Azeglio Bemporad and the "BEM" Double Stars

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Abstract: This paper aims to describe the scientific context and the life of early 20th century Italian astronomer Azeglio Bemporad (1875-1945), his work on double stars, and how the "BEM" doubles were incorporated into the Washington Double Star catalog. Included are new measures, a complete photo gallery of all 61 of his double star systems, and copies of his double star publications.

Azeglio Bemporad: An Italian Astronomer

Azeglio Bemporad was born in 1875 in Siena, Italy from a family that can be traced back to the larger Jewish community of Pitigliano, Tuscany. He obtained a degree in mathematics from the prestigious Scuola Normale of Pisa with maximum grades in 1898 and in January of the following year he was appointed assistant astronomer at the astronomical observatory of Turin. In 1900, with a scholarship he moved to Germany to refine his education in positional astronomy and geodesy under the guidance of Julius Bauschinger (Heidelberg Astronomisches Rechen-Institut) and Friedrich Robert Helmert (Berlin Geodetic Institute). He returned to Italy in 1904 to take up an assistant astronomer position at the Royal Astrophysical Observatory of Catania located on the east coast of Sicily (Mangano, 2015b).

The Carte du Ciel and Astrographic Catalog Project

The Catania Observatory, under the leadership of Annibale Riccò, was rapidly developing into a modern center for astrophysical studies and international collaborations (Figure 1).

The Catania Observatory was at the time one of the most developed observatories in the world with multiple reflecting telescopes, a Cooke equatorial refractor, a Reichenbach transit instrument, an Ertel meridian circle and the Steinheil astrographic telescope. The observatory was also particularly well equipped in spectroscopes and spectrographs.

Figure 1. Azeglio Bemporad (second seated from right) and director Annibale Riccò (second seated from left) together with the entire Catania observatory personnel in 1908. Photo kindly provided by Serafino Cerulli-Irelli.

At the time of Bemporad's arrival at the observatory the major focus was its participation in the Carte du

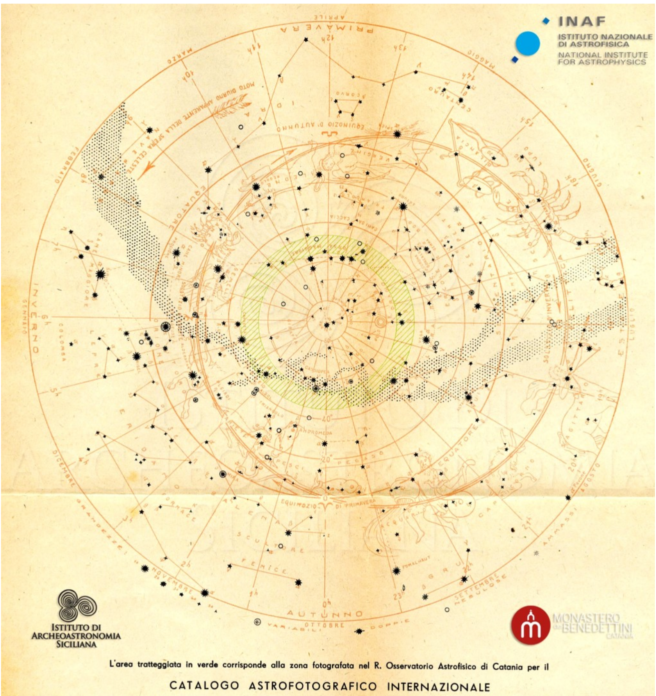

Figure 2. The +47° to +54° declination zone assigned to the Catania Observatory within the international collaboration of the Astrographic Catalog. Credits: Catania Astrophysical Observato-

Ciel - Astrographic Catalog project. This was an ambitious two-pronged task promoted by Admiral Mouchez of the Paris Observatory in 1887 with the aim of recording the position of millions of stars down to the eleventh or twelfth magnitude (the Astrographic Catalog) and to produce a photographic sky atlas of the entire sky down to magnitude 15 (the Carte du Ciel). This effort involved twenty observatories distributed throughout the northern and southern hemispheres. The Italian Observatory of Catania and the Vatican Observatory in Rome participated in this effort. Catania was assigned the +47° to +54° declination sky zone (Figure 2). Catania began its imaging effort for the project in 1894 and wouldn't complete its portion until 1932 having taken more than 1,010 plates (Urban & Corbin, 1998).

Upon his arrival at Catania, Dr. Riccò immediately recognized the mathematical ability of Azeglio and assigned him to lead the effort to calculate the stellar magnitudes and positions for the Astrographic Catalog. As it turned out, this would be the work of a lifetime for him.

The photographic plates for Carte du Ciel and Astrographic Catalog were acquired with the Steinheil astrograph (13" aperture with a focal length of 11 feet) (Figure 3). The astrograph was designed to create images on 16 x16 cm glass plates with a uniform scale of approximately 60 arc-secs/mm while covering a 2° × 2° field of view (Figure 4).

Figure 3. The Catania Observatory Steinheil Astrograph used for the Carte du Ciel and Astrographic Catalog in a photo dating to 1894. Credits R. Osservatorio Astrofisico di Catania all'Esposizione Universale di Roma A. XX; Tav. V

For the Astrographic Catalog, multiple plates with overlapping fields of view were taken of each region of the sky to ensure that every star showed up on at least two plates. This would provide redundancy in the measurements and highlight any plate flaws or asteroid images (Urban & Corbin, 1998). Exposure times were typically 6 minutes for the Astrographic Catalog plates and 20 minutes for the Carte du Ceil plates (Riccò, 1907).

Due to his work, particularly in the budding science of astronomical photometry, the Academy of the Lincei (National Science Academy of Italy) bestowed upon Bemporad the Royal Prize for Astronomy in 1910.

In 1912 he won an open competition for the Directorship of the Astronomical Observatory of Capodimonte in Naples. Upon his arrival he found the academic atmosphere at the observatory to be more resistant to innovation, being focused more on positional astronomy than on the rising new field of "Astrophysics". He published studies on variable stars

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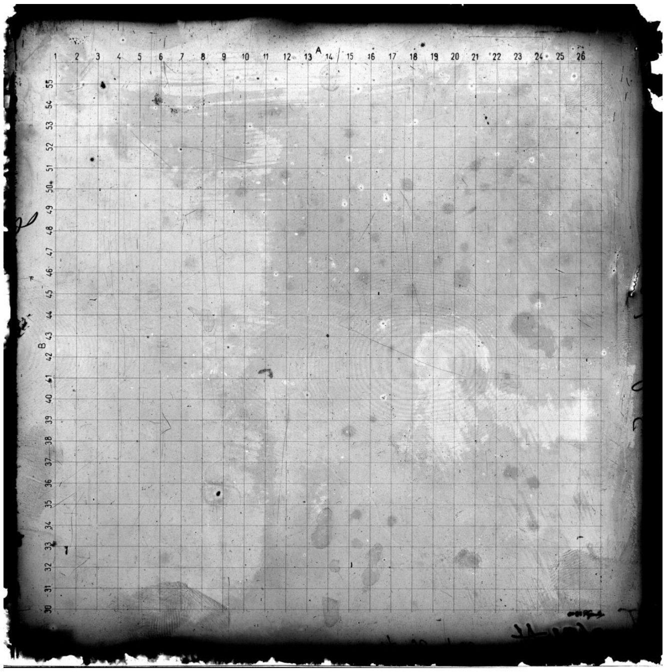

Figure 4. Original plate (plate 1692: centered at coordinates 17h 36m +50° 00') acquired by Azeglio Bemporad during the Astrographic Catalog project. The plate shows the photographically superimposed 5mm square grid to monitor any possible shifting of the photographic emulsion as well as to aid in the astrometric measurements. Photo courtesy of Dr. Pietro Massimino and Dr. Vincenzo Greco, Catania Astrophysical Observatory.

Figure 5. Azeglio Bemporad and his family in Naples, 1917. Photo kindly provided by Serafino Cerulli-Irelli.

and novae, was a lecturer at the University of Naples, and taught Nautical Astronomy at the local naval college (Figure 5). Though he was no longer associated with the Catania Observatory, during the period 1924-1932 more than 400 plates were sent to him by the Catania's Director Giuseppe Favaro (1876-1961) so that he could continue his work on the catalog (Mangano, 2015b).

He also applied his energy to inaugurating public outreach programs to spread the fruits of scientific research. He gave public lectures, wrote magazine and newspaper articles, and opened the observatory to the public and is now considered to have been a pioneer in this area (Fulco, 1998).

In 1933 he returned to Catania as the Director of the Observatory. Bemporad had been an early supporter of Mussolini and Italian fascism but soon his Jewish roots and the fact that he was the head of a major institution would bring him increasingly under the scrutiny of the fascist authorities. In 1938 his world was devastated by the promulgation of the "Racial Laws", whose aim was to enforce racial discrimination directed mainly against the Italian Jews. On December 14, 1938, with World War II on the horizon, Bemporad was asked to vacate his observatory apartment and leave the direction of the Catania Observatory in the hands of Luigi Taffara (1881-1966). As a further humiliation, his request to be allowed to complete his work on the Astrographic Catalog without official position or pay was rejected (Mangano, 2015a).

Unable to continue his life's work he moved his family to Adrano, near Mount Etna, where they lived until Sicily was liberated by the allies in December 1943. He was reinstated as Director of the Observatory, but overwhelmed by the war, his wife's passing in 1943, and his own poor health, he passed away two years later on February 11, 1945 at age 70.

Recognized worldwide as a superb mathematician and astronomer, he co-authored more than 200 publications covering such diverse topics as stellar and cometary photometry, solar radiation, and photometric observations of variable stars (Dizionario Biografico degli Italiani, 1966). His work in stellar photometry, stellar extinction, and light absorption by the Earth's atmosphere was pioneering and his formulas and tables for calculating air mass extinction values are still referenced to this day.

Although the Carte du Ciel project fell short in its ambitious goal of producing a complete photographic Sky Atlas, the Astrographic Catalog was essentially completed with Catania Observatory recording the positions of more than 175,000 stars, and Bemporad was a significant contributor, authoring 33 volumes of the 64 that were eventually published for the project from 1907 to 1942 (Fulco, 1998).

The BEM Doubles: Historical Background

Bemporad authored 4 publications dealing with double stars with substantially the same title: *"Misure di stelle doppie eseguite nel corso dei calcoli per il Catalogo Astrografico di Catania"* (Measurements of double stars encountered during the calculations of the Astrographic Catalog – Zone of Catania) in the journal *Astronomische Nachrichten* (AN); AN 244, 1932; AN 246, 1932, AN 248, 1933 and AN 254, 1934. As the titles suggest, these were substantially a byproduct of the calculations performed at Catania for the reduction of the magnitudes and positions of the Astrographic Catalog plates.

In the course of our research we were unfortunately unable to locate documents or letters at both Naples and Catania observatories that would allow us to describe more fully the criteria used to make selections and better describe the genesis of these four publications.

The articles contain predominately tabular data but the first paper (AN 244) contains the following commentary:

"*In General the measurement of Double stars as recorded on the photographic plates for the Astrographic Catalog can be difficult. The measures become more difficult as the brightness of the stellar image increases. For pairs of 11th magnitude resolutions on the order of 1 arc-sec can be measured while for 9th magnitude pairs 3 arc-sec separations can barely be resolved. Despite these severe limitations of the photographic method we managed to resolve nearly all double stars contained in the Burnham Catalog in the zone + 47° to 48°. In addition we found 17 new pairs, in general very faint, not previously listed in the catalogue.*"

The only BEM double not published in the *Astronomische Nachrichten* was BEM39, the only multiple system (quintuple) cataloged by Bemporad. The particulars for this system were presented in *Contributi Astrofisici No. 42, 1938.* Bemporad was very proud of this discovery and it must have been one of his last articles to be published before his removal from the Observatory. This article provides details of the discovery of the system and is reprinted in detail below. The footnotes from the article have been inserted into the text as "(…)" to enhance the flow of the narrative:

"Everyone knows that double stars are not a very frequent phenomenon; the largest catalog of Aitken ("New General Catalog of Double Stars", 1932), which goes far beyond magnitude 14 and extends from the North Pole up to 120 deg polar distance, only contains about 17,000 double or multiple stars. A statistic compiled by me on about 10,000 stars contained in vol. III, part 8 of Astrographic Catalog of Catania has established the existence of 129 double stars, ie only 1.3% of the number of single stars in area of 21h to 24h RA between parallel +48d and +50° Dec up to magnitude 12+. The number of triple stars among the10,000 stars can be counted on the fingers (In vol. IV, Part 8 of 11,265 stars only 7 triple stars were found).

"Absolutely outstanding is finding a quintuple star on plates with just 5 minutes of exposure which was generally used for the Catania Catalog and it is worth giving an account of the circumstances that led to the discovery.

"In the review of the drafts of vol. II Part 8, namely the compilation of the notes for double stars contained on Plate No. 752 (21h 40m, + 48°) my eye fell on a pair of stars on the edge of the grid constituting a rather large double which, precisely because of the unfavorable position, elements had not yet been determined. (It is obvious that the stars there [on the edge of the grid] are always elongated and often deformed by the various lens aberrations. The writer believes, however, it is useful to extend measures and calculations to the range of 3 mm around the perimeter [of the grid], as they can confirm the circumstances of stars contained in a more favorable positions on adjacent plates. The utility of this extension of measures could not be better demonstrated than with the discovery of this quintuple.)

"On closer inspection I noticed that for a minor star its corresponding image in the second exposure was missing, so it could be considered as doubtful or illusory, instead of corresponding to a real star. (To distinguish stellar images from those caused by defects during development it was decided to perform on each Plate a second exposure of two and a half minutes with the image offset from the original exposure at a convenient distance (20"). When a star was at the limit of visibility, the second exposure was usually nearly imperceptible.)

"Only a second plate, Plate 1810, could clarify the situation, where the double in question appeared near the center [of the Plate]. At first glance it confirmed the existence of the triple, but upon closer examination in the neighborhood revealed the existence of two other satellite stars, also present in the aforementioned Plate 752 and by two more recent plates still to be measured. The fairly consistent results of the measures from the two plates are summarized here. This is the first quintuple that has been observed in the course of the calculations for the Astrographic Catalog of Catania begun about 10 years ago which now contains the positions of 350,000 stars."

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Scanned images of this publication as well as the four *Astronomische Nachrichten* publications have been included in Appendix 2 at the end of this article.

Many of the double stars in these publications were incorporated into the *"Index Catalog of Double Stars"* (IDS) as BEM1-39 (IDS; Jeffers, van den Bos & Greeby 1963). Compiled by Lick Observatory, the IDS consolidated all of the various double star catalogs (ADS, BDS, SDS etc.) into a common double star database. In 1964 Lick relinquished the responsibility of maintaining the database to the U.S. Naval Observatory (USNO) where the catalog was renamed the *"Washington Double Star Catalog"* (WDS).

In 2010 Brian Mason of the USNO, with the help of Freiderich Damm, determined that not all of Bemporad's discoveries in the four AN publications had been included in the IDS, so in July 2010 an additional 24 doubles were added to the WDS under the designations BEM 9001-9024.

Also in 2010 Friedrich Damm cataloged a faint "C" component to each of four Bemporad pairs; DAM258AC (BEM9005), DAM259AC (BEM9011), DAM260AC (BEM9022) and DAM261AC (BEM9024).

Because of this protracted progression of getting the Bemporad double star observations incorporated into the mainstream catalogs, these systems have been rather neglected with most not having a follow-on measurement to Bemporad's originals until the 1990's. In the case of BEM36 a follow-on measurement was not submitted until 2006 – a span of 109 years from the date of the original Astrographic Catalog plate taken in 1897.

As is typical with most double star catalogs, the vast majority of Bemporad's systems are likely only optical associations. Based on the analysis of proper motion data for the components, only 13 systems show a possible physical relationship based on common proper motions (BEM 1, 5, 11, 12, 16, 18, 27, 38, 9002, 9017, 9018, 9019 & 9022) (Stelle Doppie website).

In the case of optical systems, BEM3 has been included in the USNO "*Catalog of Rectilinear Elements*" created to present linear solutions (non-keplerian) of the relative movement of high proper motion pairs (Hartkopf, 2011).

In the 1990's the USNO undertook the task of analyzing the original Astrographic Catalog data with the aim of refining the original plate constants and reducing the systematic errors of the original plate reductions (Urban, 1998). This data was then used to convert the Astrographic Catalog into the Hipparcos system, the result of which is the "*Astrographic Catalog 2000*" (AC2000). As a result, many of Bemporad's original measures from the AN publications have been refined or superseded using this updated Astrographic Catalog Data.

Measurements

In general the Bemporad pairs are comprised of relatively wide but dim stars, with none of the components shining brighter than magnitude 10. The majority of the pairs are located away from the galactic plane and in sparse star fields with few nearby bright stars or asterisms to make locating them easy. This makes them challenging objects in moderately sized amateur scopes and a Go-To mount was found to be indispensable for this project.

All the photos were taken using a 120 mm f7.5 apochromatic refractor (Takahashi TSA120) and an Olympus E-PL-5 14 Mega-Pixel Camera which produces a plate scale of 0.88 arcsec/pixel at prime focus. Typical exposures for these objects were in the 15 to 30 second range at ISO 800 with the lower end of the exposure range used for the systems with the closest separations. Over a thousand photos were taken with 445 being chosen as suitable for measurement. This works out to an average of 7 frames for each of the 61 systems.

The photos were taken in Camera RAW format and processed prior to making any measurements. Master Dark and Bias frames were produced prior to the start of project and were subtracted from the science frames. Background gradients and vignetting were removed using the Automatic Background Extraction tool in the software package PixInsight to produce a flat-field image. The green channel was then extracted and the resulting image converted to FITS format. These green channel images which approximate the band pass of a photometric V-Band filter image (AAVSO, 2016, Sect 6.1) were used for our astrometric and photometric measurements.

The photos were plate-solved using Astrometrica and the Separation (Sep) and Position Angle (PA) calculated from the coordinates of the components using the formulas found in Buchheim (2008). Astrometrica will calculate the magnitude of selected star(s) based on comparison to reference stars in the photographic frame. The URAT1 Catalog was selected as the reference catalog used by Astrometrica for both plate-solving and photometric comparisons as it is up-to-date (released in 2015) and optimized to target stars in the 9 to 17 magnitude range - a good match to magnitudes found in the Bemporad catalog.

The quality and accuracy of the current visual magnitude values for these pairs is very uneven and almost non-existent for more than a few of these systems. Tycho2 VT magnitudes are available for only 20 systems and AAVSO-APASS visual magnitudes (excluding overlaps with the Tycho2 values) are available for another 13 of the pairs. The most uniform source of recorded magnitudes is the 2MASS catalog which provides H, J & K band magnitudes for all the systems with the exception of BEM9016.

To compensate for the scarcity of visual magnitude data, equivalent V-band magnitudes were calculated for all the systems using the equation below (Warner, 2007) which converts J and K band magnitudes of a given star to an equivalent V-Band Magnitude in the BV(RI)c system:

$$V_{mag} = J + 0.1496 + 3.5143(J-K) - 2.325(J-K)^2 + 1.4688(J-K)^3$$

Provided: $-0.1 < J\text{-}K < 1.0$ [1]

These values are recorded in Table 1 as M1 and M2 in the "Measures" section and referred to herein as "Calculated Vmag". These values were used as a baseline number to compare both the current WDS magnitudes and our own Astrometrica generated magnitudes. The J and K Band magnitudes used to calculate the Vmag values have not been tabulated herein but are available through the on-line Aladin Sky Atlas and are also recorded in the WDS Historical Data files for these systems.

Table 1 lists measures for all 61 Bemporad systems which are comprised of 68 secondary components. The following is an explanation of the data presented:

- **BEM Catalog Number (WDS) & Constellation**
- **WDS Values** – The Current WDS Values: Separation (Sep), Position Angle (PA) & Magnitudes (M1, M2) of the components.
- **Primary RA & Dec** – The coordinates of the Primary star based on the average of our plate solved results.
- **Sep & PA** – The calculated Separation and Position Angle of the system based on the plate solved coordinates – the reported error is the Standard Error: SE = Std Dev/(No. of frames)$^{1/2}$
- **M1 & M2** – The calculated V magnitude (Vmag) from Equation 1. Astrometrica measured magnitudes (Ma) are presented in the "Comments" section when the calculated Vmag differs significantly from the current WDS values.
- **Date** - Bessel Epoch of the observation(s)
- **Number of Frames** - Number of Photos (independent measures) used in the data reduction for the given system.

Measures that vary significantly from the current WDS values or that highlight some anomaly in the current record have been highlighted in red

We found that there was a very good correlation between the calculated Vmag values and the Astrometrica photometry measurements. Excluding measures for stars fainter than Magnitude 15 due to poor SNR, the average difference between the two metrics was 0.120 mag, with a maximum difference of 0.42 magnitude for BEM32. The standard deviation taken across all the components was 0.10 magnitude.

A summary of our results are:

- Magnitude revisions recommended for 32 systems.
- Location Errors: 1 (BEM36)

A photo gallery of all of the Bemporad Doubles can be found in Appendix 1 at the end of this article. All of the separations and magnitudes shown on the photos are from our measurements presented herein. Magnitudes shown for the reference field stars are UCAC4 or URAT1 V-Band magnitudes. Separation and PA values for other double stars that may be in the frames are the current WDS values.

Notes on Selected Systems

In the discussion of specific Bemporad systems below, the historical Separation and Position Angles used in the plots are from the WDS Historical Data files available through the USNO.

BEM1: The current WDS listing has the secondary at 0.74 magnitude brighter (11.44, 10.7) than the primary while UCAC4 has the components listed as equal in magnitude at 11.157. The photos clearly show the primary as being brighter. The calculated Vmag values (11.42 & 12.23) and the Astrometrica magnitudes (11.36 & 12.20) are nearly identical; in both cases a Δ M of ~0.8. No significant changes to Separation and PA from 2003 were noted.

BEM2: Similar to BEM1, the WDS has the secondary listed as being brighter (12, 11.4) while the photos clearly show the primary as being significantly brighter. Calculated Vmag values are 12.17 & 13.07 - a ΔM of 0.9 magnitude. The Astrometrica measures (11.89, 12.90) show a ~1.0 magnitude difference and ~0.3 mag brighter than the calculated Vmag values.

