry and photometry. Along with his students and colleagues he was responsible for the famous star catalog, Bonner Durchmusterung (BD). This catalog, consisting of 324,188 stars with magnitude brighter than about nine, had an astrometric precision was 0.1′ in declination and 0.1 second in Right Ascension (RA). It was the first comprehensive astrometric and photometric catalog of the Northern sky. The catalog, for its time, was considered to have superior photometry.

The BD catalog laid the standard for future photometric and astrometric star catalogs. The BD catalog was re-issued in 1950! Many BD stars serve as absolute photometric standards for ground- and space-based telescopes (e.g. BD +28◦ 4211, BD +17◦ 4708). Separately, Argelander founded the Astronomische Gesellschaft ( Astronomical Society), which in collaboration with many observatories expanded his work to produce the AG catalog.

2.1. Variable Stars & Argelander

A small note in Popular Astronomy by Annie J. Cannon of the Harvard College Observatory [Argelander & Cannon 1912] written in 1911 is an excellent gateway to appreciate the role played by Argelander in the development of variable star astronomy. In that note Cannon refers to a chapter on variable stars, entitled An appeal to the friends of Astronomy, written by Argelander for the 1844 edition of Schumacher’s Astronomical Year book. Argelander exhorts fellow astronomers to undertake observations of variable stars and catalog the photometry. Cannon notes “After reading the article, one feels like reviewing the advances in our knowledge of the variable stars since 1844. Instead of 18 variables, as in Argelander’s catalogue, we must provide for more than 4000.”

Argelander was interested in more than simply amassing data and identifying variable stars. Even with the meager sample of variable stars at his disposal, Argelander in the afore mentioned chapter speculated about the physical origins of variability, making the following prescient suggestions:

On account of the low state of our knowledge of these stars, nothing in general can at present be offered nor, by any means, can a definite theory be given, which can refer the light changes to any one cause. But happily, hypotheses, even if full of error, fail us not. Omitting those which at first glance are seen to be untenable, they resolve themselves into the following three.

1. Revolution of the stars on their axes, their surfaces being of different luminosity on the different sides, whereby they would be brighter if they turned towards us the side of greatest illumination, or conversely, darker if the side of less illumination.

2. Revolution on their axes, with strongly compressed figure, and considerable variation of angle of the axis of rotation towards the line of sight. If the axis nearly coincides with the line of sight, then the star turns towards us a very extensive surface, sends us much more light, and therefore shines brighter than if they, because of a very large angle, turn their edge, if I may so call it.

3. Huge planets revolving around the stars, in the plane of whose orbits the line of sight nearly falls and which, therefore, by inferior conjunction with the star, cut off a large part of the light formerly coming from it to us, so that it seems less bright.

The first of these hypotheses seems to be the most plausible and, in general, to explain observed appearances of several of the stars, if we assume that the constitution of these stars is similar to that of our Sun.

Argelander’s suggested phenomena can be summarized as: (1) rotational modulation of star spots; (2) precession of a rapidly rotating ellipsoidal star, and (3) transits of extrasolar planets. Although none of Argelander’s eighteen original variables fit his hypotheses, star spots and transiting extrasolar planets are today commonly observed phenomena. Doubtless, Argelander stood on the shoulders of giants; observations of transits within our solar system date back to at least 1631, when Pierre Gassendi recorded the transit of Mercury, while Immanuel Kant and Pierre-Simon Laplace are often credited for suggesting that planets should also exist around other stars just a generation before Argelander. Nevertheless, Argelander’s suggestion that transits of extrasolar planets might be observed is apparently the first such mention in the literature. In contrast to his prescience in astronomy, Argelander appears to have been an unsophisticated (simple?) person in real life.

Footnotes:

7 Here Argelander points to the observations of sunspots from Herschel, Schröter, and Sommering, though at that time mountain chains were considered a plausible explanation for the spots.
8 Many are Mira-type pulsators, Cepheids, or semi-detached eclipsing binaries, which do exhibit ellipsoidal modulation though not due to precession of a single star.
9 Though this idea may even go back to Democritus.
10 My colleague Prof. Franciscus Wilhelmus Maria Verbunt, University of Nijmegen, The Netherlands, informed me: “There is a nice anecdote about Argelander. I read this in the book on Greek Cultural History by Burckhardt, in the introduction, where it is
I end by noting that this section, for most part, was contributed by graduate student Trevor David and Prof. Lynne Hillenbrand, both of my own department.

3. A SCHEME TO NAME VARIABLE STARS

Thanks to Argelander’s enthusiasm for variable star astronomy research and perhaps more importantly to the precision of the photometry in the BD catalog Argelander realized that the sky could be teeming with variable stars. The old scheme of assigning interesting stars (not merely variable) with romanized Latin alphabets had a capacity for 23 stars. In order to accommodate larger populations of variable stars Argelander designed a new naming scheme. The scheme was reformulated several times as the number of cataloged variable stars increased. The reader is referred to Townley (1915) for a historical account of the evolution of the naming framework.

The naming formulation has three steps and is explained below.

I. The designation of a variable star is a prefix to the name of the constellation in which the variable star is located. The first prefix is R. As additional stars were discovered they were assigned prefixes S, T, U, V, W, X, Y and Z. These 9 entries, per constellation, constitute the first (“I”) series. Examples include “R Coronae Borealis” (exotic carbon rich star), “S Andromedae” (supernova of 1885 in the Andromeda galaxy) and “T Tauri” (the archetypical pre-main sequence star).

II. However, by 1881, the number of variable stars in some constellations already exceeded nine. In 1881 Hartwig proposed adding the next series: RR to RZ, SS to SZ, TT to TZ and finally ZZ. Thus series II has 9+8+7+6+5+4+3+2+1 stars or a total of 45 stars. For instance, “RR Lyrae” is an exemplar of a class of pulsating variables. “RS CVn” is a prototype of stars with strong magnetic and related activity powered by binarity. “ZZ Ceti” is famous for being the first white dwarf seismological pulsator.

III. By 1904, the number of variable stars had increased (particularly in the Orion constellation) to such an extent that a new series was added: AA through AZ, BB to BZ and end with QQ to QZ. However, as noted earlier, the letter “J” was excluded. The scheme ends with QZ. With some care it can be shown that the number of prefixes in series III is 25 + 24 + ...11 + 10 or 280 stars.

Adding the number of entries from series I, II and III leads to 334 prefixes. We will call such stars as “classic” Argelander stars.

IV. The advent of photography vastly increased the number of variable stars. When the classic 334 prefixes were used up the scheme switches to the “modern” V (for variable) numbering scheme. This scheme was suggested by several astronomers including Townsley (ibid). The scheme starts with “V335” and marches to larger numbers. For example the variable after “QZ Cyg” (an “irregular” variable) is “V335 Cyg” (an M1 variable star). Fortunately, mathematicians inform us that there exists an infinite supply of integer numbers. Thus astronomers can safely expect no future reformulation of the scheme to name variable stars.

It is important to note that the Argelander designation was based on optical variability. As a result some super-famous variable stars of our age have lowly Argelander designation. I quote some examples. “V404 Cyg” is a famous X-ray nova and very much in the news since its burst in 2015. Aquila X-1 (V1333 Aql) is a famous soft X-ray transient. SS 433, an exotic and unique, to date, stellar system is merely V1334 Aql.

3.1. Criticism of the Argelander Scheme

In contrast to the effusive praise of Argelander by Canon Townsley was critical of Argelander for his choice of naming scheme. There is some merit in Townsley’s dislike of the convoluted and idiosyncratic naming scheme described above. However, from personal experience I know that naming schemes (1) rarely have a foundation in some “rational” framework and (2) invoke strong emotional response from otherwise reasonable people. Rather than distract the reader for the main topic of this article I refer the interested reader for my experience and thoughts on naming schemes.