BEM3: Calculated Vmag values and Separation are similar to the current WDS values. The PA measurement however shows a 2 Degree change (206.90 vs 204.95) from the 2003 WDS measures.

BEM5: Current WDS values show the components to be nearly equal in magnitude with the secondary being slightly brighter (12.85, 12.6) but examination of our photos along with DSS images show the primary to be slightly brighter. The calculated Vmag

(Text continues on page 336)

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Table 1.

		WDS VALUES		MEASURES					
SYSTEM	**CON**	**SEP**	**PA**	**Primary RA**	**SEP (Err)**	**PA (Err)**	**Date**	**No.**	**Comments**
		M1	**M2**	**Primary DEC**	**M1**	**M2**	**2000+**	**Frm**	
BEM 1	CVn	9.59	202.90	RA 12 : 43 : 59.13	9.558 (.028)	202.781 (.177)	16.121	9	UCAC4 = 11.16, 11.16
		11.44	10.70	DEC + 49 : 50 : 39.614	11.42	12.23			**Ma = 11.36, 12.20**
BEM 2	Uma	5.00	271.40	RA 12 : 54 : 14.026	4.901 (.035)	270.942 (.214)	16.461	5	UCAC4 M1 = 11.771
		12.00	11.40	DEC + 52 : 51 : 23.332	12.17	13.07			**Ma = 11.89, 12.90**
BEM 3	CVn	18.20	206.90	RA 12 : 59 : 30.082	18.124 (.007)	**204.951 (.072)**	16.461	4	Last Measure 2003
		11.74	12.17	DEC +49:00:17.708	11.67	12.06			Ma = 11.83, 12.17
BEM 4	CVn	22.33	356.28	RA 13 : 07 : 46.672	22.123 (.057)	356.33 (.038)	16.138	4	Last Measure 2013
		11.51	11.70	DEC + 49 : 54 : 46.742	11.64	11.77			WDS MAG=UCAC4
BEM 5	Uma	9.51	214.50	RA 13 : 25 : 39.232	9.502 (.015)	216.108 (.161)	16.622	6	Last Measure 2015
		12.85	12.60	DEC + 52 : 26 : 13.018	11.62	12.13			**Ma = 11.64, 12.20**
BEM 6	UMa	8.37	189.90	RA 13 : 33 : 45.121	8.306 (.025)	189.865 (.147)	16.140	7	Last Measure 2013
		10.43	11.19	DEC + 54 : 18 : 4.336	10.49	11.24			Ma = 10.61, 11.18
BEM 7	UMa	4.60	84.80	RA 14 : 05 : 7.518	4.468 (.02)	84.834 (.115)	16.455	10	Last Measure 2015
		11.80	11.98	DEC + 49 : 13 : 36.996	11.86	11.98			Ma = 11.92, 11.86
BEM 8	Boo	24.55	240.10	RA 14 : 11 : 44.586	24.448 (.082)	240.4 (.182)	16.253	6	Last Measure 2013
		9.85	11.04	DEC + 49 : 46 : 20.455	9.78	11.15			UCAC4 = 9.76, 11.16
BEM 9	Boo	11.60	284.00	RA 14 : 13 : 8.341	11.571 (.009)	283.525 (.053)	16.253	5	M2 = APASS
		12.00	12.48	DEC + 50 : 31 : 14.294	12.13	12.23			**Ma = 11.94, 12.02**
BEM 10	Boo	14.60	16.00	RA 14 : 15 : 9.74	NA	NA	NA	-	Bogus Pair
		11.62	11.10	DEC + 50 : 48 : 11.8	NA	NA			No secondary found
BEM 11	Boo	14.60	16.00	RA 14 : 28 : 30.654	14.66 (.017)	16.281 (.083)	16.253	5	Last Measure 2002
		12.00	12.20	DEC + 49 : 32 : 9.728	11.80	11.70			**Ma = 11.75, 11.61**
BEM 12	Boo	8.70	185.80	RA 14 : 30 : 28.219	8.719 (.033)	185.779 (.11)	16.253	7	Last Measure 2003
		12.00	11.60	DEC + 50 : 13 : 2.937	11.84	12.53			**Ma = 11.71, 12.45**
BEM 13	Boo	28.70	129.10	RA 14 : 31 : 32.677	29.006 (.092)	130.147 (.049)	16.253	6	Last Measure 2002
		11.47	11.89	DEC + 50 : 16 : 19.047	11.43	11.87			Ma = 11.33, 11.73
BEM 14	Boo	27.35	151.00	RA 14 : 55 : 50.539	27.174 (.064)	151.11 (.082)	16.253	7	Last Measure 2015
		10.92	12.11	DEC + 49 : 14 : 14.508	10.98	12.11			Ma = 10.72, 12.04
BEM 15	NA								Bogus Pair
									No Pri or Sec Found
BEM 16	Boo	25.14	66.00	RA 15 : 09 : 41.703	25.16 (.023)	65.976 (.022)	16.253	6	WDS Mags =APASS
		11.58	12.31	DEC + 49 : 41 : 45.00	11.67	12.01			Ma = 11.57, 12.45
BEM 17	Boo	23.19	119.40	RA 15 : 14 : 31.395	23.137 (.016)	119.285 (.04)	16.253	10	Last Measure 2003
		13.16	12.99	DEC + 50 : 19 : 28.935	13.28	12.95			Ma = 12.94, 12.64
BEM 18	Boo	8.60	13.66	RA 15 : 18 : 36.179	8.646 (.016)	12.963 (.15)	16.338	10	UCAC4 M1 = 10.29
		10.51	11.40	DEC + 51 : 58 : 58.359	10.42	12.09			**Ma = 10.26, 11.99**
BEM 19	Boo	26.95	240.50	RA 15 : 45 : 18.54	26.775 (.141)	240.504 (.282)	16.283	6	WDS Mags =APASS
		10.59	11.85	DEC + 49 : 6 : 8.678	10.74	12.05			Ma = 10.58, 11.70
BEM 20	Dra	22.32	283.70	RA 15 : 59 : 11.241	22.454 (.04)	283.705 (.152)	16.253	4	WDS Mags =APASS
		12.22	12.27	DEC + 51 : 10 : 2.968	12.41	12.23			Ma = 12.26, 12.3

Table 1 conitinues on next page.

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Table 1 (cointinued).

		WDS VALUES		MEASURES					
SYSTEM	CON	SEP	PA	Primary RA	SEP (Err)	PA (Err)	Date	No.	Comments
		M1	M2	Primary DEC	M1	M2	2000+	Frm	
BEM 21	Dra	19.04	103.60	RA 16 : 02 : 58.279	19.121 (.052)	104.004 (.114)	16.283	8	URAT1 = 10.33, 10.92
		10.33	10.92	DEC + 51 : 11 : 39.384	10.41	10.01 N.G.			Ma = 10.28, 10.73
BEM 22	Dra	7.60	104.80	RA 16 : 42 : 13.872	7.544 (.014)	104.766 (.053)	16.606	8	URAT1 M1 = 10.723
		11.00	11.30	DEC + 52 : 35 : 16.83	10.97	11.69			**Ma = 11.00, 11.70**
BEM 23	Her	24.87	21.30	RA 16 : 57 : 12.226	24.918 (.022)	21.336 (.042)	16.390	6	Last Measure 2003
		12.89	12.83	DEC + 49 : 3 : 17.197	12.89	12.85			Ma = 12.86, 12.84
BEM 24	Her	31.68	196.60	RA 17 : 00 : 9.373	32.38 (.036)	196.011 (.156)	16.390	7	Last Measure 2003
		12.35	12.45	DEC + 50 : 40 : 59.084	12.32	12.38			Ma = 12.42, 12.57
BEM 25	Her	24.17	27.30	RA 17 : 00 : 54.4	24.143 (.047)	28.069 (.118)	16.390	7	Last Measure 2003
		12.98	13.24	DEC + 49 : 29 : 13.393	12.93	13.23			Ma = 13.12, 13.17
BEM 26	Dra	15.40	198.00	RA 17 : 08 : 36.711	15.448 (.01)	**195.994 (.151)**	16.390	7	UCAC4 = 11.06, 13.33
		11.06	13.34	DEC + 50 : 22 : 45.397	10.94	12.84			**Ma= 10.90, 12.85**
BEM 27	Dra	13.05	204.90	RA 17 : 31 : 48.03	13.042 (.031)	204.578 (.104)	16.422	6	WDS MAGS = APASS
		11.53	11.81	DEC + 53 : 48 : 44.978	11.49	12.00			Ma = 11.80, 12.13
BEM 28	Her	3.18	359.60	RA 17 : 38 : 48.081	2.959 (.064)	358.016 (.399)	16.422	7	URAT1 M1 = 10.945
		12.00	12.40	DEC + 49 : 22 : 32.766	11.41	11.68			**Ma= 11.42, 11.72**
BEM 29	Her	5.04	136.40	RA 17 : 49 : 24.189	5.035 (.049)	**134.534 (.427)**	16.425	9	Blue - Gold
		10.47	12.60	DEC + 48 : 22 : 36.133	10.56	12.61			Ma = 10.39, 12.43
BEM 30	Her	14.52	113.60	RA 17 : 51 : 13.354	14.75 (.031)	**114.44 (.046)**	16.425	4	Last Measure 2003
		12.20	12.60	DEC + 50 : 06 : 20.89	11.20	12.64			**Ma = 11.25, 12.60**
BEM 31	Dra	11.95	305.70	RA 18 : 09 : 41.211	11.986 (.033)	305.412 (.046)	16.450	6	Yellow-Blue
		9.90	12.30	DEC + 53 : 29 : 31.412	9.87	12.30			Ma = 9.91, 12.28
BEM 32	Dra	7.97	315.70	RA 18 : 22 : 2.715	7.931 (.011)	315.108 (.196)	16.450	6	Last Measure 2010
		10.52	9.60	DEC + 53 : 36 : 8.692	10.25	13.13			**Ma = 10.27, 12.72**
BEM 33	Dra	8.24	45.80	RA 18 : 24 : 23.317	7.972 (.038)	46.056 (.232)	16.450	6	Last Measure 2010
		10.40	11.30	DEC + 53 : 31 : 46.475	11.91	11.43			**Ma = 11.90, 11.20**
BEM 34	Dra	10.44	27.00	RA 18 : 34 : 25.739	10.494 (.005)	26.418 (.047)	16.450	6	Last Measure 2008
		11.08	11.06	DEC + 52 : 39 : 33.417	11.12	11.64			**Ma = 11.17, 11.69**
BEM 35	Dra	17.19	156.90	RA 18 : 51 : 10.831	17.125 (.041)	156.236 (.08)	16.606	7	URAT1 M1 = 11.094
		10.80	11.70	DEC + 52 : 09 : 51.505	11.14	12.51			**Ma= 11.01, 12.47**
BEM 36	Dra	11.31	338.50	**RA 18 : 58 : 33.336**	**11.835 (.039)**	**336.778 (.386)**	16.461	7	Location Incorrect
		10.05	8.90	**DEC + 53 : 07 : 2.111**	10.05	11.89			**Ma = 10.13, 11.94**
BEM 37	Dra	11.50	309.10	RA 19 : 01 : 25.457	11.235 (.032)	309.329 (.128)	16.461	6	Last Measure 2008
		12.00	11.90	DEC + 53 : 27 : 48.800	12.21	12.07			Ma = 12.03, 12.03
BEM 38	Cyg	13.30	104.40	RA 19 : 08 : 55.531	13.296 (.02)	104.113 (.132)	16.466	6	Last Measure 2012
		11.80	11.73	DEC + 53 : 32 : 00.608	10.94	11.87			Ma = 11.85, 11.86
BEM 39AB	Cyg	15.74	328.80	RA 21 : 37 : 12.335	15.678 (.021)	328.776 (.088)	16.529	6	Last Measure 2011
		10.06	11.20	DEC + 47 : 39 : 14.287	9.93	11.27			Ma = 9.82, 11.12
BEM 39BC	Cyg	6.57	124.70	RA 21 : 37 : 11.53	6.532 (.013)	124.395 (.16)	16.529	6	
		11.20	11.70	DEC + 47 : 39 : 27.693	11.27	12.56			**Ma = 11.12, 12.85**
BEM 39AD	Cyg	25.92	7.30	RA 21 : 37 : 12.335	25.853 (.016)	7.478 (.059)	16.529	6	
		10.06	14.20	DEC + 47 : 39 : 14.287	9.93	13.19			**Ma = 9.82, 12.91**
BEM 39AE	Cyg	25.15	124.30	RA 21 : 37 : 12.335	25.125 (.043)	124.484 (.025)	16.529	6	
		10.06	13.16	DEC + 47 : 39 : 14.287	9.93	13.07			Ma = 9.82, 13.03

Table 1 conitinues on next page.

Azeglio Bemporad and the "BEM" Double Stars

Table 1 (continued).

SYSTEM	CON	WDS VALUES SEP / M1	WDS VALUES PA / M2	MEASURES Primary RA / Primary DEC	MEASURES SEP (Err) / M1	MEASURES PA (Err) / M2	Date 2000+	No. Frm	Comments
BEM9001	CVn	22.07	134.20	RA 12 : 29 : 27.311	22.238 (.069)	133.94 (.146)	16.622	7	WDS Mags are UCAC4
		11.42	12.58	DEC + 47 : 2 : 39.911	11.35	12.09			Ma = 11.48, 12.22
BEM9002	CVn	8.95	223.20	RA 13 : 10 : 40.927	8.941 (.039)	223.01 (.165)	16.622	5	WDS Mags= UCAC4
		11.70	12.40	DEC + 46 : 34 : 16.868	11.80	12.27			Ma = 11.45, 12.01
BEM9003	Boo	8.50	240.80	RA 14 : 28 : 04.818	8.458 (.013)	240.751 (.072)	16.253	4	UCAC4 M1 = 12.77
		11.80	13.10	DEC + 46 : 02 : 25.458	13.38	13.66			Ma = 13.16, 13.48
BEM9004	Boo	22.70	316.40	RA 14 : 33 : 50.902	22.825 (.019)	316.512 (.008)	16.253	3	Last Measure 2002
		12.00	12.12	DEC + 47 : 07 : 17.007	11.94	11.95			Ma = 12.03, 11.96
BEM9005 AB	Boo	20.29	203.30	RA 15 : 25 : 52.516	20.285 (.021)	203.367 (.073)	16.253	10	Last Measure 2002
		11.81	12.05	DEC + 45 : 43 : 50.935	11.90	12.03			Ma = 11.59, 11.64
BEM9005 AC DAM258	Boo	12.00	228.00	RA 15 : 25 : 52.575	12.016 (.066)	227.753 (.145)	16.253	10	Last Measure 2002
		11.81	14.50	DEC + 45 : 43 : 51.035	11.90	14.88			Ma = 11.59, 14.43
BEM9006	Her	5.12	256.30	RA 15 : 51 : 41.389	5.116 (.042)	256.299 (.175)	16.261	7	Last Measure 2015
		11.10	11.30	DEC + 46 : 13 : 52.133	11.90	12.13			Ma = 11.84, 12.03
BEM9007	Her	13.33	133.10	RA 16 : 09 : 5.633	13.348 (.031)	132.347 (.104)	16.337	6	Last Measure 2002
		12.00	12.20	DEC + 46 : 33 : 35.588	11.98	12.25			Ma = 12.06, 12.26
BEM9008	Her	19.50	245.30	RA 16 :09 : 45.432	19.534 (.018)	245.092 (.095)	16.338	6	Last Measure 2002
		11.03	12.05	DEC + 46 : 23 : 36.087	11.12	12.06			Ma = 10.91, 12.08
BEM9009	Her	6.36	291.20	RA 16 : 12 : 08.75	5.686 (.079)	292.452 (.472)	16.338	5	Last Measure 2002
		10.50	11.90	DEC + 46 : 47 : 23.17	10.43	12.06			Ma = 10.57, 12.13
BEM9010	Her	20.46	57.80	RA 17 : 02 : 54.282	20.854 (.017)	56.451 (.019)	16.390	6	Orange - Blue
		10.49	11.52	DEC + 46 : 42 : 39.003	10.50	11.22			Ma = 10.25, 11.04
BEM9011AB	Her	10.48	208.70	RA 17 : 26 : 43.534	10.391 (.013)	209.052 (.073)	16.743	6	Orange - Orange
		11.76	11.70	DEC + 47 : 27 : 17.137	11.23	11.33			Ma = 11.56, 11.68
BEM9011AC DAM 259	Her	10.18	21.10	RA 17 : 26 : 43.534	10.502 (.109)	17.461 (.481)	16.743	6	Last Measure 2003
		11.76	16.40	DEC + 47 : 27 : 17.137	11.23	16.91			Ma = 11.56, 16.55
BEM9012	Her	4.52	142.80	RA 17 : 51 : 36.76	4.493 (.024)	141.539 (.088)	16.422	5	Last Measure 2003
		12.30	12.30	DEC + 47 : 21 : 36.414	12.18	12.64			Ma = 12.19, 12.47
BEM9013	Boo	5.30	331.50	RA 14 : 40 : 43.094	5.276 (.032)	330.529 (.265)	16.253	4	Last Measure 2015
		10.80	11.50	DEC + 49 : 27 : 33.608	10.89	12.00			Ma = 10.85, 11.89
BEM9014	Her	13.98	108.20	RA 16 : 28 : 33.441	14.309 (.046)	108.69 (.069)	16.343	6	Last Measure 2003
		11.22	12.28	DEC + 48 : 19 : 5.443	11.06	12.13			Ma = 11.15, 12.24
BEM9015	Dra	12.82	266.60	RA 17 : 43 : 20.298	12.982 (.032)	264.848 (.26)	16.422	6	Last Measure 2003
		12.61	12.04	DEC + 51 : 21 : 10.935	12.12	12.32			Ma = 12.03, 12.31
BEM9016	Dra	3.74	17.60	RA 17 : 49 : 53.591	4.089 (.102)	17.25 (.671)	16.479	14	Last Measure 2000
		14.00	14.00	DEC + 50 : 35 : 31.173	13.55	16.11			Ma = 13.61, 16.75
BEM9017	Uma	13.00	210.40	RA 13 : 20 : 27.201	12.97 (.011)	210.64 (.079)	16.606	4	WDS Mags =APASS
		11.39	12.30	DEC + 54 : 18 : 43.009	11.40	11.84			Ma = 11.26, 11.71
BEM9018	Boo	16.46	31.20	RA 14 : 19 : 04.663	16.339 (.008)	31.426 (.058)	16.253	4	WDS Mags =APASS
		10.73	11.51	DEC + 51 : 33 : 28.445	10.48	11.40			Ma = 10.44, 11.19
BEM9019	Boo	14.06	14.20	RA 14 : 23 : 34.238	14.119 (.037)	14.173 (.175)	16.307	7	Last Measure 2013
		10.50	10.90	DEC + 52 : 4 : 56.7	10.35	10.92			Ma = 10.33, 10.80
BEM9020	Boo	13.30	3.60	RA 15 : 09 : 11.598	13.303 (.023)	4.47 (.11)	16.307	7	Last Measure 2003
		11.70	12.20	DEC + 52 : 56 : 39.626	12.20	12.27			Ma = 12.01, 12.20

Table 1 conitinues on next page.

Azeglio Bemporad and the “BEM” Double Stars

Table 1 (conclusion).

SYSTEM	CON	WDS VALUES SEP / M1	PA / M2	MEASURES Primary RA / Primary DEC	SEP (Err) / M1	PA (Err) / M2	Date 2000+	No. Frm	Comments
BEM9021	Her	18.32	52.00	RA 16 : 26 : 21.786	18.394 (.044)	52.482 (.052)	16.343	5	Last Measure 2015
		10.62	11.95	DEC + 50 : 47 : 29.304	10.56	11.93			Ma = 10.60, 11.91
BEM9022 AB	Dra	12.00	273.30	RA 16 : 55 : 23.911	12.058 (.016)	273.357 (.062)	16.655	10	Last Measure 2003
		11.80	12.80	DEC + 52 : 51 : 59.007	12.30	12.69			**Ma = 12.34, 12.72**
BEM9022 AC DAM260	Dra	6.44	197.50	RA 16 : 55 : 23.911	6.196 (.061)	202.559 (.317)	16.655	10	Last Measure 2003
		11.80	14.40	DEC + 52 : 51 : 59.007	12.30	15.43			**Ma = 12.34, 15.36**
BEM9023	Dra	15.33	52.20	RA 17 : 31 : 27.406	15.517 (.009)	50.854 (.042)	16.622	7	UCAC4 M2 = 12.06
		11.90	11.90	DEC + 52 : 21 : 47.93	11.89	12.07			**Ma =11.98, 12.28**
BEM9024 AB	Her	17.44	276.00	RA 17 : 49 : 21.325	18.336 (.009)	**279.24 (.02)**	16.422	7	URAT1 = 11.36, 11.61
		11.59	11.74	DEC + 49 : 04 : 20.637	11.53	11.82			Ma = 11.44, 11.78
BEM9024 AC DAM261	Her	4.85	33.10	RA 17 : 49 : 21.325	4.762 (.059)	33.452 (.692)	16.422	7	Last Measure 2003
		11.59	15.00	DEC + 49 : 04 : 20.637	11.53	14.55			Ma = 11.44, 15.60

(Continued from page 332)

values and the Astrometrica derived magnitudes correlate well at (11.62, 12.13) and (11.64, 12.20) with the Astrometrica values best fitting the visual impressions from the photos.

BEM9: WDS values show a ΔM of 0.5 mag (12.0, 12.48) while the photos seem to show a much more closely matched pair. The calculated Vmag values and Astrometrica seem to confirm this impression showing the pair to have a ΔM of ~0.1 with values of (12.13, 12.23) and (11.94, 12.02) respectively.

BEM10: BOGUS PAIR - No visible companion found in our photos or in DSS images - This reported pair has been removed from the WDS database.

BEM12: The WDS shows the secondary as being brighter with a ΔM of 0.4 (12.0, 11.6). Photos show the primary to be noticeably brighter with the calculated Vmag values yielding magnitudes of 11.84 & 12.53 (primary brighter, ΔM = 0.75) which is a close match to the Astrometrica values of 11.71 & 12.45 (primary brighter, ΔM = 0.74).

BEM15: BOGUS PAIR – Unlike BEM10 where there is a plausible candidate for the primary at the reported location, in the case of BEM15 (See AN 254 in Appendix 2 with the assumed candidate) there is no sign of a plausible primary at or near the reported location. Therefore BEM15 is not listed at all in the WDS database.