Returning to the topic of this article it is simply the case that we can remember short names. It is equally true that we cannot remember long names, even if constructed on a rational basis. Below, I provide one specific example to illustrate this point.

Some time ago I got interested in compact double degenerates. Even within this group of interesting sources the ROSAT source RX J0806.3+1527 (sometimes shortened to RX J0806+15) is extremely interesting. It has an orbital period of only 5.4 minutes. I had a very hard time remembering the name of the source (other than remembering it is an “8-hour” source). Every time I had to look up the literature on this source I would consult a specific paper (which I could remember since one of the authors was my friend) which referred to the source and then passed the ROSAT source name to SIMBAD to find recent papers on the source.

The ROSAT designation, RX J0806.3+1527, was consistently used since discovery (Burbidge & Reinsch 1999; Israel et al. 1999) until 2007 when Barros et al. (2007) used an Argelander designation, HM Cncn. The reader will undoubtedly agree that it is much easier to HM Cncn than RX J0806.3+1527. Thanks to this short name, practically a nemonic to me, I can now query the As-

11 The romanized Latin alphabets did not include J, U and W. The alphabet I and J are variants and also not pronounced uniformly in European languages. An astute person may have noticed that the “I” column is excluded in airplane seat names. The reader may wish to ascertain this claim the next they fly on an airplane.

12 Since the previous alphabets of Romanized Latin were already assigned to special stars, e.g. the will known P Cygni and Q Cygni (Nova Cygni 1867).

13 An object which, in my youth, I intensively observed searching in vain for the disappearance of the accretion disk and emergence of radio pulses.

14 This system propelled Bruce Margon to stardom.
trophysical Data System (ADS) using the SIMBAD object filer (with name set to HM Cancri) and find all the papers related to this source. The “upgrade” of RX J0806.3+1527 to HM Cancri has increased my productivity!

Finally, as with many other aspects in our culture, conventions once established, however arcane, are hard to uproot and one may as well as celebrate tradition rather than complain.

I end this section by condensing the history of variable star research post Cannon’s era. After the second World War the International Astronomical Union (IAU) gave the responsibility of maintaining the catalogue of variable stars to two groups in the Soviet Union (Moscow University and the Academy of Sciences). The two teams painstakingly maintained the rapidly growing lists of variable stars (with new entries from non-optical bands, particularly X-ray missions). The task involved obtaining the most accurate positions, cross-matching of names and classification (determining to which class each variable belongs to). The “General Catalogue of Variable Stars” (GCVS) was the primary reference for practitioners of stellar variable research. GCVS is now linked primarily to Varbial Star Index (VSX). However, like many professional astronomers I use SIMBAD because it has links to catalogues (especially those published as accompaniments of papers) and also papers (via ADS).

4. THE TOP ARGELANDER STARS: A PEDAGOGICAL TOOL

Two years ago I taught a course on High Energy Astrophysics. I started the white dwarf teaching module by describing the gradual identification of a curious star (Sirius B) and the puzzle it posed to astronomers, especially to the then doyen of astronomy, Arthur Eddington. This was then followed by the usual discussion of degeneracy pressure, polytropic solutions and the rich and interesting physics of white dwarf cooling.

Inspired by a popular cultural practice of “top ten in the last ten years” I compiled a list of top ten white dwarfs (ranked by the number of papers attributed to them). I then asked the students to read up on the literature and then have each student write up a report and deliver a presentation on the white dwarf that caught their attention or piqued their interest. I believe that the experiment was a success in that the students were able to proceed to the next level of education, namely develop a sound understanding of the phenomenology of the subject. My colleague and good friend E. Sterl Phinney implemented the same scheme for an undergraduate class but for neutron stars. He too reported success.

In the spirit discussed above I decided that rank ordering the Argelander stars would be of some value. After all the Argelander stars are the brightest variable stars in the optical sky. Thus, any astronomer who wishes to undertake research in variable star astronomy would clearly benefit from being familiar with the popular (top ranked) Argelander stars.

4.1. Data Generation & Results

The sky, following an IAU resolution in 1919, is divided into 88 constellations. As noted in [2.1] in a given constellation, there can be up to maximum of 334 variable stars with Argelander prefixes. Thus the total number of classical Argelander stars over the entire sky is 88 \times 334 = 29,392.

I wrote a short program in MATLAB to inquire SIMBAD the details of each of these 29,392 possibilities. Us-

\[21\] The exercise was carried out on 25 September 2016.
The Top Argelander Stars

I immediately noticed that not all the 29,392 possibilities had SIMBAD entries. For instance, in Antlia there are no Argelander stars beyond CF Ant. We will revisit this issue in §. Next, no papers were listed in SIMBAD for 991 stars. Examples include AY And, BF And, DD Ara, PP Vul etc. The SIMBAD websites states clearly “Simbad bibliographic survey begun in 1950 for stars (at least bright stars) and in 1983 for all other objects (outside the solar system)”. However, a check of AY And shows two references in the GCVS (Ref#00150=N.Flora, Perem Zvezdy 5, 258, 1940; Ref#03188=M.Doeppner, MVS N575, 1961). Finally, I noticed an anomaly. In a few constellations, there are gaps in the usage of the prefixes, e.g. in Andromeda all prefixes except VV have been used. This puzzle has now been solved, thanks to efforts on the part of some sincere colleagues (see §).

Once the data gathering was finished I undertook some analysis. The first exercise was to simply sort the stars in descending order of the number of papers. For the top one hundred stars thus ranked I had ADS queried for the citations to each star. Fifty of the stars ranked by the number of papers along with the corresponding number of citations are listed in Table I. Next, I re-sorted the list of hundred stars, this time by the number of citations. In Table II I list the top fifty stars rank ordered by citations and provided the corresponding number of papers. Next, in Table III I list the top three stars in each constellation. Perhaps even for an academic this is an artificial exercise since many modern astronomers do not organize their research by constellations. However, the last column in Table III is quite interesting and motivated the next section (§).

4.2. Some Remarks

At this point a reader could reasonably expect a Reader’s Digest summary for each of these stars. However, I specifically avoid doing so because the point of this write up is in fact to motivate (inspire?) young astronomers to pursue a wide knowledge of astronomical phenomenology. Such breadth can only be earned via hard work (plain old curiosity, attending colloquia without texting, reading papers without intermittently checking email and occasionally thinking). I would like to imagine that a student who is interested in stellar astronomy will be puzzled by the top-ranked Argelander star, CM Tau (hint: it is located in Messier 1). More seriously, I hope that a student who has read this writeup will make up his/her deficiency in education by reading key literature on the stars (the number to be decided by the student) listed in the Tables. Alternatively, a scholar could organize a one-day event – “Argelander Jamboree”.

Despite stating, in the previous paragraph, my desire for reticence I am compelled to make two remarks. The stars listed in Table I encompass an astonishing range of astronomical phenomena. The list includes the fundamental stellar families (nuclear burning, degenerates and collapsed stars). Next, some stars in Table I are extragalactic (AGN, quasar, blazar). Finally the list spans the full life cycle of stars, from nurseries to death (and afterlife).

5. ARGELANDER DESIGNATION AS A PRIZE

In Table III I list the number of Argelander designations that have not been assigned (“NA”). Bearing in mind of the improvement in productivity when RXJ0806.3+1527 was given an Argelander name (§) and noting the large vacancies in Table III an idea emerged in my mind – use the remaining Argelander names for particularly noteworthy sources.

Next, on-going industrial synoptic surveys will un-
The cumulative number of “not assigned” (NA) classic Argelander stars as a function of declination. The vertical line $\delta = -25^\circ$. Data drawn from Table 3.