BEM17: The WDS currently has this listed as an unequal pair with the secondary being brighter by ~0.17 magnitude (13.16, 12.99) (APASS Magnitudes). The Astrometrica measures show the pair overall to be about 0.3 magnitude brighter than currently listed and with a larger ΔM of ~0.3 (12.94, 12.64). The calculated Vmag values (13.28 &12.95) appear to confirm the current WDS values.

BEM18: The WDS currently has this listed as an unequal pair with a ΔM of ~0.9 (10.51, 11.4). The calculated Vmag values (10.42, 12.09) and Astrometrica (10.26, 11.99) show the pair to have a ΔM of ~1.7 due principally to the secondary being much dimmer than currently listed. At first glance the Sep & PA values do not seem too different from the previous measures but a look at the WDS historical records show a surprising degree of variation in recent PA measurements (3.2 deg) given the moderate separation as shown in Figure 6. Two of these measures are from automated surveys (2MASS & UCAC4). Other than Bemporad’s original

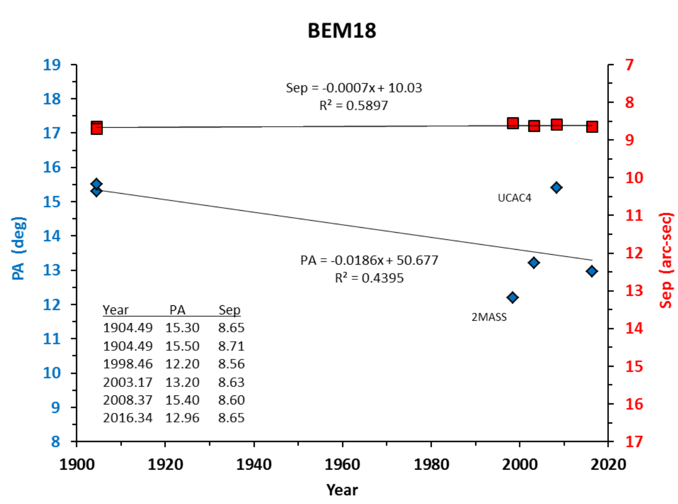

Figure 6. Historical measures of BEM 18.

1904 measurements and our own, there has only been one other independent measurement recorded in 2008.

BEM21: The current WDS magnitudes are Tycho2 VT values (10.33, 10.92). The calculated Vmag for the primary is reasonably close at 10.41 but in the case of the secondary the calculated Vmag is invalid due to the "J-K" term in EQ-1 being beyond the limits set for the equation (J-K = 1.19 > 1.0). The Astrometrica values of (10.28, 10.73) are close to the Tycho2 values.

BEM22: The calculated Vmag values and Astrometrica measures are identical at 11.0 & 11.7 for the pair. While they are in agreement with the current 11.0 mag value for the primary they show the secondary to be ~0.4 magnitude dimmer than currently listed (M = 11.3).

BEM26: Our measures roughly agree with the current WDS magnitude (UCAC4) of 11.06 for the primary. In regards to the secondary currently listed at 13.34, our measures show this star to be a half magnitude brighter (Vmag = 12.84 & Astrometrica = 12.85). Similar to BEM18, the recorded PA values for this pair show a surprising degree of scatter (± 1 deg) given the relatively large separation of the components (see Figure 7). Perhaps the only thing that can be said is that it is likely that there has been little to no change over the years as the slope of the trend line is essentially flat.

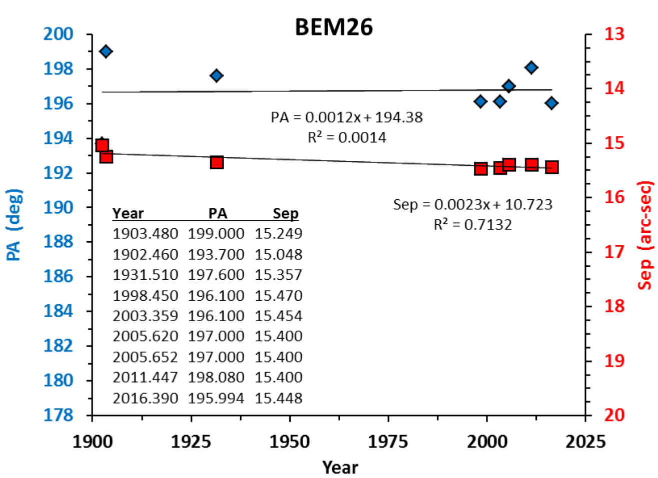

Figure 7. Historical measures of BEM 26.

BEM28: With a measured separation of 3.18" in 2003 this system is the tightest in the catalog. Our measures show that this has narrowed to 2.96". URAT1 currently has the primary listed at V=10.95, a full magnitude brighter than the current WDS value of 12.0 (Bemporads measure). The calculated Vmag & Astrometrica values for the pair are (11.41, 11.68) & (11.42, 11.72) ~0.60 magnitude brighter than the current values. It appears that the URAT1 value for the primary is the combined magnitude for the pair which is not surprising based on the current 3" separation. If we use the Astrometrica magnitudes, the combined value for the system is 10.80 not far different from the 10.95 URAT1 value.

BEM30: The WDS currently has the primary listed at 12.2 magnitude. Visual inspection of the photos show it to be considerably brighter when compared to other 12th magnitude stars in the frame and confirmed by our measures (Vmag = 11.20 & Astrometrica = 11.25). Our measures agree with the current 12.6 value for the secondary.

BEM32: Another case where the WDS lists the secondary as being brighter (10.52, 9.6) when photos show the secondary to be significantly fainter. The calculated Vmag values and Astrometrica measures for the primary are nearly identical at 10.25 & 10.27 and URAT1 has the primary listed at 10.26. The values for the secondary do not correlate as close (12.72 & 13.13) but comparison with field stars show the Astrometrica value of 12.72 to be the best match which yields a ΔM of 2.45 for the pair. This pair was also cataloged by Rev. Thomas Espin in 1908 as ES649. As can be seen in the plot below there is a significant difference in the measures by Bemporad and Espin which were taken only a few years apart. Rev. Espin estimated the magnitudes at 9.2 & 11.5 (Espin, 1909).

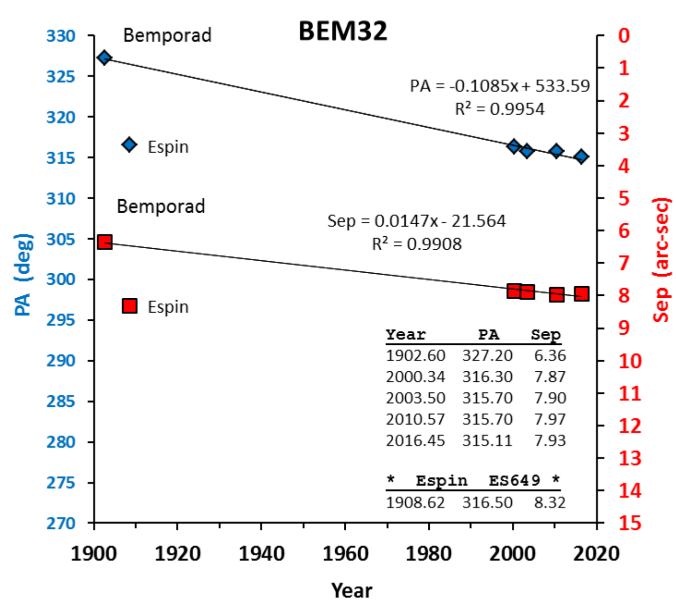

Figure 8. Historical measures of BEM 32.

BEM33: The WDS currently has the primary listed as a magnitude brighter than the secondary (10.4, 11.3). Our photos and measures show the primary as being at least a half magnitude dimmer than the secondary at magnitude 11.90. The average of our magnitudes for the secondary (11.43 & 11.2) correlates well with the current WDS value of 11.3.

BEM34: Current WDS values (APASS magnitudes) show the components to be nearly equal in magnitude (11.08, 11.06) but examination of our photos along with DSS images show a noticeable difference in magnitude. The calculated Vmag values and the Astrometrica measures correlate closely at (11.12, 11.64) and (11.17, 11.69) a ΔM of 0.6 for the system.

BEM35: The calculated Vmag values and Astrometrica measures are very close (11.14, 12.51 & 11.01, 12.47) and show that the primary to be ~0.25 magnitude dimmer and the secondary to be ~0.80 magnitude dimmer than currently listed (10.80, 11.70). Our values are also in close agreement with magnitudes measured by John Daley (10.99, 12.55) (Daley, 2003).

BEM36: This system is very photogenic, located within a loose gathering of a half-dozen 9th to 10th magnitude stars. Thus it is very surprising that other than Bemporad's original 1897 measures there has been only one other recorded measure made 109 years later in 2006. Perhaps because of this neglect several items are in need of correction.

The current WDS location for this system is incorrect, actually being located 2.08 arc-min to the west (Figure 9). This same photo shows that the current WDS magnitudes for this pair (Bemporad's original magnitudes) are also incorrect. The calculated Vmag & Astrometrica values for the primary (10.05 & 10.13) are in general agreement with Bemporad's 10.05 value. His 8.5 mag for the secondary would make it significantly brighter than the primary, and is clearly in error. The calculated Vmag and Astrometrica values show the secondary to be shining about 1.8 magnitudes fainter than the primary at 11.94.

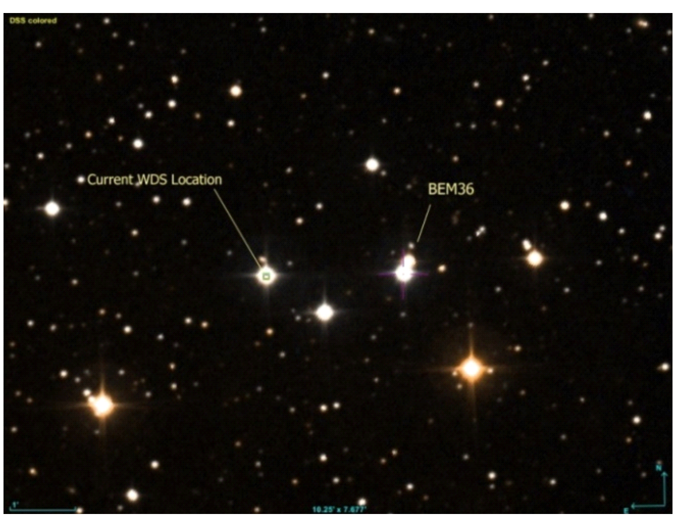

Figure 9. DSS Image showing the BEM36 location error and the relative brightness of the components.

BEM39: Though only an optical association, this quintuple is the most complex in the Bemporad catalog resembling a miniature Cassiopeia. Its members range in brightness from the 10th to 13th magnitude and subtend 42 seconds of arc. We found only minor differences in Separation and PA from the previous measures made in 2011.

In regards to magnitudes we found significant differences for components C and D. For the C component the calculated Vmag and Astrometrica measures show it to be nearly a full magnitude fainter at 12.56 and 12.85 respectively than its current listing at magnitude 11.7. For D the opposite is the case where our measures show it to be at least a full magnitude brighter at 12.91 and 13.19 from its current value of 14.2. The result is that the magnitudes for C, D & E are very closely matched at 12.6, 12.9 & 13.1 respectively and the photos seem to confirm the similarity in magnitude of these three stars.

BEM9001: The calculated Vmag and Astrometrica measures are in close agreement with each other (11.35,12.09) and (11.48,12.22) and confirm the current 11.42 value for the primary (APASS) but show the secondary to be about 0.4 magnitude brighter than currently listed (12.22 vs 12.58).

BEM9002: The WDS shows the pair to be unequal (11.70, 12.40) with a ΔM of 0.7 (UCAC4). The calculated Vmag and the Astrometrica measures all show this pair to be slightly brighter with a ΔM of ~0.5. The Astrometrica measures of 11.57 & 12.04 best fit to the photographic impression.

BEM9003: Currently the WDS listing shows this to be a very unequal pair (11.8, 13.1) ΔM = 1.3. 2Mass, UCAC4 and our own measures show this pair to have a ΔM of ~0.3. The UCAC4 magnitudes (13.11, 13.46) correlate well with our Astrometrica measures (13.16, 13.48).

BEM9006: The calculated Vmag values and Astrometrica measures are in close agreement with each other (11.90, 12.13) and (11.84, 12.03) and show this pair to be nearly a magnitude dimmer than the current WDS Values (11.10, 11.3). Visual comparisons with nearby field stars in the photos seem to confirm this. Though considered to be only an optical association, this pair appears to show a significant change in separation over the past 113 years as shown in Figure 10. However if only recent measures are considered the apparent rate of change appears to be negligible which calls into question the accuracy of the earliest measures.

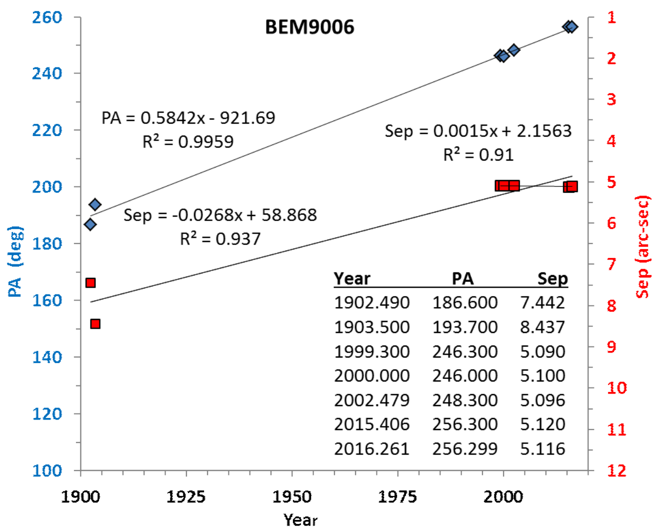

Figure 10. Historical measures of BEM9006.

BEM9011: The Current WDS magnitudes are Tycho2 VT values and show this soft orange-orange pair to be nearly equal in magnitude (11.76, 11.70). The calculated Vmag values and Astrometrica measures also show the pair to be nearly equal in magnitude but one-third to one-half magnitude brighter than the Tycho2 values (11.23, 11.33 & 11.56, 11.68). The faint C component (DAM259AC) which has a listed magnitude of 16.02 (UCAC4) was a difficult target to image being 4.26 magnitude fainter than the primary. The calculated Vmag values and Astrometrica measures show C to be at least 0.5 magnitude fainter (16.91 & 16.55).

BEM9012: The current listing shows identical magnitudes for both components (12.3,12.3). All 2Mass band passes for the system show a ΔM of ~0.3 for the components which is in line with the 0.3 ΔM reflected in our Astrometrica measures (12.19, 12.47). The calculated Vmag values show a slightly wider spread and a slightly dimmer secondary (12.18, 12.64).

BEM9015: The current listing (APASS magnitudes) shows the primary as being 0.6 magnitude dimmer than the secondary (12.61, 12.04). Our Astrometrica measures (12.03, 12.31) and the calculated Vmags (12.12, 12.32) correlate well with the UCAC4 magnitudes (11.97, 12.28) showing the primary brighter with a ΔM for the pair of ~0.3 mag.

BEM9016: The WDS currently shows this to be an equal magnitude pair with no decimal digits (14, 14) which is usually a sign that the magnitudes have not been precisely measured. These values are a significant departure from Bemporad’s original 12.5 & 12.8 magnitudes which is surprising since these measures were made from plates taken in 1932, not near the turn of the century as was the case for the majority of the pairs.

The calculated Vmag of the components of 13.55 and 16.11 makes this the faintest of all the pairs and also the pair with the largest ΔM (2.55). The tight separation of 4.1" along with the faint 16 mag secondary made this a difficult target to image with our equipment - the secondary barely registering above the noise floor and makes the Astrometrica generated magnitude of 16.75 for the secondary somewhat suspect. Examination of the photos shows the calculated Vmag value for the secondary (16.11) to be a better fit.

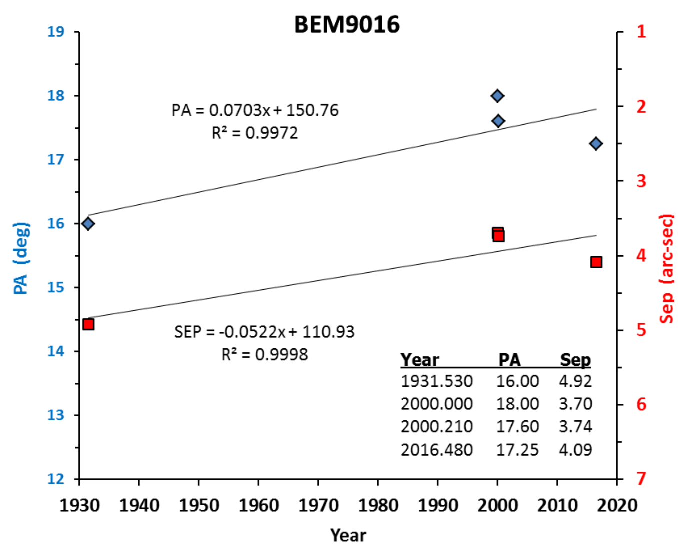

Figure 11. Historical measures of BEM9016.

BEM9018: The current listing is based on APASS magnitudes (10.73, 11.51) ΔM = 0.8. Our Astrometrica measures (10.44, 11.19) correlate well with the UCAC4 magnitudes (10.36, 11.19) showing both components to be slightly brighter (~0.3 mag) also with a ~0.8 ΔM for the pair. The calculated Vmags (10.48, 11.40) roughly correlates with the primary but gives a slightly dimmer value for the secondary.

BEM9020: The WDS currently shows this to be an unequal pair (11.70, 12.20) a ΔM of 0.5. Photos show a nearly equal magnitude pair and the calculated Vmag values yield the nearly equal magnitudes of 12.20 & 12.27. The Astrometrica measures show a slightly brighter primary (12.01, 12.20) with ΔM = 0.2. The PA measurements show a difference of nearly one degree (4.47 vs 3.6) from the 2003 values.

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BEM9022AB: The current WDS listing show the AB pair at magnitudes 11.8 & 12.8, a ΔM of 1.0 which is at odds with the visual impression of a more closely matched pair in the photos. The calculated Vmag values and Astrometrica measures correlate well at (12.30, 12.69) and (12.34, 12.78) which makes the primary about 0.5 mag dimmer (ΔM = ~0.4) than currently listed and a better fit to the photos.

BEM9022AC (DAM260): The calculated Vmag and Astrometrica measures show, show the secondary to be a full magnitude dimmer at 15.43 & 15.67 mag than currently listed (14.4). A 5.0 degree difference in the PA value from the previous 2003 measure (197.5 vs 202.56) was noted which at first glance might seem excessive but when plotted seems to fall on the historical trend line (see Figure 12).

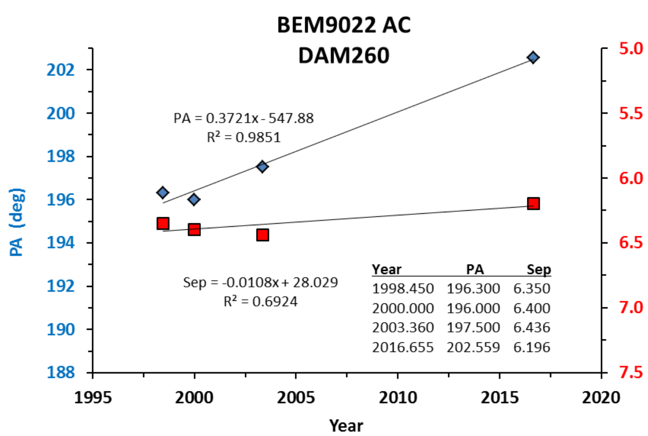

Figure 12. Historical measures of BEM9022AC.

BEM9023: The current WDS magnitudes show the pair to be identical at 11.90. The calculated Vmag values and Astrometrica measures correlate well at (11.89, 12.07) and (11.98, 12.28) a ΔM of ~0.20 magnitude for the pair.

BEM9024 AB: This triple system looks like a mirror image of BEM9022/Dam261 and curiously shows a similarly large (+3.2 Degree) difference in PA (279.2 vs 276) from its previous measure (2003). The plot below shows our measures follow the historical trends for this system. There is good agreement between the current WDS magnitudes (Tycho2) and the Calculated Vmag and Astrometrica measures for both the primary and secondary.

BEM9024 AC (DAM261): The calculated Vmag and Astrometrica measures of the "C" component (14.55, 15.60) straddle the current WDS value of 15.0 (Average = 15.08). Due to the ambiguity of the data the current 15.0 magnitude value appears to be the best fit.

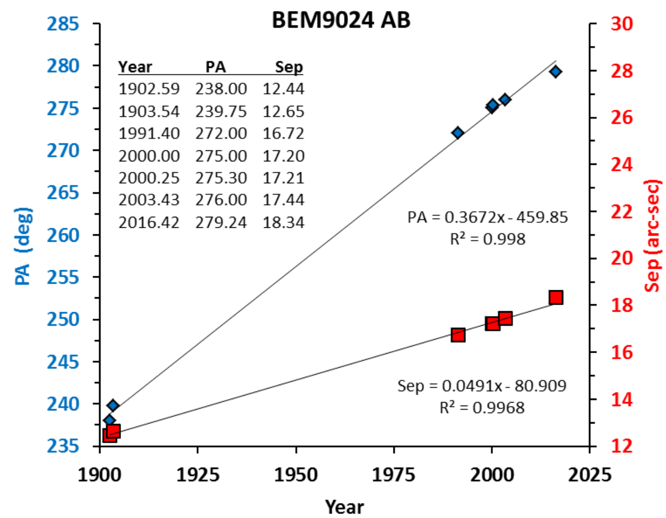

Figure 13. Historical measures of BEM9024.

Acknowledgements

Our special thanks to Dr. Brian Mason and Dr. William Hartkopf of the U.S. Naval Observatory for providing technical insights and historical background regarding the Bemporad Catalog and its inclusion into the WDS and for providing the Historical Data Files for all of the Bemporad systems.

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WDS, Washington Double Star Catalog, Mason,B.D & Hartkopf, W.I., 2013, http://ad.usno.navy.mil/wds/, (Accessed via Aladin and Stelle Doppie)

Resources

Adobe Photoshop Elements, Version: 5.0

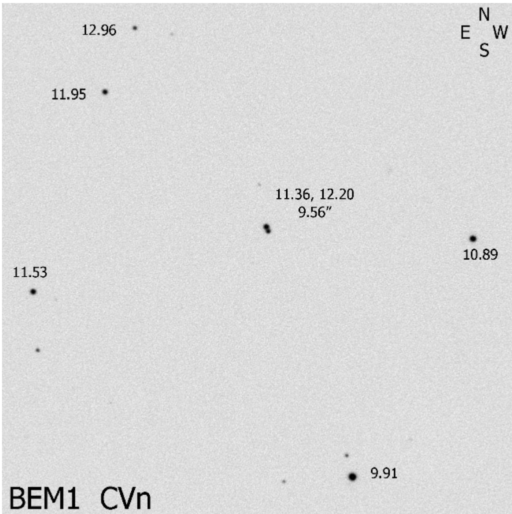
Aladin Sky Atlas, Centre de Donńees Astronomiques de Strasbourg (CDS), v9.010, http://aladin-strasbg.fr

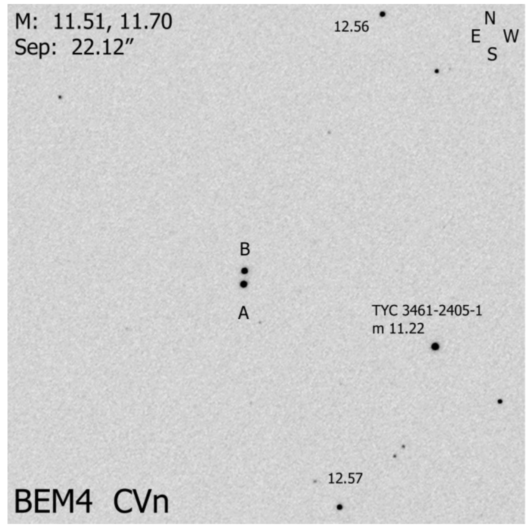
Astrometrica, Version 4.9.1.420, Herbert Raab, http://astrometrica.at

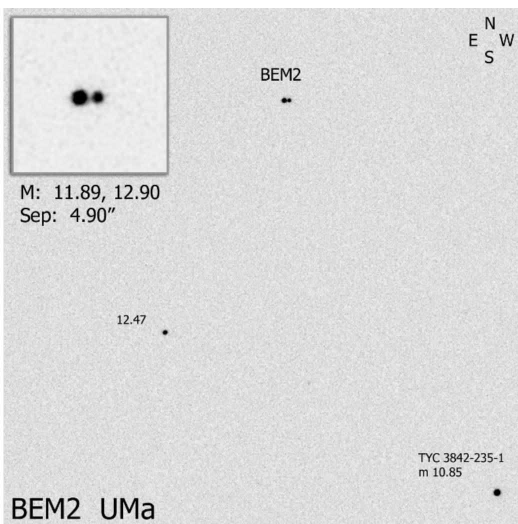
PixInsight, Pleiades Astrophoto, Version 01.08.04.1195 Ripley (x64).

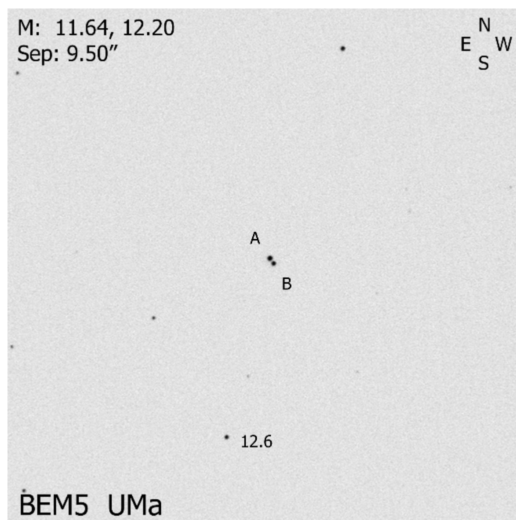
Stelle Doppie, WDS Interface, version 2.1. http://stelledoppie.goaction.it

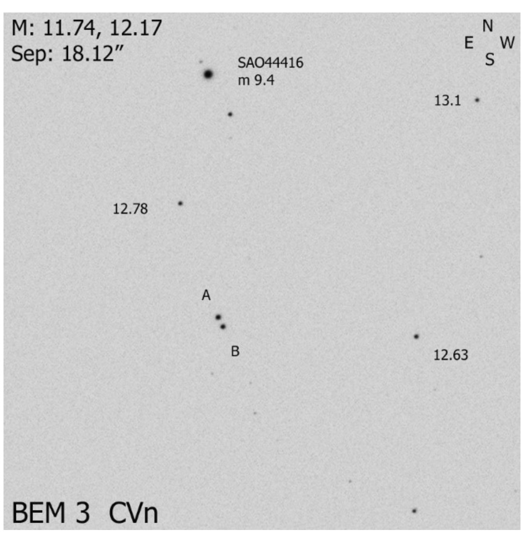
Appendix 1: Photo Gallery of all Bemporad (BEM) Double Stars

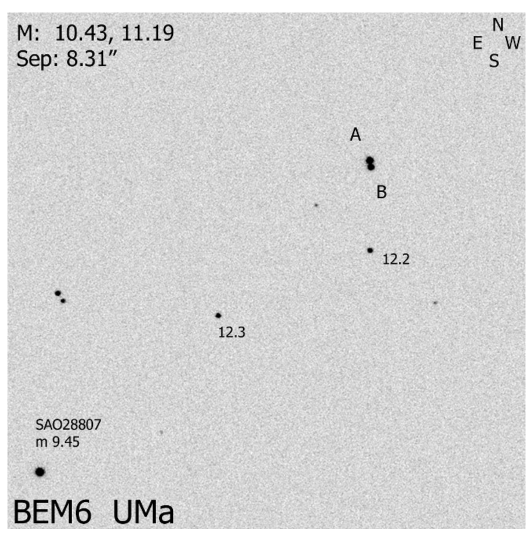












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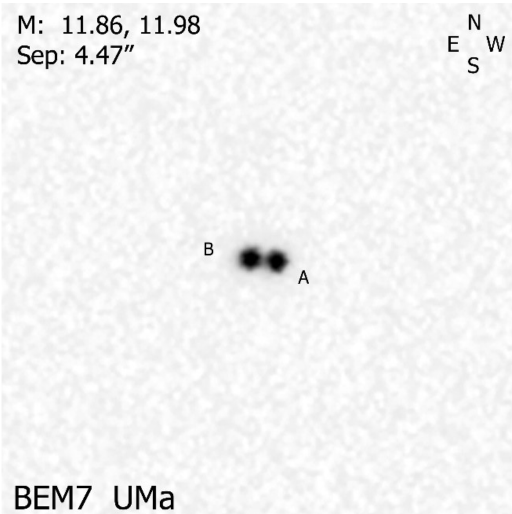
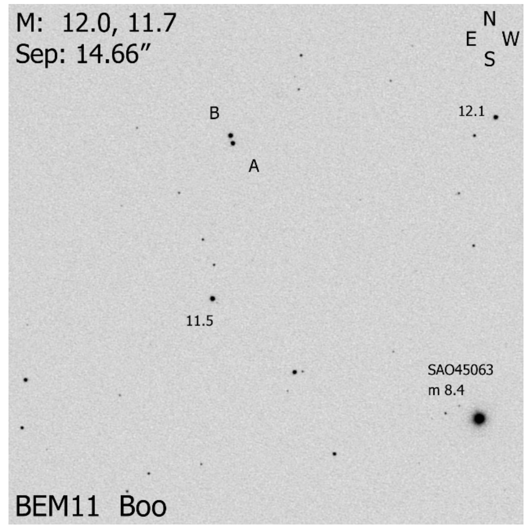
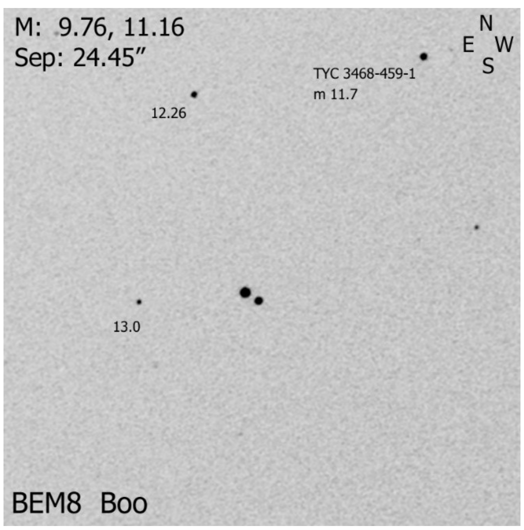
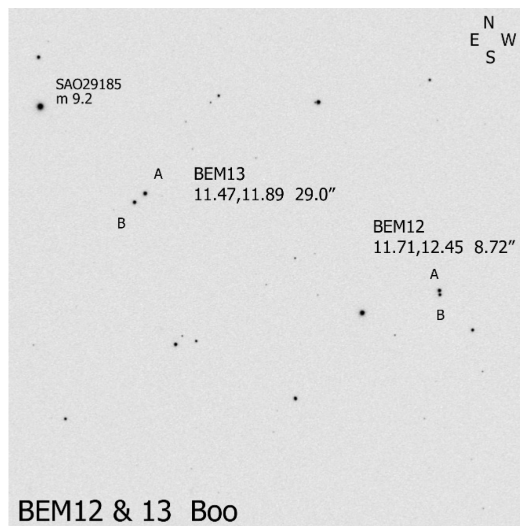
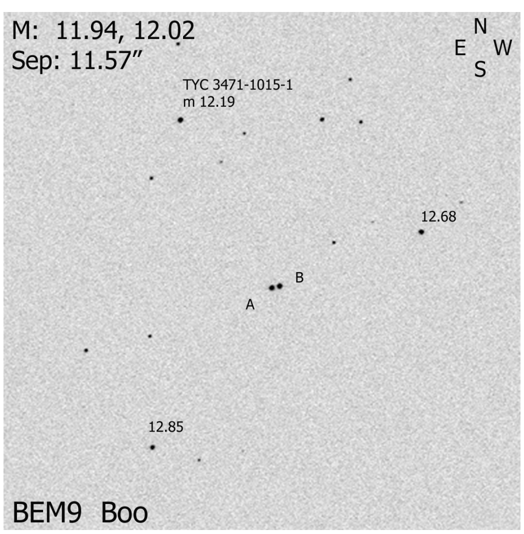
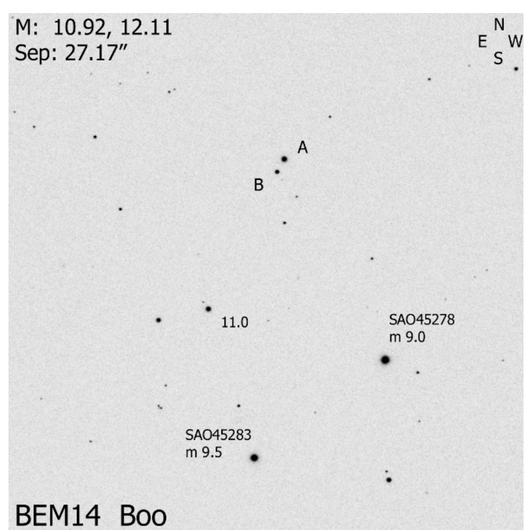




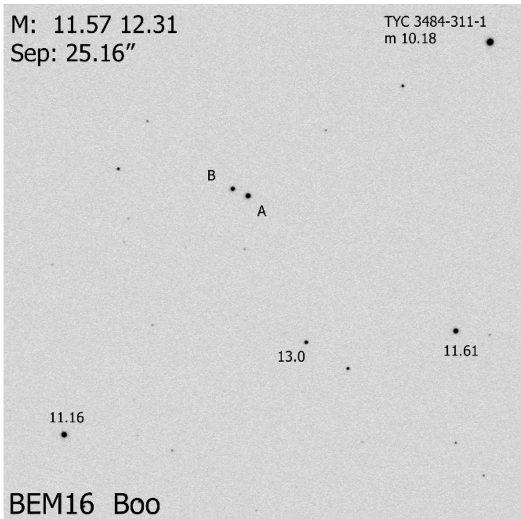


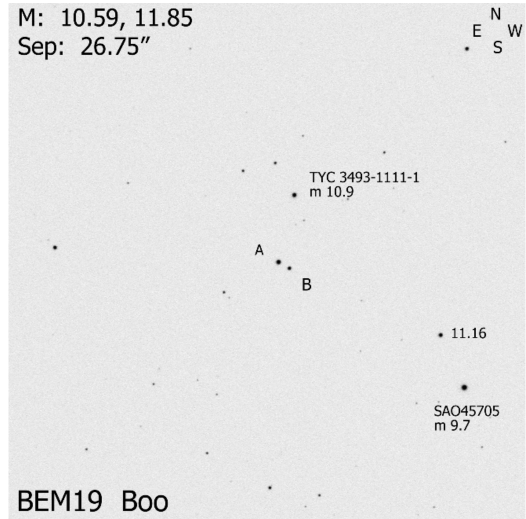


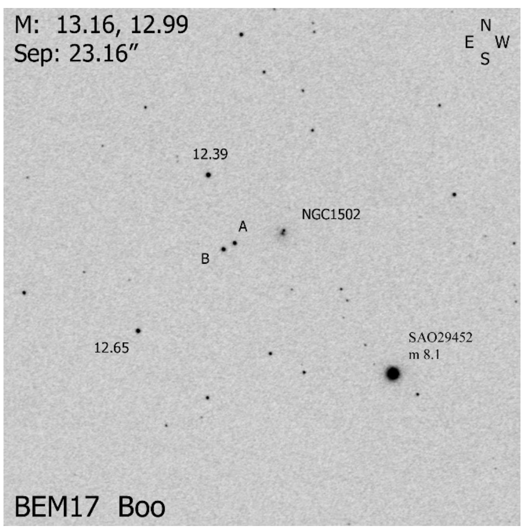


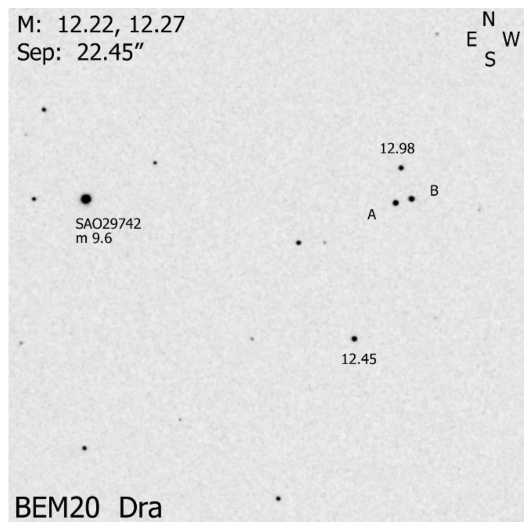


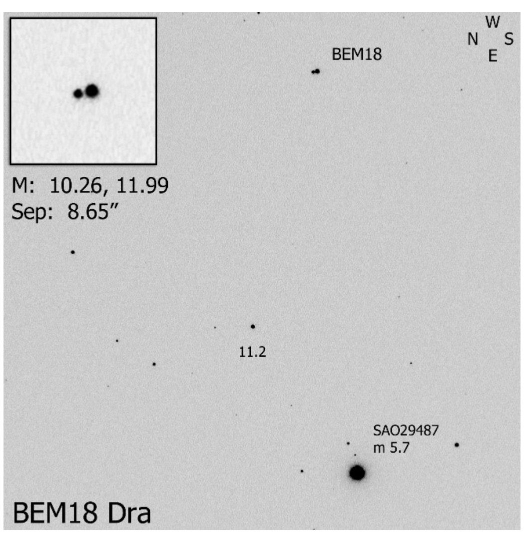
Azeglio Bemporad and the "BEM" Double Stars

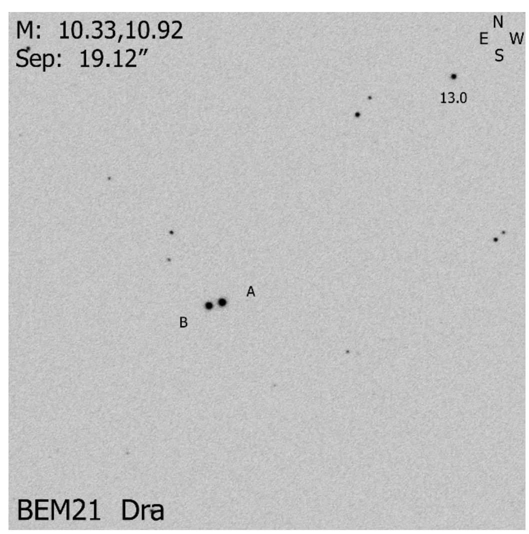












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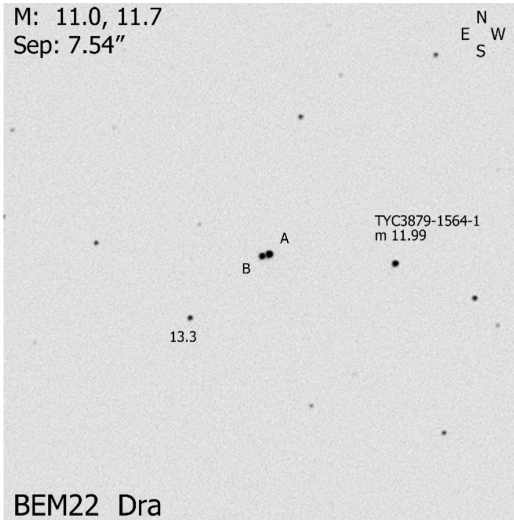