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**APPENDIX**

A. NAMING SCHEMES

The first experience I had with naming scheme was on the eve of the commissioning of the Palomar Transient Factory ([Law et al. 2009](#)). This was a project aimed at a systematic study of the variable and transient optical sky. The eponymous project was expected to churn out a large number of transients. The question arose on the naming scheme for PTF discovered transients. The ensuing discussion was intense and emotional. In the end the collaboration voted to continue the existing scheme for supernovae in which the A–Z, AA–AZ, BB–BZ,...,AAA-AAZ serve as postfixes to the year of discovery (e.g. SN 1987A) except we dropped the number of centuries, e.g. PTF 09uj and iPTF 14atg.

My next experience arose in the field of gamma-ray bursts (GRBs). The traditional naming scheme is GRB yyyyddd where yyyy is the last two digits of the year, mm is the month number (January=1, December=12) and dd is the UT day number (1, 2, .. 31). Astronomers working in this field immediately recognize, for example, GRB 970228, GRB 970508, GRB 980204, GRB 990123 and GRB 030329. This scheme served well for quite some time until the rate of detection of GRBs increased to the point where more than one GRB was discovered in a single UT day. At this point, there were two options: use fractional day to distinguish one GRB from another that happened on the same day or adopt the supernova convention. I voted for the former (and felt strongly about it). In the end the latter convention was adopted.

In retrospect I think the decision that was adopted was the better choice. To start with the GRB rate is probably no more than 1,000 per year (REF) or $\lambda = 2.73\text{day}^{-1}$. Thus the chance of detecting $> [2, 4, 6, 8, 10]$ GRBs per day by an all-sky detector is $[0.76, 0.29, 0.06, 0.007, 0.0056]$, respectively. For a detector which covers say a fourth of the sky but at sufficient sensitivity to probe the faint end (a more reasonable prospect) the probabilities for $> [2, 3, 4, 5]$ are $[0.15, 0.03, 0.005, 0.0007]$, respectively. Thus the adopted scheme has sufficient granularity to accommodate days when the celestial sky is particularly fecund with GRBs. Next, the designation A, B, C is easier to remember, compared to, say, GRB 190304.15.

This report grew out of a during-the-dinner conversation at a recently concluded PTF-Theory Network meeting. I am grateful to Edwin Henneken, IT specialist, ADS, Center for Astrophysics, Harvard University for helping me understand the language of machine queries to ADS; Sterl Phinney for excellent comments; Howard Bond for catching a number of embarrassingly elementary errors and typographical mistakes; Lynne Hillebrand for bringing to my attention the important paper by Townsely; Trevor David for his contribution to [2.1](#) Anna Ho for a most careful reading; and N. Samus for educating me about GCVS and VSX. I would like to thank Bruce Margon and Virginia Trimble for their enthusiasm for this sort of work and Chris Bochanek for feedback of an earlier version. Finally, this informal article would not have been possible without the selfless work of librarians, software engineers and astronomers at ADS and SIMBAD.

research in variable star astronomy and likely have a halo effect and bring attention of the larger astronomical community to stellar astronomy. Perhaps a patron of astronomy could be persuaded to underwrite the annual gala prize ceremony to be held either at Moscow or Bonn!

Observers using Northern facilities may worry that most of the Argelander slots in the Northern constellations have been used up. Fortunately, as can be seen from Figure there still remain significant number of slots that Northern facilities can strive for.

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As noted and expanded below short names are preferred over long names. However, if the sample size is very large then it makes little sense to use short names. For this reason catalogs with large number of entries (e.g. ROSAT catalog, the Sloan Digital Sky Survey) have adopted a logically constructed name (as in RX.J0806.3+1527).

My above experiences made me investigate naming schemes in other areas of human activity. I quote two examples for which considerable thought was given to the naming schemes, though with entirely different goals in mind.

A1. HURRICANES.

In some regions of the world hurricanes have a major impact. Consequently the National Hurricane center has given considerable thought on how hurricanes are named. “Experience shows that the use of short, distinctive given names in written as well as spoken communications is quicker and less subject to error than the older more cumbersome latitude-longitude identification methods.”