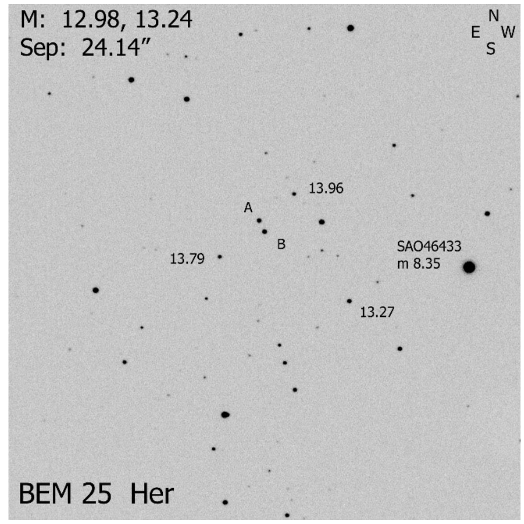

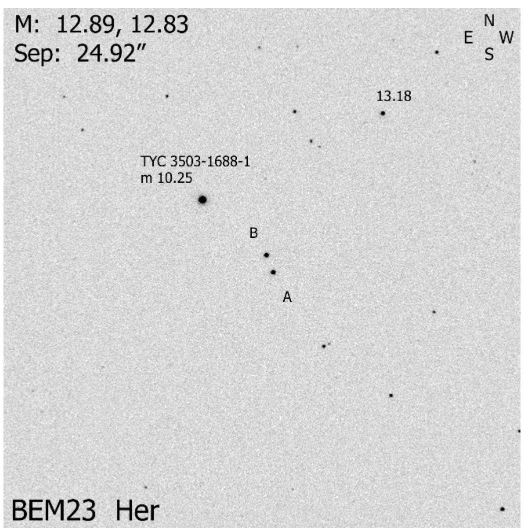

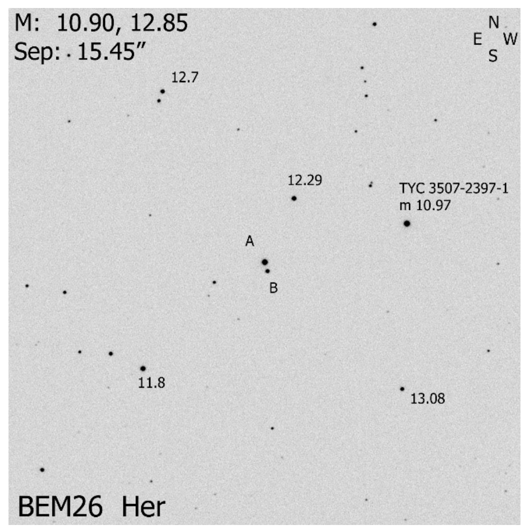

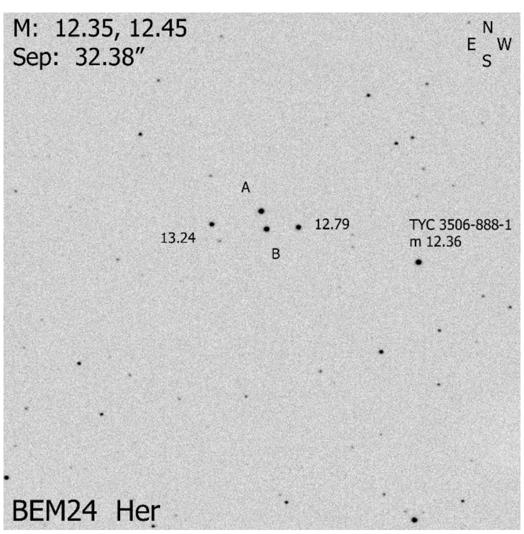

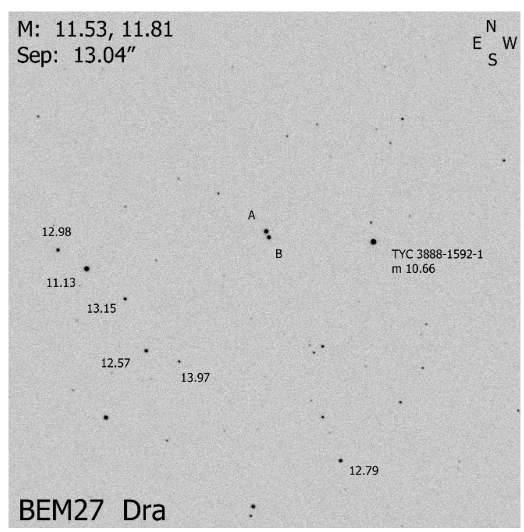

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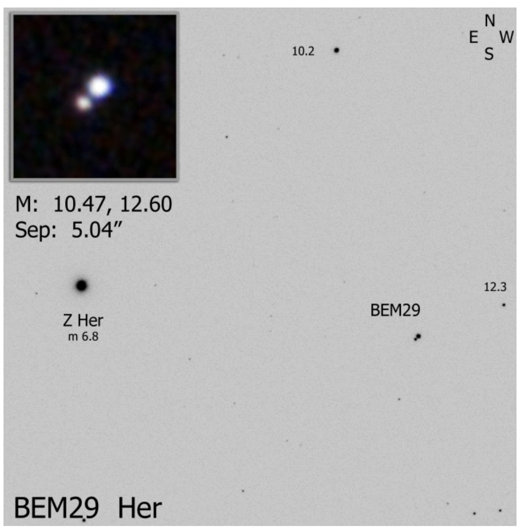
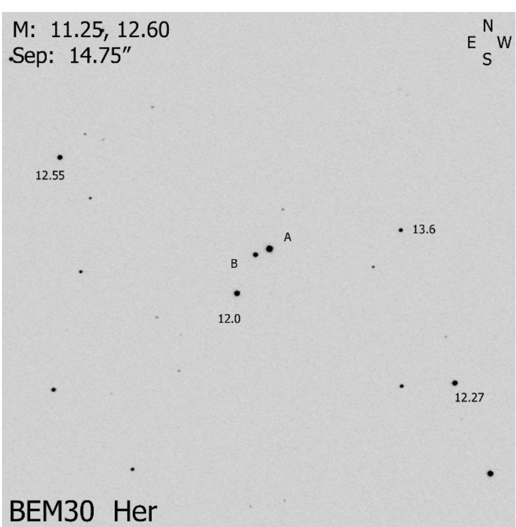
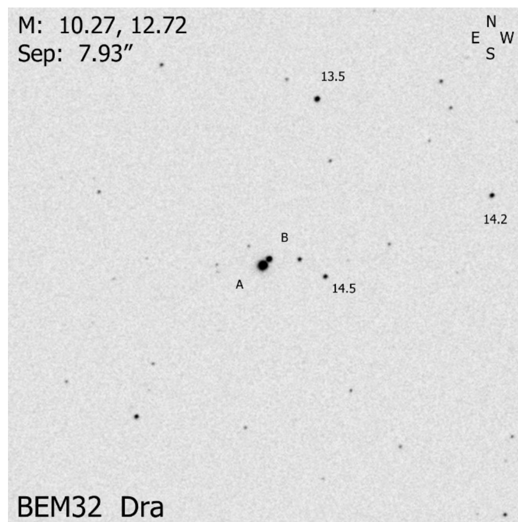
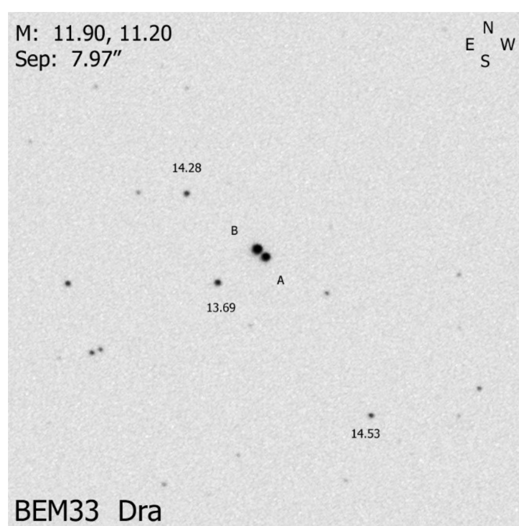
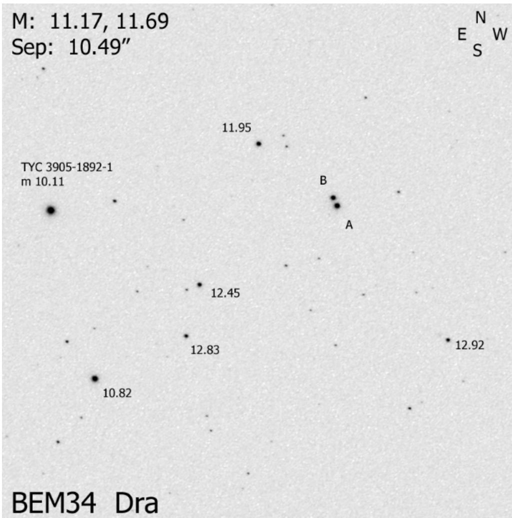


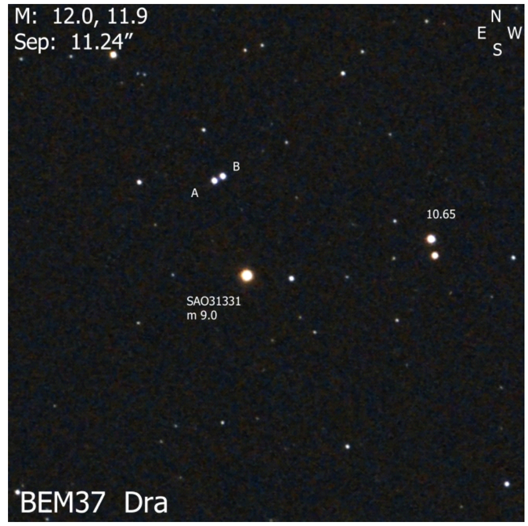


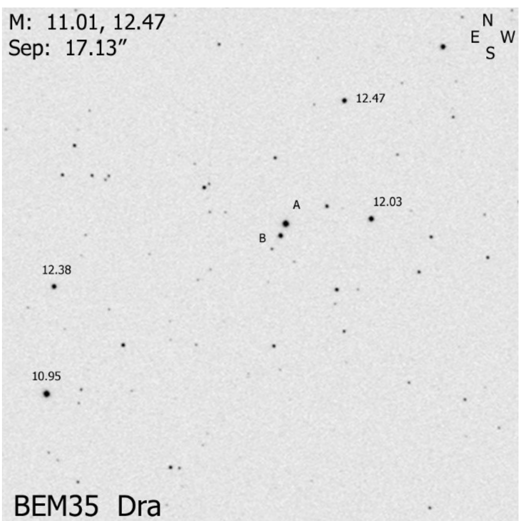


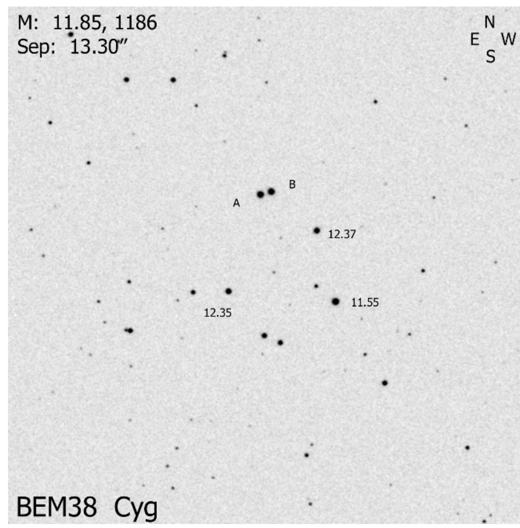


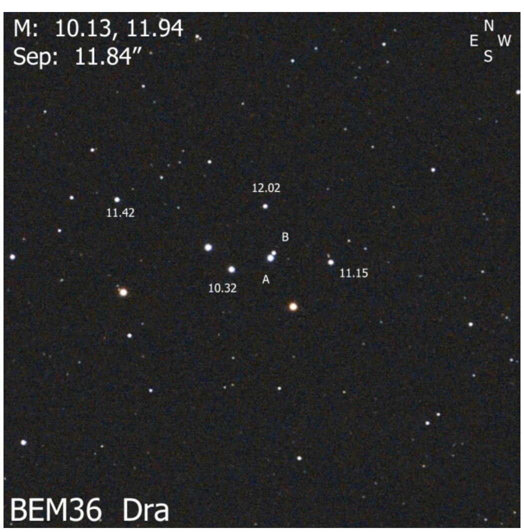
Azeglio Bemporad and the "BEM" Double Stars

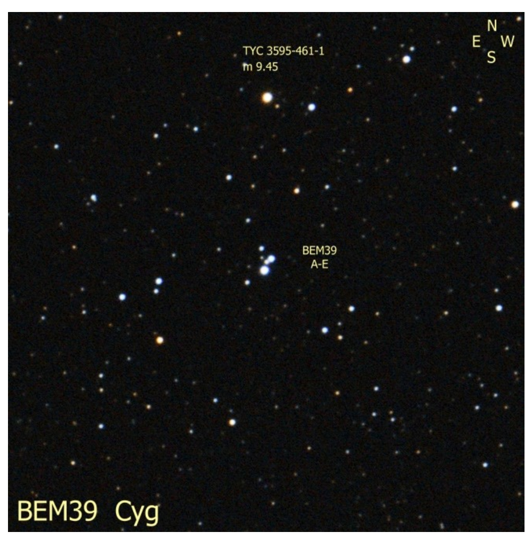












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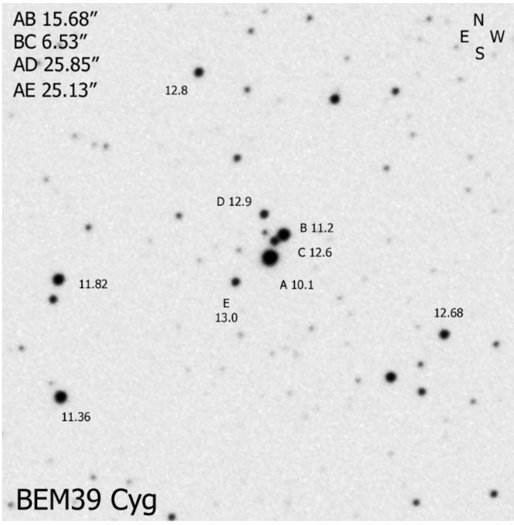

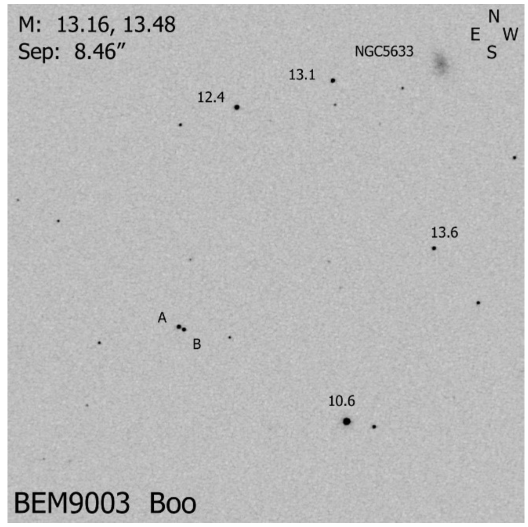

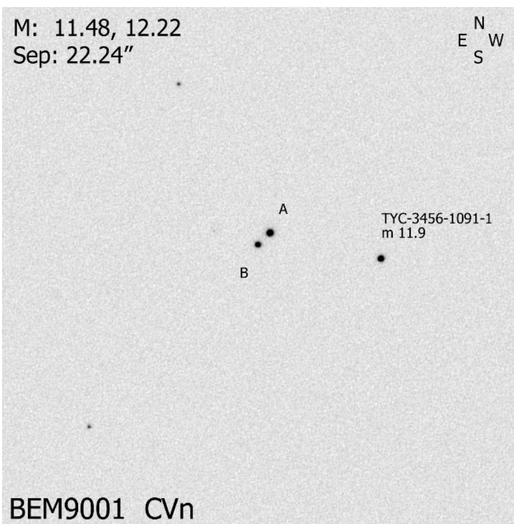

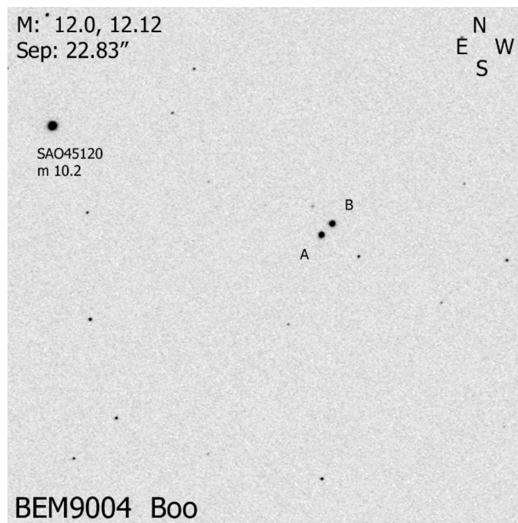

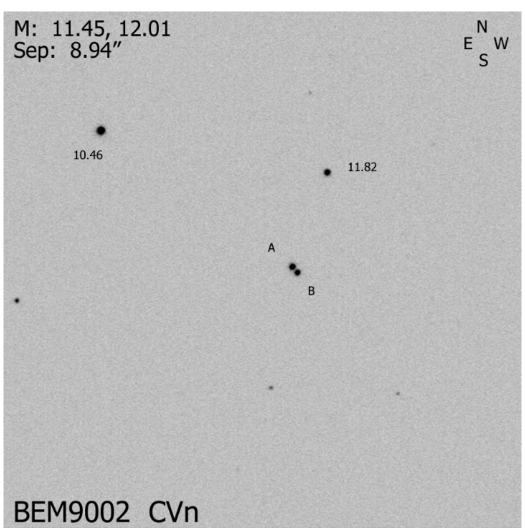

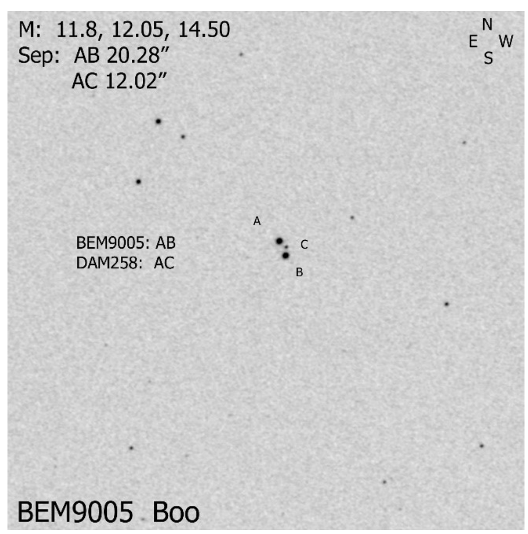

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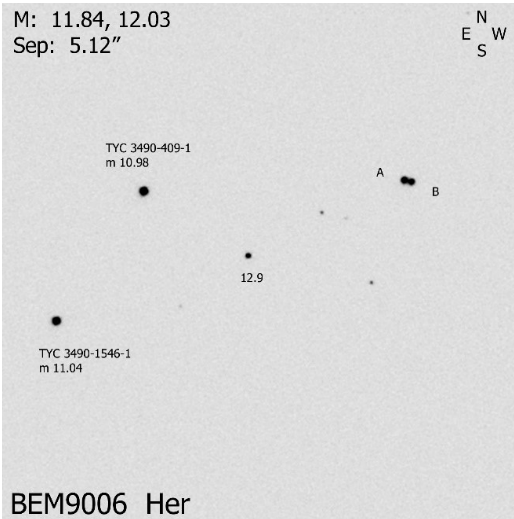

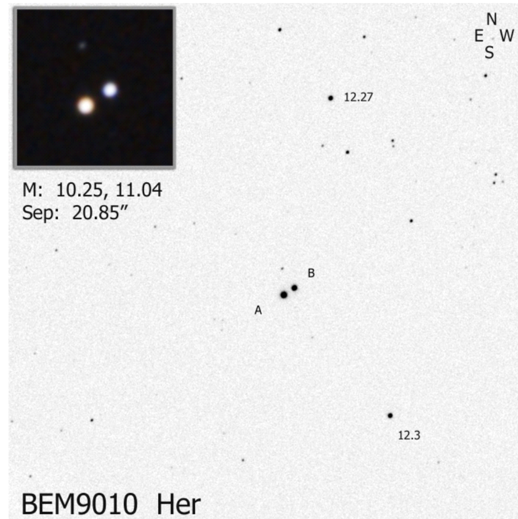

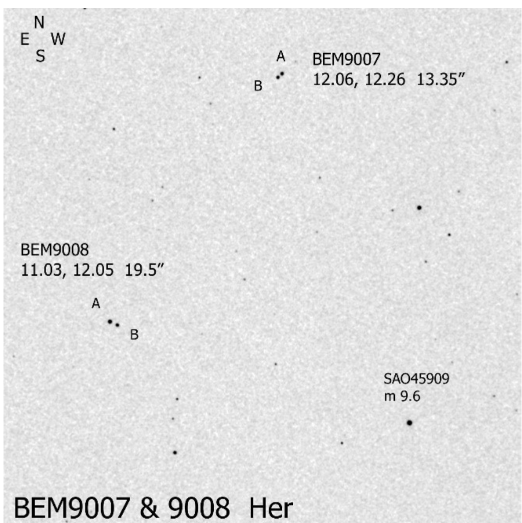

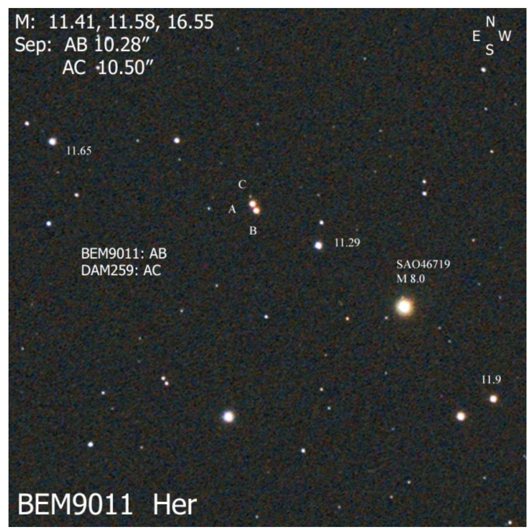

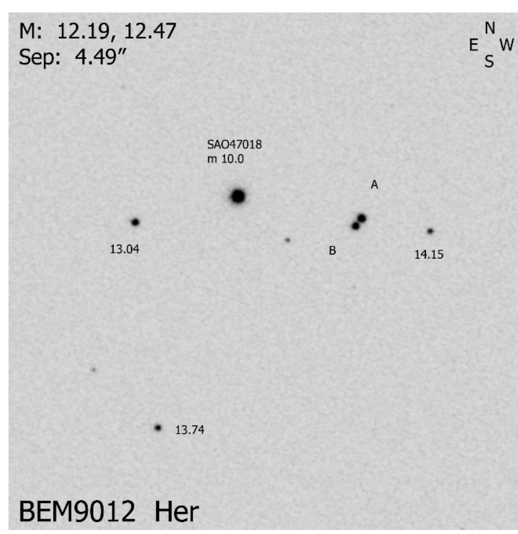

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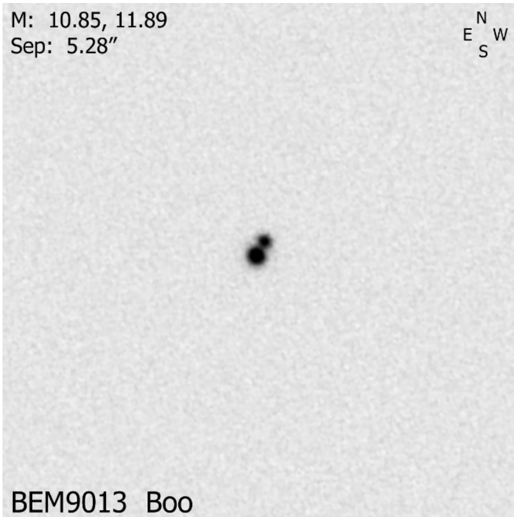
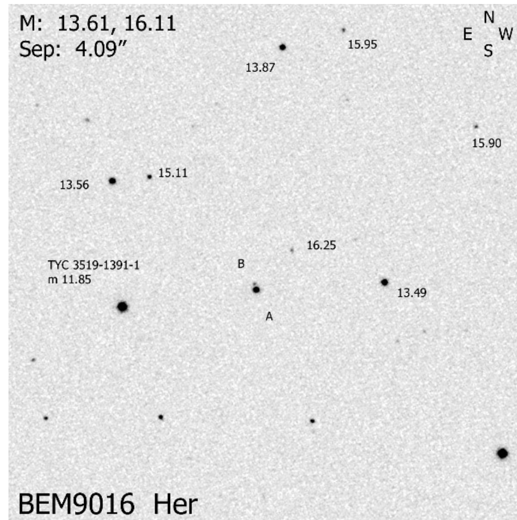
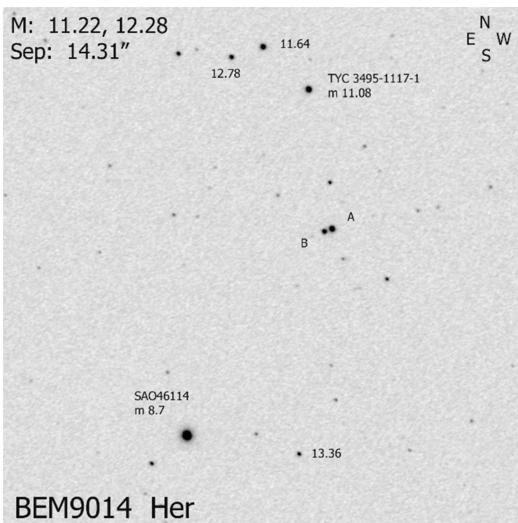
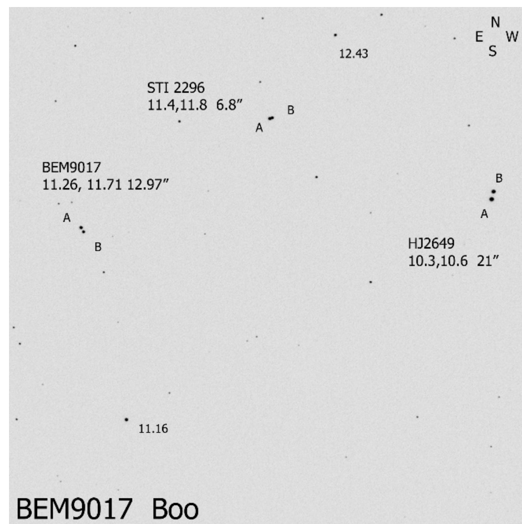
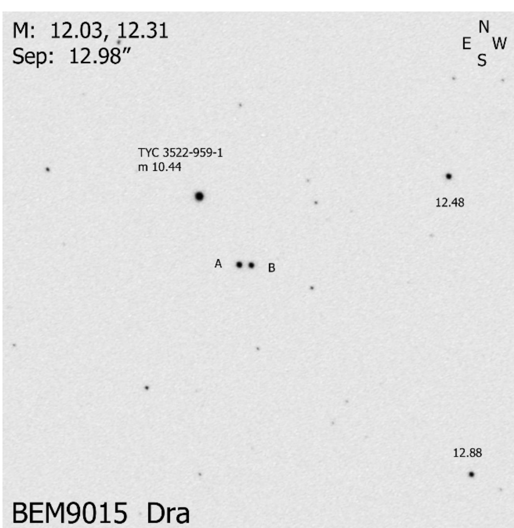
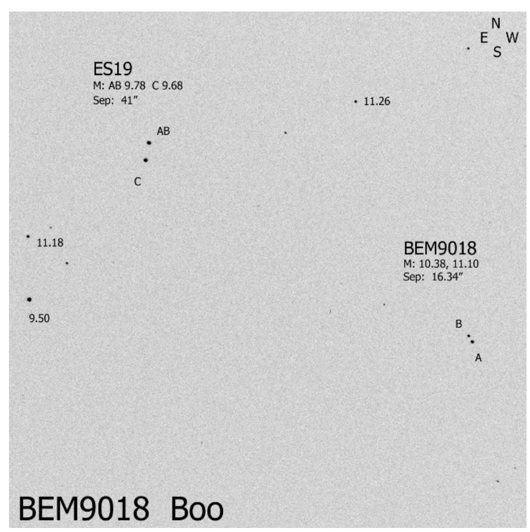




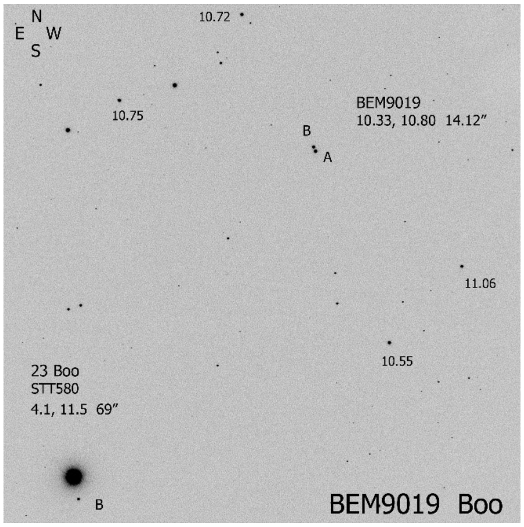


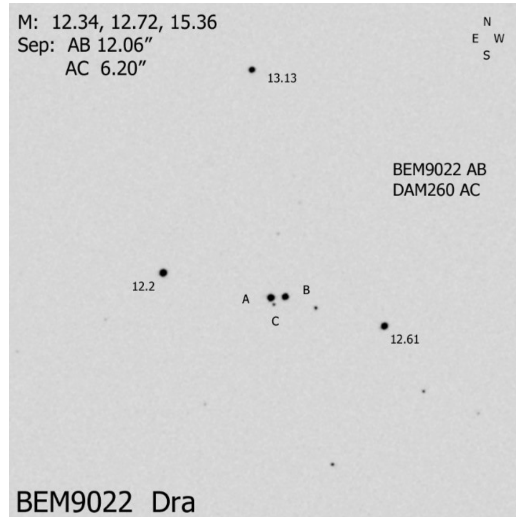


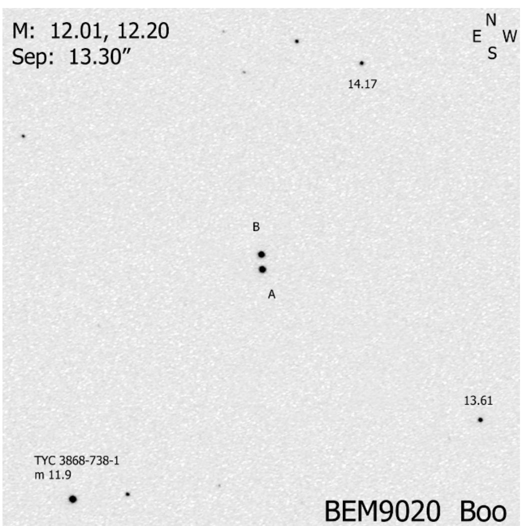


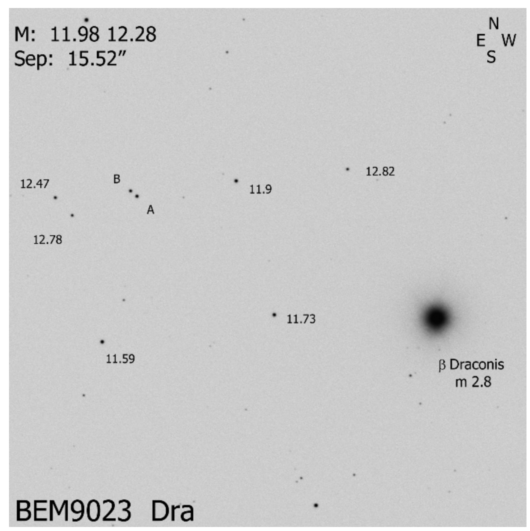


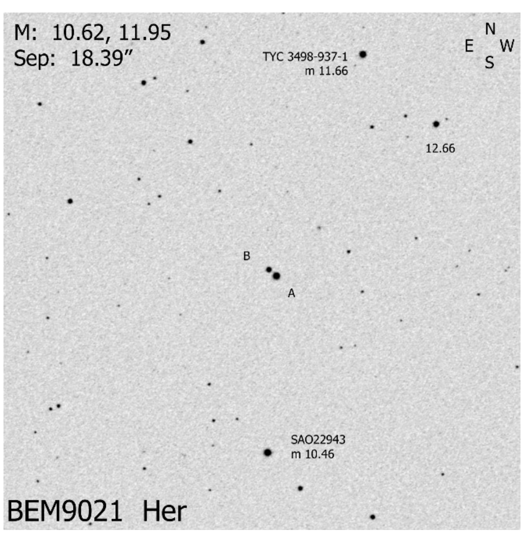
Azeglio Bemporad and the "BEM" Double Stars

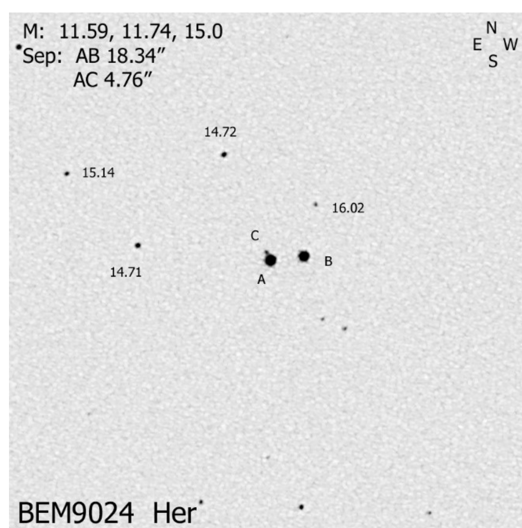












Azeglio Bemporad and the "BEM" Double Stars

Appendix 2: Bemporad Double Star Publications

The following pages contain scanned images of the publications detailing Bemporad's measurements of previously cataloged pairs along with measures of his own double star discoveries in the course of his work on the Astrographic Catalog. All of Bemporad's doubles were published in four *Astronomische Nachrichten* (Astronomical News) journals with the exception of BEM39 which was published in *"Contributi Astrofisici No. 42, 1938"*.

The **Red** annotations have been added to show the BEM Catalog numbers for the pairs that have been incorporated into the Washington Double Star Catalog. It is evident that the sequential BEM numbers do not strictly follow the chronological order of the publications which have been arranged herein to best follow the BEM numbering sequence.

It is clear from the annotations that not all of Bemporad's "discoveries" were incorporated into the catalog. For many of these entries no likely or plausible match can be found at or near the reported locations or the reported pair had been previously cataloged.

Astronomische Nachrichten, Volume 254, Issue 3, 03/1934, p.37 & 38

Misure di stelle doppie

eseguite nel corso dei calcoli per il Catalogo Astrografico di Catania. Da *A. Bemporad.*

Con riferimento alle precedenti comunicazioni col medesimo titolo in AN **244**, Nr. 5850; AN **246**, Nr. 5882; AN **248**, Nr. 5930 comunichiamo le coordinate approssimate (1900.0) e gli elementi ricavati per 60 doppie misurate sulle lastre in corso di stampa del Catalogo Astrografico (da +49° a +54° fra 12^h e 19^h A. R.).

Sono segnati in corsivo gli elementi desunti dal Burnham (General Catalogue, 1906).

	Burnham	α 1900.0	δ	Angolo di posiz.	Distanza	Grandezze	Epoca	Lastra No.	Note
1		$12^h39^m21^s$	+50° 23'.5	202°.5	9".43	$12^m.0$, $11^m.3$	1899.32	923	(1)
				200.0	8.40	12.2, 11.6	1904.26	2383	
3		12 55 2	+49 32.6	220.2	20.14	11.9, 11.8	1902.36	1548	
				215.3	19.24	12.0, 11.9	1904.34	2441	
4		13 3 24	+50 26.8	21.8	21.21	11.2, 11.8	1904.29	2439	
				22.2	21.25	11.4, 11.9	1904.34	2441	
	6604	13 39 0	+50 31.9	*125.7*	*40 ±*	*8.5, 10*	*1830 +*	—	H
				129.8	26.57	8.7, 11.1	1904.29	2447	
				125.5	29.40	8.2, 11.0	1905.33	2602	
7		14 1 20	+49 42.3	85.9	2.03	11.6, 11.7	1902.36	1552	
				82.0	2.58	11.6, 11.7	1904.34	2449	
8		14 8 3	+50 14.2	241.4	24.91	11.2, 10.0	1905.33	2600	
				241.4	24.90	11.1, 10.0	1924.41	4004	
9		14 9 30	+50 59.3	283.7	11.16	12.0, 12.0	1905.33	2600	
				289.2	11.53	12.0, 12.0	1905.40	2612	
				284.0	11.49	12.0, 11.9	1924.41	4004	
	6778	14 9 54	+52 15.5	*237.7*	*12.60*	*7.2, 5.1*	*1832.50*	—	Σ 7
		(κ Bootis)		237.7	13.36	7.8, 5.6	1901.33	1350	(2)
				236.8	13.22	7.2, 5.0	1905.40	2612	
10		14 11 33	+51 16.1	273.8	13.49	12.1, 11.6	1924.41	4004	
	6802	14 12 37	+51 49.7	*33.2*	*38.05*	*4.9, 7.5*	*1836.22*	—	Σ 4
		(ι Bootis)		32.9	37.72	4.9, 8.9	1905.23	2608	(3)
				32.2	37.86	5.2, 9.3	1905.40	2612	
				31.6	37.22	5.1, 9.6	1924.41	4004	
	6813	14 14 6	+49 12.9	*321.8*	*23.67*	*8.6, 8.4*	*1892.17*	—	β 4
				321.1	23.83	9.7, 9.2	1902.35	1569	
				320.3	24.13	9.8, 9.2	1905.33	2600	
11		$14^h24^m59^s$	+49° 59'.2	196°.2	14".93	$11^m.9$, $11^m.8$	1904.34	2443	
				200.7	12.95	12.2, 11.9	1904.44	2532	
12		14 26 59	+50 39.7	185.9	8.63	11.9, 11.5	1898.37	604	(4)
				182.9	8.01	12.0, 11.6	1904.34	2443	
13		14 28 4	+50 42.7	119.4	27.24	11.2, 11.6	1898.37	604	
				120.2	27.95	11.5, 11.9	1904.34	2443	
	6963	14 36 48	+49 8.2	*106.3*	*6.98*	*7.2, 11.2*	*1848.19*	—	OΣ 3
				104.0	6.53	8.0, 11.6	1897.34	319	(5)
				101.7	7.21	7.9, 12.0	1905.44	2617	
	6982	14 38 40	+49 33.1	*288.4*	*25.73*	*9.2, 7.7*	*1830.65*	—	Σ 2
				288.1	25.67	9.9, 9.4	1897.34	319	(6)
				288.0	26.32	9.9, 9.5	1905.34	2617	
	7032	14 46 18	+51 47.3	89.2	15.06	7.1, 10.5	1902.38	1580	Σ
				90.2	16.09	7.0, 10.3	1904.29	2474	
	7063	14 51 31	+51 2.7	*139.0*	*25.03*	*9.1, 9.4*	*1900.43*		Es 2
				136.6	25.11	10.0, 11.6	1902.37	1565	
14		14 52 31	+49 38.4	153.6	23.91	10.4, 11.7	1902.37	1565	
				151.5	24.55	10.8, 11.6	1904.35	2531	
15?		15 4 27	+51 18.9	64.5	5.30	10.4, 11.5	1930.48	4034	
16		15 6 30	+50 4.7	65.4	24.40	11.9, 12.2	1930.48	4034	
		15 11 27	+50 41.5	298.3	23.36	12.1, 11.9	1930.48	4034	
17		15 11 45	+51 9.8	38.7	7.07	10.7, 11.1	1904.49	2519	(7)
				41.2	6.61	11.0, 11.2	1930.48	4034	
	7291	15 25 19	+50 0.2	*226.0*	*12 ±*	*13 9*	*1830 +*		H
				228.7	17.42	11.6, 9.9	1898.39	609	
				234.1	17.80	11.5, 10.3	1903.50	2093	
				232.0	19.11	11.7, 10.3	1904.42	2463	
	—	15 37 58	+50 28.0	278.3	8.06	11.0, 10.9	1903.50	2100	
				273.6	8.21	11.2, 11.2	1904.46	2525	
19		15 42 20	+49 24.9	232.8	28.01	11.5, 10.5	1903.50	2099	
				233.8	27.85	11.6, 10.6	1903.50	2100	
				232.9	27.50	11.2, 10.4	1905.40	2611	
20		15 56 28	+51 27.0	280.8	21.36	12.3, 12.2	1903.49	2136	
				280.6	21.39	12.2, 12.1	1904.50	2522	
21		16 0 16	+51 28.2	103.4	17.86	11.3, 12.2	1903.49	2136	
				103.6	17.76	11.4, 12.0	1904.50	2522	

3*

Azeglio Bemporad and the "BEM" Double Stars

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39 6075 40

Burnham	α (1900.0)	δ	Angolo di posiz.	Distanza	Grandezze	Epoca	Lastra No.	Note
23	$16^h54^m33^s$	$+49°12'.5$	23°.4	25".17	$13^m.2$, $13^m.5$	1931.51	4053	
24	16 57 40	+50 49.8	200.5	27.85	13.1, 12.8	1931.51	4053	
25	16 58 19	+49 37.9	26.7	24.05	13.1, 13.5	1931.51	4053	
7894	17 5 50	+50 58.1	*274.0*	*17.0*	*11.8, 6.6*	*1901*	—	Es
			278.2	19.00	12.6, 6.4	1902.47	1625	
			271.6	18.04	12.2, 6.5	1903.48	2140	
			264.9	18.79	12.6, 7.3	1931.51	4053	
26	17 6 7	+50 30.3	194.1	14.96	12.6, 11.3	1902.47	1625	(8)
			199.4	15.23	12.5, 11.1	1903.48	2140	
			198.1	15.39	13.1, 11.0	1931.51	4053	
7895	17 6 9	+49 53.0	*201.8*	*3.31*	*10.5, 9.0*	*1830.63*	—	Σ3
			204.5	2.47	11.0, 10.0	1902.47	1625	
			211.9	3.11	10.8, 9.8	1902.51	1713	
			211.9	3.11	11.2, 10.0	1931.51	4053	
7909	17 9 7	+49 51.9	*116.3*	*5.33*	*6.2, 10.0*	*1830.14*	—	Σ3
			104.1	3.92	6.8, 8.7	1902.47	1625	(9)
—	17 21 52	+49 36.8	223.3	18.39	10.9, 8.1	1901.47	1370	Σ
			222.5	18.83	10.6, 8.5	1902.50	1643	
8026	17 23 8	+51 34.8	67.1	5.04	9.5, 11.7	1902.48	1623	
			59.2	3.44	9.2, 11.7	1902.56	1764	
			62.5	*4.21*	*8.0, 11.0*	*1904.36*	—	Hu
8057	17 26 34	+50 56.9	*265.3*	*3.17*	*7.2, 7.0*	*1831.29*	—	Σ6
			256.9	4.31	8.3, 7.2	1902.50	1643	
			258.6	3.25	8.0, 7.6	1902.56	1764	
27	17 29 42	+53 53.0	204.8	12.88	12.0, 11.7	1902.47	1640	
			205.1	12.73	12.0, 11.9	1902.52	1683	
8073	17 30 9	+47 57.5	*100.0*	*21.07*	*7.9, 10.3*	*1901.39*	—	β3
			100.8	21.18	7.9, 12.5	1901.48	1368	
—	17 34 10	+54 29.0	296.8	3.89	11.2, 11.0	1902.52	1683	
—	17 38 13	+54 15.8	199.3	1.88	11.7, 10.7	1902.52	1683	
			188.2	*2.57*	— —	*1908.53*	—	Es
8167	17 42 53	+51 59.2	*342.8*	*4.82*	*11.6, 8.4*	*1868.85*	—	Δ4
			334.1	4.21	12.2, 10.3	1902.45	1693	(10)
			342.7	5.61	12.2, 10.3	1931.53	4054	
30	17 48 46	+50 7.8	111.7	12.70	12.1, 12.4	1902.59	1784	
			108.5	13.27	12.2, 12.9	1931.53	4054	
8297	17 55 50	+52 13.6	*262.5*	*9.21*	*9.5, 7.5*	*1829.80*		Σ2
			261.9	9.89	10.5, 8.2	1902.56	1721	d
			262.0	9.84	10.8, 7.0	1902.59	1772	
—	17 57 51	+53 16.4	339.8	3.96	11.5, 10.5	1902.56	1721	(11)
			340.4	3.74	11.3, 10.3	1902.59	1783	
8320	17 58 7	+52 51.3	*262.3*	*1.88*	*8.3, 7.3*	*1831.48*	—	Σ3
			256.0	1.96	8.0, 8.9	1902.56	1721	
—	17 58 46	+54 52.7	74.6	8.06	9.3, 11.2	1902.59	1783	
31	18 7 34	+53 28.3	304.3	12.96	11.4, 10.9	1902.47	1635	
			305.0	13.05	11.5, 10.4	1902.50	1708	
—	18 8 58	+53 28.1	242.1	16.35	11.0, 10.4	1902.47	1635	
			241.4	16.25	10.8, 10.2	1902.50	1708	
32	18 19 56	+53 33.1	317.6	7.94	11.5, 10.3	1902.55	1736	
			321.2	7.96	11.5, 10.8	1902.60	1763	
33	18 22 16	+53 28.5	221.8	11.12	11.1, 10.2	1902.55	1736	
			224.1	9.61	11.5, 10.7	1902.60	1763	
34	18 32 11	+52 34.7	31.5	10.29	10.8, 11.2	1902.58	1770	(12)
			30.4	10.79	11.0, 11.5	1907.59	2722	
35	18 48 51	+52 2.6	160.6	15.27	10.7, 11.6	1897.51	382	
			162.4	16.47	11.0, 11.8	1902.55	1738	

Burnham	α (1900.0)	δ	Angolo di posiz.	Distanza	Grandezze	Epoca	Lastra No.	Note
36	$18^h56^m18^s$	$+52°58'.8$	343°.6	10".45	$11^m.5$, $10^m.4$	1897.51	382	
37	18 59 11	+53 19.1	280.4	9.93	11.2, 11.1	1897.51	382	
			290.4	9.77	11.4, 11.4	1902.47	1637	
			285.1	10.39	10.8, 10.8	1902.59	1780	
38	19 6 42	+53 22.2	103.9	13.82	11.0, 11.0	1901.61	1436	
			103.1	13.69	11.3, 11.3	1902.47	1637	
—	19 23 48	+53 57.1	104.7	11.86	9.7, 9.9	1901.59	1400	
			108.0	11.99	10.8, 10.9	1901.60	1423	
			107.4	12.54	11.0, 11.0	1902.60	1750	
9411	19 29 33	+52 46.2	*254.1*	*11.31*	*8.7, 8.2*	*1830.85*	—	Σ2
			253.0	12.34	10.4, 8.8	1902.46	1579	
			252.2	11.43	9.4, 8.7	1902.60	1750	
—	19 35 54	+51 57.5	183.4	7.81	10.5, 10.1	1899.60	1011	(13)
			184.7	7.93	10.8, 10.6	1902.45	1614	
			186.3	8.45	10.3, 10.1	1902.59	1703	
			187.2	7.11	11.1, 10.3	1902.62	1750	(14)

Note.