The Center maintains six lists of 21 names (which featured only names of women until 1979) and these are recycled every six years. When the number of hurricanes exceeds 21 the greek alphabets are invoked (α, β, ...). Hopefully, global warming will not result in the usage of Sanskrit, Hebrew and Cyrillic alphabets. Fortunately, given the correlation length of hurricanes it is unlikely that we will have to face this particular concern.

A2. MOODY’S RATING SCHEME

In the financial world, Moody’s is a well known financial rating company. The adjective “well known” is simply a statement about the perceived standing of Moody’s. The fortunes of companies and even countries are tied to the Moody’s rating. If you come down a notch in the Moody’s rating then you could be losing say a few billion to a few trillion dollars of perceived wealth. In fact, some of my colleagues who planned to retire around 2008 had to rapidly revise their future plans owing to the considerable losses in the market, aided in part by (false) high ratings given to funds based on mortgage funds.

Given the burden carried by Moody’s one would expect great financial and mathematical sophistication on their part. However, one glance at their rating terminology should keep you wondering whether the next global financial meltdown is round the corner.

1. A series: Aaa, Aa1, Aa2, Aa3, A1, A2, A3. These ratings include the preferred stocks and bonds ranging from “gilt edged” to favorable investments.

2. Baa1, Baa2, Baa3, Ba1, Ba2, Ba3 B1, B2, B3. These range from adequate investments to investments with some risks.

3. Caa1, Cass2, Caa3, Ca, C. Poor prospects.

It is one thing for astronomers to revel in DQ Hercules and PTF 11kly but an entirely different thing for the world to trust Moody’s ratings which appear to be based on an arcane and obscure naming scheme.

B. VV ANDROMEDAE

Upon my drawing attention to the curious problem of VV And, both Sterl Phinney, California Institute of Technology and Howard Bond, Space Telescope Science Institute, investigated and independently came to the same conclusion. Here is paraphrased report from Phinney: “I believe I have solved the mystery of VV Andromedae. A Google search shows that VV Andromedae was reported in Popular Astronomy. VV And is star 110 in the list of newly assigned designations, giving position as 23h 33m 45s +34 59 (max mag 9.7, min mag 10.2).

However a later paper (Pavel 1928) explains why it doesn’t have further data: In this note, to the limits of my German, Pavel (ibid) states that someone named Praćka claimed to have discovered an Algol star with a period of 0.959 days, varying between mag 9.7 and 10.2, near ST Andromedae. However Pavel, in 29 exposures with the 40-cm astrograph, was unable to find any variable star down to 13–14 magnitude at or near that position other than ST Andromedae, and concludes that if Praćka observed a variable star at all, it was certainly not in the vicinity of ST Andromedae.

So it seems VV Andromedae was given a name based on Praćka’s data, but was later determined by Pavel to have been some kind of a mistake on Praćka’s part. It is not clear why SIMBAD did not find either of the above (under -either- VV And or ST And!), while Google did.”

I consulted Dr. Nikolai N. Samus who is the head of the group of General Catalogue of Variable Stars, Sternberg Astronomical Institute of Russia. He remarked “The problem of VV And is not unique. There were cases of repeated discoveries of the same stars, giving variable-star names to asteroids, even to images on photographic plates exposed twice.” In fact, GCVS maintains a list of such errant entries.