(1) Mediante eliminazione della differenza sistematica risultante per le due lastre da 10 stelle in zona ($-0^s.221$, $+0''.016$) si ottengono le posizioni e i MP seguenti:

		α (1900.0)	δ	μ_α	μ_δ
Prec.	L 923	$12^h39^m20^s.30$	$+50°23'22''.2$	$-0^s.0020$	$-0''.081$
	L 2383	20.29	21.8		
Seg.	L 923	12 39 20.68	+50 23 31.0	−0.0182	−0.283
	L 2383	20.59	29.6		

(2) Dalle posizioni di AG Cbr M. ridotte al sistema di Yale mediante le correzioni $-0^s.144$ $+0''.8$ ricavate da 10 stelle in zona si ottengono le posizioni e i MP seguenti:

	α (1900.0)	δ	Ep.
Cbr M. 4464	$14^h\ 9^m52^s.59$	$+52°15'21''.20$	1871.4
CA	52.91	20.75	1903.4

μ_α	μ_δ	Boss	
$+0^s.0100$	$-0''.014$	$+0^s.0062$	$-0''.032$

	α (1900.0)	δ	Ep.
Cbr M. 4465	$14^h\ 9^m53^s.81$	$+52°15'27''.60$	1871.4
CA	54.13	27.60	1903.4

μ_α	μ_δ	Boss	
$+0^s.0100$	$0''.000$	$+0^s.0072$	$-0''.015$

(3) Dalle posizioni di AG Cbr M. ridotte al sistema di Yale mediante le correzioni $-0^s.139$ $+0''.25$ ricavate da 10 stelle in zona si ottengono le posizioni e i MP seguenti:

	α (1900.0)	δ	Ep.
Cbr M. 4480	$14^h12^m37^s.771$	$+51°49'40''.55$	1875.0
CA	37.40	43.7	1905.4

μ_α	μ_δ	Boss	
$-0^s.0122$	$+0''.104$	$-0^s.0157$	$+0''.086$

	α (1900.0)	δ	Ep.
Cbr M. 4481	$14^h12^m40^s.071$	$+51°50'12''.75$	1875.0
CA	39.65	15.6	1905.4

μ_α	μ_δ	Boss	
$-0^s.0138$	$+0''.094$	—	—

(4) Previa riduzione della L 2443 al sistema di Yale mediante le correzioni $-0^s.146$ $+0''.74$ ricavate da 10 stelle in

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zona si sono ottenuti per le due componenti i seguenti MP:

	μ_α	μ_δ
Prec.	$-0^s.0017$	$-0''.017$
Seg.	-0.0100	-0.117

(5) Previa riduzione sistematica della L. 319 alla L 2617 mediante le correzioni $-0^s.067$ $+1''.81$ ricavate da 10 stelle in zona si sono ottenuti per le due componenti i seguenti MP:

	μ_α	μ_δ
Prec.	$-0^s.0185$	$-0''.148$
Seg.	-0.0086	-0.111

(6) Previa riduzione sistematica fra le due lastre sono state determinate le seguenti componenti del MP:

	μ_α	μ_δ
Prec.	$-0^s.0075$	$-0''.025$
Seg.	-0.0137	0.000

(7) Previa riduzione sistematica della L. 2519 alla L 4034 mediante 10 stelle in zona ($-0^s.013$ $+0''.19$) sono state determinate le componenti del MP:

	μ_α	μ_δ
Prec.	$+0^s.0042$	$+0''.004$
Seg.	$+0.0046$	-0.019

Catania, R. Osservatorio astrofisico, 1934 Agosto.

(8)

	μ_α	μ_δ
Prec.	$+0^s.0021$	$+0''.003$
Seg.	$+0.0011$	-0.002

(9) Forte scarto G2.

(10) Dalla L 1693, previa riduzione alla L 4053 mediante dieci stelle in zona ($+0^s.012$, $-0''.25$) si sono ottenute le posizioni seguenti, accanto alle quali riportiamo le corrispondenti della L 4054.

	Precedente ($12^m.2$)		Seguente ($10^m.3$)	
L 1693	$17^h42^m52^s.96$	$+51°59'17''.3$	$17^h42^m53^s.14$	$+51°59'13''.5$
L 4054	52.95	19.5	53.13	14.2
Δ	-0.01	$+2.2$	-0.01	$+0.7$

L 1693 Ep. 1902.45, L 4054 Ep. 1931.53.

Probabilmente binaria.

(11) Nuove misure +34.441, +16.838; +34.468, +16.767.

(12)

	μ_α	μ_δ
Prec.	$+0^s.0160$	$-0''.120$
Seg.	$+0.0220$	-0.020

(13)

Prec.	$-0^s.0200$	$+0''.100$
Seg.	-0.0067	$+0.100$

(14) Nuove misure: +54.556 −61.935; +54.568 −61.817.

A. Bemporad.

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Astronomische Nachrichten, Volume 254, Issue 3, 03/1934, p.40 & 41

Misure di stelle doppie eseguite nel corso dei calcoli per il Catalogo Astrografico di Catania. Da *A. Bemporad.*

Alle misure di stelle doppie rilevate dalle negative per il Catalogo Astrografico è di ostacolo, in generale, il fenomeno della irradiazione, per cui le misure stesse riescono tanto più difficili quanto più lucide sono le stelle. Mentre intorno alla 11ª grandezza, con immagini nitide, è facile risolvere doppie con distanza dell'ordine di 1″, per stelle intorno alla 9ª riesce difficile separare immagini distanti anche 3″. Malgrado questa grave limitazione del metodo fotografico ci è riuscito di separare quasi tutte le immagini di stelle doppie contenute per le zone +47° e +48° nel Catalogo di Burnham[1]). Si aggiungono le misure di 17 doppie, in generale assai deboli, non contenute nel detto catalogo.

Nell'elenco che segue ci limitiamo a riportare i dati essenziali delle misure eseguite sulle doppie in questione: le posizioni esatte delle singole componenti (RA. e Decl.) si potranno desumere dalle zone del Catalogo in corso di stampa (zone +47° e +48° fra 12^h e 18^h di RA.). I valori desunti da Burnham per confronto sono scritti in corsivo.

Burnham	α	δ	Angolo di posizio.	Distanza	Grandezze	Epoca	Lastra No.	Note
—	$12^h\ 5^m\ 3^s$	47° 9′	34°.9	5″.81	10.8, 11.3	1903.25	2107	
			32.1	5.63	10.6, 11.2	1903.25	2116	
			55.8	7.22	10.9, 11.5	1904.25	2437	
6073	12 7 19	46 52	223.2	23.64	11.2, 12.2	1904.25	2437	
			228.3	*25 ±*	*9.10, 10*	*1830 +*		
9001	12 24 37	47 35	130.4	20.74	11.9, 12.2	1902.30	1539	
			133.7	20.65	11.7, 12.1	1903.23	2034	
			134.3	20.05	11.8, 12.3	1904.27	2390	
6321	12 52 10	46 9	352.8	12.60	8.9, 10.3	1902.33	1545	
			353.6	*13.08*	*7.5, 8.2*	*1846.73*		
6327	12 53 7	48 0	132.0	17.44	9.7, 12.1	1901.25	1355	
			132.0	17.72	10.3, 12.2	1902.33	1545	
			135.5	*16 ±*	*9.10, 11*	*1830 +*		
9002	13 6 13	47 6	218.6	6.12	11.9, 12.0	1902.30	1536	dd
			222.3	9.05	11.6, 11.7	1903.23	2028	
6597	13 37 40	46 43	202.5	7.11	9.2, 9.6	1902.33	1546	
			200.2	*7.33*	*8.0, 8.0*	*1832.09*		
6628	13 42 5	45 54	155.8	20.59	10.5, 12.4	1904.41	2471	
			161.7	*25*	*9.10, 11*	*1830 +*		
6704	13 57 3	46 54	293.1	25.45	11.4, 11.8	1904.40	2469	
			290.8	*30 ±*	*9, 10.11*			
6710	13 58 31	46 49	12.1	3.13	10.4, 10.6	1904.40	2469	
			6.7	*2.44*	*9.0, 9.0*	*1889.39*		
6739	14 5 1	46 36	203.8	4.00	9.5, 12.0	1902.38	1588	
			196.7	*4.14*	*8.5, 11.7*	*1832.14*		
6789	14 11 24	47 26	316.0	4.22	8.7, 9.9	1904.40	2426	
			318.6	3.78	9.5, 10.0	1907.38	2689	
			315.1	*4.43*	*8.9, 9.2*	*1832.11*		
6854	$14^h\ 19^m\ 8^s$	46° 50′	86°.7	5″.00	10.9, 11.0	1904.40	2468	
			88.5	4.70	11.1, 11.4	1907.38	2689	
			266.0	*3 ±*	*11, 11*	*1830 +*		
9003	14 24 21	46 29	231.6	7.03	12.3, 12.3	1904.40	2468	
9004	14 30 11	47 34	135.6	21.63	11.7, 12.1	1898.33	590	
			136.5	21.22	11.8, 12.3	1904.40	2468	
7103	14 57 14	47 40	155.8	36.37	7.1, 9.8	1902.44	1573	
			157.6	35.20	6.6, 9.6	1902.38	1591	
			156.6	*35.51*	*6.1, 8.6*	*1867.12*		
7158	15 7 27	47 14	288.8	18.19	9.8, 10.3	1902.46	1584	
			289.7	18.49	9.9, 10.3	1904.40	2467	
			291.1	*19.01*	*8.5, 8.5*	*1830.63*		
7176	15 9 34	47 12	132.2	18.98	11.7, 12.0	1902.45	1596	
			133.7	18.69	11.5, 12.6	1902.46	1584	
			128.7	18.43	11.1, 12.2	1904.41	2467	
			148.4	*14 ±*	*10, 11*	*1830 +*		
—	15 16 35	46 24	37.5	3.82	10.4, 10.8	1902.45	1596	
9005	15 22 32	46 5	217.8	15.43	12.0, 12.0	1904.46	2526	
7281	15 23 35	46 30	316.6	1.54	10.2, 10.5	1904.46	2526	dd
			332.3	*3.16*	*9.5, 9.9*	*1901.38*		
7287	15 24 50	46 33	258.0	2.00	11.2, 11.4	1904.46	2526	
			340.0	*2.88*	*7.5, 9*	*1900.71*		7ᵐ5?
—	15 26 47	46 38	83.8	4.34	10.5, 10.8	1904.46	2526	
9006	15 48 32	46 32	177.8	7.46	12.2, 12.2	1902.50	1641	dd
			191.7	9.38	11.5, 11.9	1903.50	2096	
7508	16 2 37	47 56	284.3	22.01	10.5, 10.7	1903.51	2161	
			285.2	22.22	10.7, 10.9	1904.51	2511	
			284.4	*21.42*	*9.1, 9.2*	*1900.41*		
9007	16 6 4	46 49	320.1	12.35	12.6, 12.7	1904.51	2511	
9008	16 6 43	46 39	248.3	19.01	12.0, 12.7	1904.51	2511	
7543	16 7 36	48 4	202.3	17.65	8.1, 11.7	1897.48	354	
			201.9	16.69	8.2, 12.0	1904.51	2511	
			201.4	*17.77*	*7.2, 10.2*	*1851.73*		
9009	16 9 9	47 3	284.2	12.01	12.0, 12.5	1897.48	354	
			282.1	11.75	12.0, 12.6	1899.42	957	
			286.7	11.20	11.9, 12.4	1904.51	2511	
7686	16 31 2	47 29	253.1	4.29	9.1, 9.1	1901.53	1384	
			242.8	7.04	10.0, 9.8	1902.44	1571	
			249.7	4.54	9.0, 9.3	1903.48	2141	
			257.1	*5.46*	*8.3, 8.3*	*1830.43*		
7695	16 32 43	47 53	180.0	3.99	10.2, 11.2	1901.53	1384	
			180.9	4.31	9.9, 11.4	1903.48	2141	
			184.6	*5.05*	*8.6, 9.7*	*1830.83*		
—	16 40 11	47 46	84.5	21.23	11.5, 11.9	1901.53	1384	
			84.1	20.97	10.7, 11.6	1902.45	1593	
			84.6	20.84	11.4, 11.8	1902.47	1624	

[1]) A general catalogue of double stars. Carnegie Institution of Washington, 1906.

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Note: A translation of the preface to the table above is included in the body of this article.

Azeglio Bemporad and the “BEM” Double Stars

Astronomische Nachrichten, Volume 244, Issue 18, Nr. 5850, 02/1932. p.355 & 356

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	Burnham	α	δ	Angolo di posizio.	Distanza	Grandezze	Epoca	Lastra No.	Note
9010		17h 0m 5s	46° 51′	252°.4	18″.63	11.7, 11.8	1899.56	992	
				251.0	18.65	11.2, 11.2	1901.56	1378	
	7873	17 2 18	47 6	91.4	7.46	9.4, 12.1	1899.56	992	
				92.2	6.82	9.8, 12.1	1902.46	1631	
				111.3	*6.91*	*7.4, 10.5*	*1848.44*		
	—	17 5 35	47 4	97.8	15.41	11.6, 12.3	1899.56	992	
				94.3	14.78	12.3, 12.8	1902.46	1631	
				96.8	14.77	12.1, 12.7	1902.52	1665	
	8009	17 21 0	47 22	10.8	9.04	9.0, 10.6	1901.52	1381	
				11.9	11.22	8.9, 10.0	1902.52	1684	
				11.5	9.06	8.7, 10.0	1903.48	2122	
				16.5	*8.82*	*7.8, 9.3*	*1829.46*		
9011		17 24 0	47 32	27.9	10.84	12.9, 12.9	1903.48	2122	
	8040	17h 25m 0s	46° 30′	140°.2	2″.33	9.3, 10.6	1903.48	2122	
				133.7	*3.15*	*8.5, 10.0*	*1831.46*		
	8046	17 25 15	46 22	183.7	7.85	11.5, 12.1	1903.48	2122	
				183.8	*7.58*	*9.2, 9.7*	*1879.34*		
	8073	17 30 9	47 57	99.3	20.67	7.4, 12.3	1902.50	1714	
				98.3	20.56	7.6, 12.8	1903.48	2122	
				100.2	21.50	8.1, 12.6	1903.48	2138	
				100.0	*21.07*	*7.9, 10.3*	*1901.39*		
9012		17 48 54	47 20	130.8	4.08	12.4, 12.5	1901.50	1571	
				154.5	3.87	12.6, 12.7	1901.50	1372	dd
				139.9	4.20	12.7, 12.8	1902.54	2510	
	—	17 49 25	46 58	220.3	6.14	10.3, 12.1	1901.50	1371	
				233.0	6.63	9.8, 12.2	1901.50	1372	
				224.6	6.34	9.9, 12.4	1902.54	2510	

Napoli, R. Osservatorio astronomico di Capodimonte, 1931 Ott. 31.

A. Bemporad.

Azeglio Bemporad and the "BEM" Double Stars

Astronomische Nachrichten, Volume 246, Issue 2, Nr. 5882, 1932, p.23 & 24

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Misure di stelle doppie eseguite nel corso dei calcoli per il Catalogo Astrografico di Catania. Da *A. Bemporad.*

Con riferimento alla precedente comunicazione col medesimo titolo in AN **244**, Nr. 5850 ci limitiamo a riportare nell'elenco seguente le coordinate approssimate e gli elementi ricavati per No. 34 doppie rinvenute nei volumi in corso di stampa del Catalogo Astrografico (da +48° a +52°).

Burnham	α	δ	Angolo di posizio.	Distanze	Grandezze	Epoca	Lastra No.	Note
6068	12h 6m 41s	51° 23′.6	206°.2	11″.75	8m.2, 10m.7	1900.31	1169	
			208.3	11.32	8.2, 11.0	1904.38	2480	md
			206.2	11.32	8.5, 10.6	1905.33	2605	
			206.3	*10.81*	*7.7, 9.5*	*1831.90*		Σ2
6140	12 16 24	51 31.9	140.7	25.27	10.7, 11.0	1900.31	1169	
			138.1	25.62	11.1, 11.2	1904.38	2483	
			144.7	*18 ±*	*9, 10*	*1830 +*		H
6268	12 41 24	50 22.2	208.3	6.22	10.0, 10.4	1899.32	923	
			209.8	5.01	9.7, 10.1	1904.28	2383	
			211.1	5.52	9.8, 10.5	1904.30	2431	
			208.3	*5.52*	*8.5, 9.0*	*1832.05*		Σ3
6383	13 1 8	51 31.4	272.0	13.18	9.9, 10.2	1899.26	918	
			272.8	13.45	10.0, 10.3	1904.28	2439	
			272.6	13.32	9.7, 9.9	1906.40	2637	
			272.4	*13.12*	*8.5, 9.0*	*1831.50*		Σ2
6401	13 3 39	49 38.7	177.5	9.08	11.0, 11.6	1904.34	2441	
			178.6	9.06	11.1, 11.7	1904.39	2425	
			179.4	*8 ±*	*10 , 11*	*1830 +*		H
6446	13 12 23	51 5.9	139.3	2.65	9.8, 10.1	1903.22	2114	md
			141.9	1.79	9.6, 9.8	1904.28	2439	
			133.0	*2.26*	*7.7, 8.5*	*1846.83*		OΣ3
6495	13 23 32	48 16.9	346.7	14.89	10.0, 10.4	1898.39	612	
			347.1	14.53	10.2, 10.3	1902.38	1590	
			344.7	15.67	10.3, 10.5	1904.36	2415	
			346.5	*14.98*	*8.2, 9.5*	*1831.50*		Σ2
6527	13 28 45	49 39.3	309.8	6.31	9.3, 9.4	1904.36	2415	md
			312.5	5.36	9.4, 9.7	1905.31	2597	
			311.4	*4.21*	*8.0, 8.2*	*1832.14*		Σ3
6554	13 31 35	50 10.1	193.5	2.66	9.4, 10.1	1902.22	2112	md
			201.5	2.20	9.9, 10.2	1905.33	2602	
			9.2	*3.17*	*8.9, 9.1*	*1902.30*		Es4
6570	13 33 40	48 45.3	3.4	13.79	11.0, 11.4	1902.30	1534	
			5.4	13.83	11.1, 11.3	1904.36	2415	
			6.6	*8 ±*	*11 = 11*	*1830 +*		H
6573	13 33 42	51 13.4	110.7	2.73	8.6, 7.9	1902.22	2112	
			121.0	*1.79*	*6.4, 7.9*	*1831.80*		Σ4
6589	13 36 25	51 1.5	136.1	17.04	7.0, 11.4	1902.22	2112	
			137.3	17.73	7.1, 11.4	1904.28	2447	
			137.0	17.93	6.9, 11.7	1904.41	2478	
			134.2	*17.93*	*6.7, 10*	*1879.26*		β1
6738	14 4 58	48 58.8	170.3	13.47	10.4, 11.2	1902.35	1552	
			174.9	12.71	10.4, 11.4	1904.36	2413	
			175.0	12.93	10.3, 11.2	1904.40	2426	
			173.5	*13.19*	*9.0, 10.0*	*1831.76*		Σ3
6754	14h 7m 22s	50° 43′.2	258°.6	11″.33	9m.6, 10m.4	1905.33	2600	1)
			259.6	11.43	10.2, 10.5	1924.41	4004	
			256.2	*11.03*	*8.5, 9.0*	*1831.54*		Σ2
—	14 27 33	48 34.1	316.5	6.52	11.2, 11.4	1898.33	590	
			317.9	6.56	11.2, 11.4	1904.43	2532	
—	14 33 56	48 9.1	7.7	4.82	10.4, 12.1	1898.33	590	
			4.7	2.72	10.5, 12.0	1904.43	2532	
9013	14 37 17	49 53.3	323.4	5.15	11.1, 11.7	1897.33	319	
			322.1	6.23	11.5, 12.0	1905.44	2617	
7063	14 51 30	51 2.7	138.8	25.94	10.2, 10.8	1904.28	2474	
			138.9	25.43	10.0, 10.5	1907.46	2694	
			139.0	*25.03*	*9.1, 9.4*	*1900.43*		Es2
7299	15 26 12	48 3.4	127.2	10.66	6.6, 11.7	1899.43	975	
			128.5	*10.74*	*6.5, 12.5*	*1879.28*		β2
7499	16 1 11	49 13.8	254.0	8.22	10.6, 10.8	1903.47	2125	
			256.5	8.09	10.9, 11.1	1903.51	2111	
			254.8	*8.19*	*9.3, 9.4*	*1900.38*		Es3
7508	16 2 39	47 55.6	284.6	22.03	10.7, 10.9	1903.51	2111	2)
			284.4	*21.42*	*9.1, 9.2*	*1900.41*		Es2
9014	16 25 45	48 32.2	102.0	12.31	11.3, 12.2	1902.45	1595	
			102.7	12.25	11.1, 12.1	1903.48	2120	
			103.7	12.03	11.4, 12.0	1903.48	2141	
7714	16 35 49	49 3.6	91.6	23.29	7.2, 10.7	1902.46	1611	
			91.6	24.18	7.2, 11.0	1902.46	1632	
			91.8	24.65	6.8, 10.6	1903.48	2120	
			92.3	*22.39*	*4.0, 10.7*	*1828.43*		Σ3
7752	16 41 9	50 51.1	296.7	24.65	9.6, 12.0	1897.48	355	
			294.1	23.68	9.0, 11.0	1902.46	1632	
			294.5	23.22	9.7, 11.4	1902.56	1706	
			295.7	*22.88*	*8 , 10*	*1900.46*		Es2
28	17 36 15	49 25.9	350.8	2.50	11.8, 12.3	1902.51	1692	
			345.7	1.46	12.3, 12.4	1902.50	1715	
8139	17 39 37	49 2.9	117.6	3.57	9.8, 11.1	1902.50	1715	
			121.9	*2.97*	*8.5, 10.0*	*1831.73*		Σ4
9015	17 41 0	51 23.8	277.1	12.39	12.5, 12.6	1931.53	4054	
8167	17 42 30	51 57.7	308.9	9.57	—, —	1902.51	1693	
			308.1	9.29	—, —	1902.60	1752	
			307.1	8.57	10.9, 11.4	1931.53	4054	
			319.4	*9.07*	*8.9, 9.2*	*1830.25*		Σ4
8175	17 43 25	50 13.3	343.2	6.72	9.8, 11.4	1902.59	1784	
			346.3	5.30	9.4, 10.5	1931.53	4054	
			342.0	*6.13*	*7.7, 9.7*	*1830.46*		Σ3
—	17 44 20	50 49.0	113.8	8.44	13.1, 13.2	1931.53	4054	
—	17 46 49	50 13.0	356.4	2.76	11.4, 11.6	1902.59	1784	
			343.5	3.32	10.9, 11.1	1931.53	4054	
9016	17 47 39	50 41.6	196.0	4.92	12.5, 12.8	1931.53	4054	
—	17 47 40	51 4.8	341.3	8.51	10.9, 12.9	1931.53	4054	
8247	17 52 2	49 39.0	27.2	15.10	9.5, 12.3	1902.51	1701	
			25.9	15.05	9.8, 12.1	1902.59	1784	
			32.5	*14.41*	*8.2, 11.2*	*1830.43*		Σ3

1) Doppia fisica: Prec. μ_α −0s.0372 μ_δ +0″.111
Seg. −0.0356 +0.100

2) Cfr. AN **240**, Nr. 5850.

Napoli, R. Osservatorio astronomico di Capodimonte, 1932 Juni 20.

A. Bemporad.

Astronomische Nachrichten, Volume 248, Issue 2, Nr. 5930, 02/1933, p.29-32

29 5930 30

Misure di stelle doppie

eseguite nel corso dei calcoli per il Catalogo Astrografico di Catania. Da *A. Bemporad.*

Con riferimento alle precedenti comunicazioni col medesimo titolo in AN **244**. Nr. 5850, e AN **246**, Nr. 5882, comunichiamo le coordinate approssimate (1900.0) e gli elementi ricavati per Nr. 40 doppie rinvenute nei volumi in corso di stampa del Catalogo Astrografico (da +48° a +54°). Sono segnati in corsivo gli elementi desunti da *Burnham*.