22http://www.nhc.noaa.gov/aboutnames.shtml
24See http://www.moodys.com.
25Popular Astronomy, Volume 21 (1913). Linked to “recently discovered variable stars” from Astronomische Nachrichten #4669.
| Star       | Star       | Star       | Papers | NA |
|------------|------------|------------|--------|----|
| Z And      | GX And     | RT And     | 478, 377, 347 | 1  |
| AG Ant     | BW Ant     | U Ant      | 263, 141, 123 | 227|
| MY Aps     | S Aps      | NN Aps     | 109, 107, 79  | -  |
| IL Aqr     | R Aqr      | AE Aqr     | 697, 685, 554 | 15 |
| R Aql      | FF Aql     | RR Aql     | 518, 317, 253 | -  |
| S Ara      | AE Ara     | R Ara      | 84, 65, 63   | -  |
| UX Ari     | TT Ari     | X Ari      | 633, 398, 236 | 219|
| AL Aur     | RW Aur     | SU Aur     | 781, 621, 486 | -  |
| RX Boo     | RN Boo     | HP Boo     | 389, 218, 217 | -  |
| RR Cae     | R Cae      | X Cae      | 106, 79, 65  | 309|
| Z Cam      | AX Cam     | SV Cam     | 452, 353, 337 | -  |
| RS Cnc     | R Cnc      | X Cnc      | 279, 266, 244 | 64 |
| AU CVn     | RS CVn     | Y CVn      | 667, 657, 441 | 137|
| VV CMa     | EZ CMa     | Z CMa      | 892, 707, 480 | -  |
| YZ CMi     | CY CMi     | BG CMi     | 689, 284, 189 | 172|
| BY Cap     | BB Cap     | RT Cap     | 158, 128, 103 | 212|
| AG Car     | OY Car     | HR Car     | 552, 525, 271 | -  |
| R Cas      | RX Cas     | SU Cas     | 636, 416, 389 | -  |
| Y Cen      | BV Cen     | XX Cen     | 217, 162, 152 | -  |
| VV Cep     | U Cep      | VV Cep     | 499, 447, 411 | -  |
| UV Cet     | BE Cet     | FS Cet     | 737, 404, 341 | 112|
| Z Cha      | CU Cha     | DX Cha     | 564, 355, 276 | 97 |
| RR Ctr     | BW Ctr     | AX Ctr     | 662, 151, 108 | 166|
| TV Col     | TX Col     | T Col      | 278, 126, 85  | 251|
| W Com      | LS Com     | FK Com     | 684, 392, 327 | 18 |
| R CrA      | TY CrA     | S CrA      | 409, 249, 237 | -  |
| R CrB      | T CrB      | TZ CrB     | 733, 589, 450 | 230|
| TV Crv     | R Crv      | W Crv      | 110, 76, 69   | 281|
| TV Crt     | R Crt      | SV Crt     | 297, 180, 175 | 265|
| BP Cru     | BZ Cru     | S Cru      | 545, 235, 157 | 158|
| SS Cyg     | CH Cyg     | X Cyg      | 1141, 710, 414 | 1  |
| HR Del     | NT Del     | EU Del     | 457, 318, 151 | 17 |
| AB Dor     | S Dor      | R Dor      | 823, 307, 213 | 249|
| BY Dra     | AG Dra     | CM Dra     | 565, 451, 360 | -  |
| S Equ      | SY Equ     | U Equ      | 116, 78, 54   | 298|
| EP Eri     | ER Eri     | DO Eri     | 418, 394, 345 | 51 |
| UZ For     | R For      | TZ For     | 223, 164, 89  | 255|
| U Gem      | YY Gem     | OU Gem     | 986, 764, 207 | 1  |
| BP Gru     | RS Gru     | S Gru      | 97, 85, 66    | 183|
| HZ Her     | DQ Her     | AM Her     | 1801, 907, 879 | - |
| R Hor      | TW Hor     | WW Hor     | 156, 116, 70  | 270|
| TW Hya     | EX Hya     | W Hya      | 1063, 606, 524 | -  |
| VW Hyi     | WX Hyi     | BL Hyi     | 583, 186, 184 | 198|
| CI Ind     | T Ind      | CD Ind     | 112, 75, 70   | 207|
| BL Lac     | EV Lac     | AR Lac     | 1772, 701, 677 | -  |
| CW Leo     | AD Leo     | R Leo      | 1941, 973, 829 | 68 |
| RW LMi     | SV LMi     | R LMi      | 343, 309, 297 | 270|
| ZZ Lep     | R Lep      | SS Lep     | 956, 285, 188 | 248|
| AP Lib     | HO Lib     | KX Lib     | 494, 424, 403 | -  |
| IL Lup     | RU Lup     | EX Lup     | 360, 316, 206 | -  |
| El Lyn     | RR Lyn     | AE Lyn     | 181, 178, 157 | 147|
| RR Lyn     | EL Lyn     | MV Lyn     | 821, 287, 225 | -  |
| TU Men     | YY Men     | TZ Men     | 140, 115, 107 | 251|
| AU Mic     | AT Mic     | AX Mic     | 739, 296, 179 | 203|
| S Mon      | R Mon      | T Mon      | 688, 474, 414 | -  |
| GU Mus     | KR Mus     | KN Mus     | 637, 463, 275 | -  |
| QX Nor     | QV Nor     | S Nor      | 713, 338, 312 | -  |
| CL Oct     | DR Oct     | UV Oct     | 121, 95, 82   | 162|
| RS Oph     | U Oph      | Y Oph      | 824, 343, 325 | 1  |
| FU Ori     | U Ori      | BM Ori     | 618, 456, 306 | -  |
| AR Pav     | S Pav      | Y Pav      | 137, 73, 70   | -  |
| II Peg     | AG Peg     | EQ Peg     | 639, 466, 390 | -  |
| X Per      | GK Per     | MX Per     | 835, 802, 345 | -  |
| SX Phe     | AE Phe     | AI Phe     | 291, 103, 97  | 203|
| RR Pic     | VZ Pic     | AK Pic     | 289, 230, 108 | 260|
| TX Psc     | ZZ Psc     | WX Psc     | 415, 384, 370 | 110|
| TW PscA    | HU PscA    | TY PscA    | 234, 104, 90  | 275|
| VX Pup     | VV Pup     | RS Pup     | 463, 373, 284 | -  |
| T Pyx      | TV Pyx     | VW Pyx     | 334, 239, 104 | 192|
| R Ret      | S Ret      | TT Ret     | 58, 58, 45    | 286|
| WZ Sge     | QX Sge     | QV Sge     | 845, 605, 516 | -  |
| VX Sgr     | U Sgr      | RV Sgr     | 510, 404, 346 | 1  |
| U Sco      | AK Sco     | RV Sco     | 413, 183, 161 | -  |
| R Scl      | BB Scl     | VY Scl     | 253, 130, 128 | 211|
| R Sct      | RY Sct     | EV Sct     | 276, 259, 210 | -  |
### TABLE 3 — Continued

| Star   | Star   | Star   | Papers   | NA       |
|--------|--------|--------|----------|----------|
| NP Ser | MQ Ser | MM Ser | 558, 291, 275 | -        |
| AY Sex | SW Sex | RW Sex | 170, 168, 163 | 237      |
| CM Tau | BW Tau | T Tau  | 4346, 1646, 1183 | -        |
| RR Tel | PZ Tel | QS Tel | 496, 199, 108 | -        |
| RW Tri | X Tri  | R Tri  | 272, 205, 175 | 212      |
| KZ TrA | MM TrA | R TrA  | 480, 196, 152 | -        |
| CF Tuc | W Tuc  | BS Tuc | 205, 88, 79  | 174      |
| CF UMa | KV UMa | W UMa  | 679, 615, 602 | -        |
| RR UMi | S UMi  | U UMi  | 154, 117, 108 | 276      |
| HU Vel | GP Vel | IM Vel | 1815, 1247, 238 | -        |
| GW Vir | CU Vir | EQ Vir | 437, 310, 296 | -        |
| UY Vol | R Vol  | AI Vol | 498, 70, 36   | 268      |
| QZ Vul | SV Vul | ER Vul | 380, 372, 323 | -        |

Columns (1-3): Star names. Columns (4): The corresponding numbers of papers which refer to the stars. Column (5): number of classic Argelander designations that have not yet been assigned to variable stars. A "-" indicates that all Argelander designations have been used up.