Burnham	α	δ	Angolo di posiz.	Distanza	Grandezze	Epoca	Lastra No.	Note
5988	11h54m40s	53°37'.3	29°.8	0".89	9m1, 9m5	1899.32	928	dd
			10.9	*0.72*	*7.8, 8.8*	*1846.04*		OΣ 3
6025	12 0 29	52 29.3	92.2	8.17	8.6, 8.8	1901.33	1351	
			94.3	8.01	8.4, 8.6	1904.36	2417	
			93.4	7.60	8.0, 8.2	1904.38	2480	
			93.2	*7.63*	*7.0, 8.0*	*1832.35*		Σ 4
6026	12 0 30	53 25.9	307.3	2.00	8.9, 8.6	1899.32	928	
			311.7	3.68	9.5, 8.8	1904.36	2417	
			319.0	*3.31*	*9.2, 7.2*	*1850.13*		OΣ 4
6064	12 6 28	53 58.7	223.4	12.25	9.3, 9.1	1899.32	925	
			221.1	12.44	9.1, 8.9	1899.32	928	
			219.5	12.29	8.9, 8.8	1904.36	2417	
			223.9	*10.59*	*7.7, 7.5*	*1832.04*		Σ 3
—	12 26 5	54 24.7	183.9	8.80	11.9, 10.6	1907.38	2690	
BEM2	12 49 47	53 24.0	267.7	4.23	12.5, 11.9	1928.38	4029	
6451	13 14 17	54 51.6	332.1	25.26	10.9, 10.2	1904.41	2477	
			345.4	*25:*	*9+, 9*	*1830+*		H
—	13 15 26	54 55.2	289.4	7.13	11.9, 11.7	1904.41	2477	
9017	13 16 22	54 50.7	211.4	13.74	11.6, 11.4	»	»	
—	13 17 12	53 52.9	210.0	5.27	11.4, 10.5	1904.39	2409	
			213.6	6.06	11.5, 10.2	1904.40	2398	
			206.9	5.59	11.4, 10.2	1904.41	2477	
—	13 17 54	51 53.5	168.5	6.15	11.3, 11.7	1903.22	2114	
			172.8	6.39	11.3, 11.8	1904.26	2401	
			170.0	5.55	11.2, 11.7	1904.39	2420	
			170.3	6.18	11.4, 11.6	1904.39	2409	
BEM5	13 21 35	52 57.5	229.9	8.85	12.0, 11.9	1904.35	2401	dd
			220.5	10.12	11.7, 11.2	1904.39	2409	
BEM6	13 29 51	54 48.8	190.7	7.05	11.2, 10.6	1904.40	2398	
6797	14 11 50	50 54.3	152.5	5.62	7.8, 8.8	1905.23	2608	
			157.0	5.50	8.3, 9.0	1905.33	2600	
			161.5	5.65	8.3, 9.3	1924.41	4004	
			150.3	*5.30*	*7.7, 8.2*	*1831.11*		Σ 3
9018	14 15 33	52 1.1	30.8	15.92	10.7, 11.6	1904.39	2406	
			33.6	16.09	10.8, 11.6	1905.23	2608	
			32.1	16.16	10.5, 11.4	1905.40	2612	
6836	14 16 56 A e B	52 8.7	51.0	1.54	10.2, 10.9	1904.39	2406	dd
			59.2	1.44	10.4, 11.2	1905.40	2612	dd
			47.3	*1.71*	*9.0, 10.3*	*1902.18*		β 2
6836	14 16 56 A e C	52 8.7	170.4	41.31	10.2, 9.9	1904.39	2406	
			171.8	41.42	10.3, 9.6	1904.43	2533	
			170.7	41.05	10.4, 9.8	1905.40	2612	
			170.3	*40.84*	*9.0, 9.0*	*1902.18*		β 2
9019	14h20m 7s	52° 32'.2	16°.8	14".10	10m7, 11m5	1904.39	2406	
			14.3	14.13	10.9, 11.5	1904.43	2553	
9020	15 6 14	53 19.9	354.5	12.79	11.6, 11.5	1904.42	2464	
			355.4	13.05	11.8, 11.7	1904.48	2513	
			357.9	13.28	11.4, 11.3	1905.40	2610	
BEM18	15 15 39	52 20.8	15.1	8.65	10.7, 11.6	1904.49	2517	
			15.5	8.65	10.7, 11.0	1904.49	2519	
—	15 15 55	53 55.4	30.8	3.02	9.8, 10.5	1904.48	2513	dd
			24.2	2.72	10.0, 11.1	1904.49	2517	
—	15 16 56	53 6.6	237.5	9.53	11.5, 10.0	1903.50	2109	
			235.8	9.82	11.3, 10.0	1904.48	2513	
			233.5	9.25	11.4, 9.7	1904.49	2517	
—	15 35 42	52 53.8	207.5	5.84	11.6, 11.1	1902.46	1622	
			210.2	5.96	11.6, 11.2	1902.50	1647	
			220.8	6.34	11.4, 11.0	1904.45	2528	
			220.8	5.81	11.7, 11.0	1904.48	2514	[1])
—	15 42 57	54 0.9	131.1	4.85	11.5, 11.6	1902.50	1647	
			128.1	5.76	11.7, 12.0	1903.51	2110	dd
			126.0	5.45	11.7, 12.1	1904.48	2514	dd
—	15 44 22	53 55.8	82.2	3.81	9.6, 9.8	1903.51	2110	[2])
7428	15 48 33	53 12.4	264.7	6.70	9.4, 6.8	1903.51	2110	dd
			266.3	7.74	9.6, 7.0	1904.48	2514	dd
			258.3	7.25	10.2, 6.5	1904.49	2516	dd
			273.8	*6.53*	*8.5, 6.2*	*1836.72*		Σ 4
7428½	15 49 22	52 51.8	251.1	9.50	9.0, 9.8	1902.46	1629	[3])
			251.4	10.02	9.6, 9.4	1903.51	2110	
			253.6	9.36	9.6, 9.5	1904.48	2514	
			254.3	9.71	9.5, 9.5	1904.49	2516	
			255.2	*9.30*	*8.9, 8.8*	*1900.37*		Es 2
—	15 52 47	53 10.6	339.8	3.95	11.6, 11.2	1902.38	1568	dd
			322.9	3.86	11.7, 11.2	1903.51	2110	
			327.6	5.02	11.3, 10.8	1904.49	2516	
—	16 15 59	51 34.3	287.0	11.98	11.4, 10.5	1903.50	2134	
			286.1	12.54	11.5, 10.6	1904.50	2523	
7595	16 17 7	51 48.5	232.6	3.47	11.4, 10.5	1902.46	1634	
			217.8	3.95	11.5, 10.4	1903.49	2134	
			228.7	3.24	11.0, 10.5	1904.50	2523	
			224.2	*4.16*	*12.5, 8.5*	*1904.31*		Hu 2
9021	16 23 45	51 0.9	32.7	17.85	11.0, 12.2	1897.51	379	
			36.9	18.57	11.0, 12.3	1902.49	1626	
			35.0	17.45	10.8, 12.5	1903.49	2134	
7702	16 33 49 (16 e 17 Drac.)	53 6.1	13.9	91.29	5.8, 5.6	1902.50	1645	
			13.8	91.15	5.8, 5.5	1904.45	2518	
			14.7	*90.42*	*5.0, 5.0*	*1833.39*		Σ 6
7703	16 33 52 (17 Drac.)	53 7.5	121.3	3.64	5.7, 6.6	1902.50	1645	
			122.1	3.93	5.5, 6.5	1904.45	2518	
			116.5	*3.74*	*5.0, 6.0*	*1831.91*		Σ 7
BEM22	16 39 51	52 46.6	104.5	7.80	11.5, 11.8	1897.50	374	
			105.0	7.52	11.6, 11.8	1902.50	1720	

[1]) Dal confronto fra i primi due osservazioni e i seguenti appare un forte spostamento angolare che si concilierebbe coll'ipotesi di un moto di rivoluzione con periodo di circa 60 anni.

[2]) Quattro osservazioni gentilmente comunicate dal sig. *W. Milburn* di Tow Law per incarico del Direttore Rev. *T. H. Espin* danno i valori medi 83°.8, 3".38.

[3]) La precedente in qualche lastra appare diffusa. Spettro? Variabile?

31 5930 32

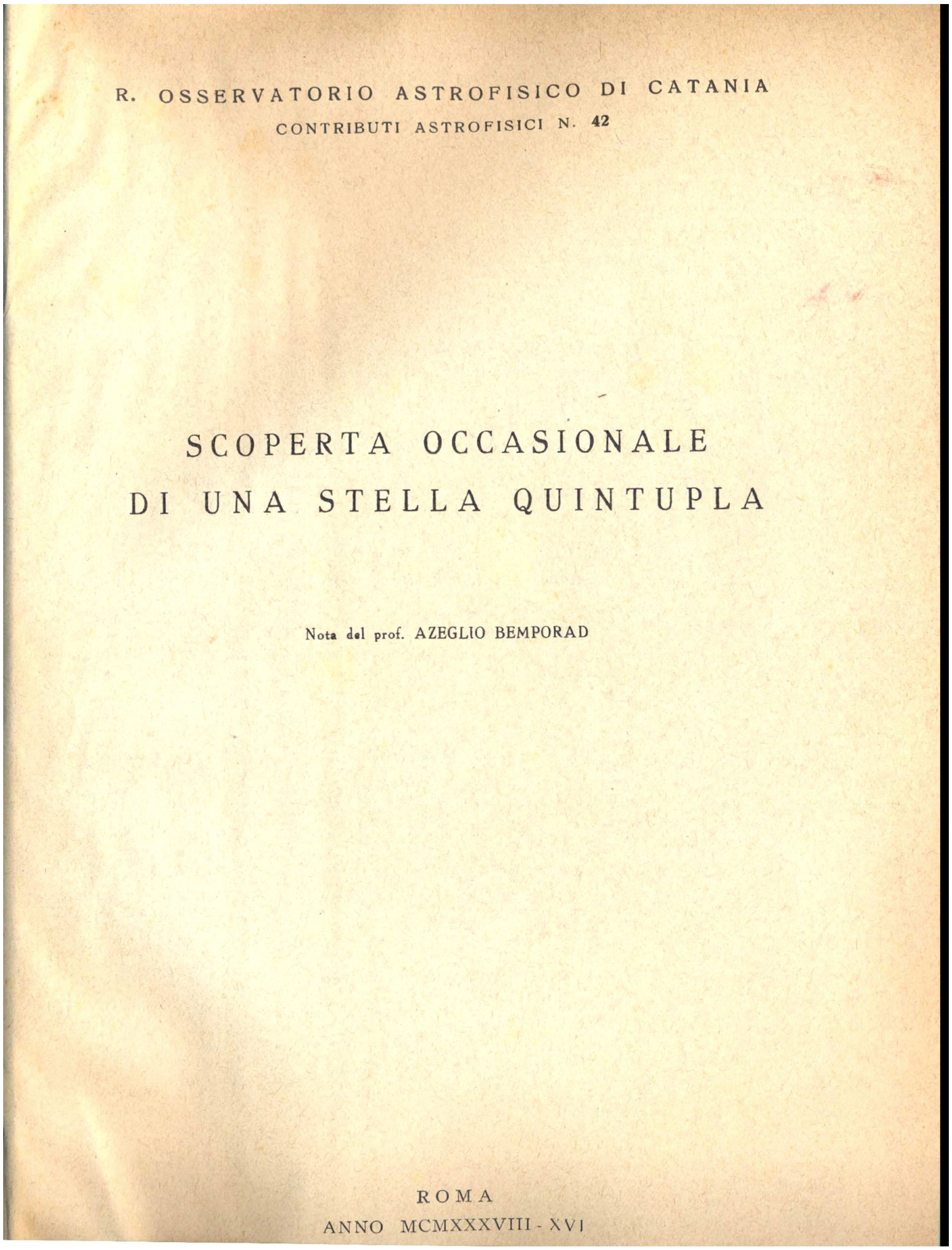
Burnham	α	δ	Angolo di posiz.	Distanza	Grandezze	Epoca	Lastra No.	Note
7796	16h49m 6s	53°57'.1	197°.1	7".57	12m5, 9m3	1902.47	1627	
			203.1	7.00	12.0, 9.4	1902.49	1619	
			197.2	*7.12*	*10.2, 8.6*	*1902.37*		β 2
9022	16 53 6	53 1.5	273.8	12.05	12.4, 12.2	1902.47	1627	
9023	17 29 12	52 26.1	64.2	13.61	11.8, 12.5	1902.47	1640	
			62.2	14.39	11.9, 12.3	1902.47	1623	
—	17h29m42s	53°53'.0	204°.8	12".88	12m0, 11m7	1902.47	1640	
			207.5	13.14	12.1, 11.8	1902.48	1618	
9024	17 46 47	49 6.2	241.3	12.81	12.7, 12.2	1902.50	1715	
			238.2	12.49	12.7, 12.4	1904.58	2510	
BEM29	17 46 47	48 24.3	148.6	2.84	10.7, 12.5	1902.50	1715	dd
			142.5	4.17	10.3, 12.8	1902.58	2510	

Napoli, Capodimonte, 1932 Dic. 18.

A. Bemporad.

Azeglio Bemporad and the "BEM" Double Stars

Contributi Astrofisici No. 42, 1938



R. OSSERVATORIO ASTROFISICO DI CATANIA

CONTRIBUTI ASTROFISICI N. 42

SCOPERTA OCCASIONALE
DI UNA STELLA QUINTUPLA

Nota del prof. AZEGLIO BEMPORAD

ROMA
ANNO MCMXXXVIII - XVI

Azeglio Bemporad and the "BEM" Double Stars

Riassunto: Su due lastre esposte per soli 5 o 6 minuti è stata misurata una stella quintupla, l'unica riscontrata finora nel corso dei lavori del Catalogo Astrografico che datano da 40 anni e sono ormai prossimi al termine con 350.000 posizioni stampate.

Ognuno sa che le stelle doppie non sono un fenomeno molto frequente. Il grande catalogo di Aitken (1), che si spinge fin oltre la 14ª grandezza e si estende dal Polo Nord fino a 120° di distanza polare, non contiene che circa 17000 stelle doppie o multiple. Una statistica da me compilata su circa 10000 stelle contenute nel vol. III, parte 8ª del Catalogo Astrografico di Catania ha accertato l'esistenza di 129 stelle doppie, vale a dire appena l'1,3 % del numero delle stelle semplici, nella zona fra 21^h e 24^h A. R. fra i paralleli + 48° e + 50° di Decl. fino alla grandezza 12 +. Le stelle triple fra queste 10000 stelle si contano addirittura sulle dita (2). Assolutamente eccezionale è dunque il ritrovamento di una stella quintupla su lastre con soli 5 minuti di posa, come sono in generale quelle del Catalogo di Catania, e vale la pena di dar conto delle circostanze che hanno condotto alla scoperta.

Nel corso della revisione delle bozze del vol. II parte 8ª, e precisamente nella compilazione delle note sulle stelle doppie contenute nella lastra n. 752 (21^h 40^m, + 48°) mi è venuta sott'occhio una coppia di stelle *fuori quadrato* (3) costituenti una doppia piuttosto larga della quale, a causa appunto della posizione sfavorevole, non erano stati ancora determinati gli elementi. Guardando più attentamente ho notato presso la stella minore una traccia più debole che, mancando della seconda immagine (4), poteva venir ritenuta come dubbia o illusoria, anzichè come corrispondente ad una stella reale. Solo una seconda lastra poteva decidere in merito e questa fu la

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(1) « New general Catalogue of double stars... », Vol. I and II. Washington, 1932.

(2) Nel vol. IV, parte 8ª su 11265 stelle vennero riscontrate solo 7 stelle triple.

(3) Nel linguaggio corrente dei calcolatori dell'Osservatorio di Catania si chiamano stelle fuori quadrato quelle esterne al perimetro del reticolato di riferimento, tali cioè che una delle coordinate *x*, *y* misuri più di 65 mm. E' ovvio che queste stelle si presentano sempre con immagine allungata e spesso deformata dalle varie aberrazioni dell'obiettivo. Lo scrivente ritiene utile tuttavia estendere misure e calcoli anche alle immagini comprese nella fascia di 3 mm. intorno al perimetro, in quanto possono confermare o smentire circostanze emergenti da stelle contenute in posizione favorevole in altre lastre. L'utilità di questa estensione delle misure non poteva venir meglio dimostrata che con la scoperta di questa quintupla.

(4) Per distinguere le immagini stellari da quelle causate da difetti di sviluppo si è divisato di eseguire su ciascuna lastra una seconda posa di 2 minuti e mezzo a distanza conveniente (20″) dall'immagine principale. Quando una stella è al limite di visibilità, la seconda posa di solito diviene impercettibile.

Azeglio Bemporad and the "BEM" Double Stars

L. 1810, dove la doppia in questione compariva vicina al centro. A prima vista venne confermata l'esistenza della tripla, ma un esame più accurato nei paraggi di questa rivelò l'esistenza di altre due stelle satelliti, subito confermata dalla predetta L. 752 non che da altre lastre più recenti non ancora sottoposte a misura. I risultati abbastanza concordanti delle misure subito eseguite sulle due lastre in questione vengono qui riepilogati. Questa è la prima quintupla che sia mai stata osservata nel corso dei calcoli per il Catalogo Astrografico di Catania iniziati circa 40 anni addietro e comprendenti ormai 350000 posizioni stellari stampate.

La lastra N. 752 ($21^h 40^m$, $+ 48^0$) fotografata il 29 agosto 1898, con 6 minuti di posa, ha dato i seguenti risultati:

Stella	*x*	*y*	*D*	*Gr*	*α* (1900)	*δ*
a . .	— 66'.2785	— 46'.9095	8	11.6	$21^h33^m29^s.922$	47°12'28".89
b . .	— 66'.1682	— 46'.9533	1	12.7	$21^h33^m30^s.575$	47°12'26".41
c . .	— 66'.1387	— 47'.1360	16	10.3	$21^h33^m30^s.772$	47°12'15".49
d . .	— 66'.0778	— 46'.6905	1	12.7	$21^h33^m31^s.074$	47°12'42".23
e . .	— 65'.7645	— 47'.3639	1	12.7	$21^h33^m33^s.002$	47°12' 3".32

Coppia	*ab*	*cd*	*ce*	*ca*
Distanza	7".10	26".92	26".27	15".96
Angolo di posizione . . .	110°.4	6°.6	120°.1	327°.1

La lastra N. 1810 ($21^h 35^m$, $+ 47^0$) fotografata il 10 settembre 1902, con 5 minuti di posa, ha dato corrispondentemente:

Stella	*x*	*y*	*D*	*Gr*	*α* (1900)	*δ*
a . .	— 15'.4045	+ 12'.6128	12	11.3	$21^h33^m30^s.114$	47°12'29".28
b . .	— 15'.2896	+ 12'.5604	1	12.2	$21^h33^m30^s.791$	47°12'26".16
c . .	— 15'.2698	+ 12'.3858	17	10.3	$21^h33^m30^s.911$	47°12'15".69
d . .	— 15'.2026	+ 12'.8086	1	12.2	$21^h33^m31^s.298$	47°12'41".05
e . .	— 14'.9079	+ 12'.1600	1	12.2	$21^h33^m33^s.044$	47°12' 1".96

Coppia	*ab*	*cd*	*ce*	*ca*
Distanza	7".57	25".67	25".72	15".83
Angolo di posizione . . .	114°.3	8°.8	122°.3	329°.1

Una ripetizione della L. 1810 con 10^m di posa è già predisposta per ottenere migliori elementi di queste coppie, dato che da stelle fuori quadrato e al limite di visibialità non è certo possibile ottenere risultati sicuri.

Azeglio Bemporad and the "BEM" Double Stars

The following is a translation of the plates shown on pages 359-361.

The Occasion of the Discovery of a Quintuple Star

Summary: On two plates exposed for only 5 or 6 minutes was measured a quintuple star, the only detected so far in the course of the Astrographic Catalog work dating for 40 years which is now coming to an end with 350,000 printed positions.

Everyone knows that double stars are not a very frequent phenomenon; the largest catalog of Aitken (1), which goes far beyond magnitude 14 and extends from the North Pole up to 12° polar distance, only contains about 17,000 double or multiple stars. A statistic compiled by me on about 10,000 stars contained in vol. III, part 8 of Astrographic Catalog of Catania has established the existence of 129 double stars, ie only 1.3% of the number of single stars in area of 21h to 24h RA between parallel +48d and +50° Dec up to magnitude 12+. The number of triple stars among the10,000 stars can be counted on the fingers (2). Absolutely outstanding is finding a quintuple star on plates with just 5 minutes of exposure which was generally used for the Catania Catalog and it is worth giving an account of the circumstances that led to the discovery.

In the review of the drafts of vol. II Part 8, namely the compilation of the notes for double stars contained on Plate No. 752 (21h 40m, + 48°) my eye fell on a pair of stars on the edge of the grid (3) constituting a rather large double which, precisely because of the unfavorable position, elements had not yet been determined. On closer inspection I noticed that for a minor star its corresponding image in the second exposure was missing (4), so it could be considered as doubtful or illusory, instead of corresponding to a real star.

Only a second plate (Plate 1810) could clarify the situation, where the double in question appeared near the center. At first glance it confirmed the existence of the triple, but upon closer examination in the neighborhood revealed the existence of two other satellite stars, also present in the aforementioned Plate 752 and by two more recent plates still to be measured. The fairly consistent results of the measures from the two plates are summarized here. This is the first quintuple that has been observed in the course of the calculations for the Astrographic Catalog of Catania begun about 10 years ago which now contains the positions of 350,000 stars.

Plate No. 752 (21h 40m, + 48°) photographed on August 29, 1898, with 6 minutes exposure, gave the following results:

See top table on page 361.

Plate No. 1810 (21h 35m, + 47°) photographed on September 10, 1902, with five minutes of exposure, gives correspondingly:

See bottom table on page 361.

A repeat of Plate 1810 with 10m exposure was made so as to get the best data for these pairs, since it is not possible to get reliable results when the stars are deformed and at the limit of visibility.

(1) "New General Catalog of Double Stars", Vol I & II, Washington, 1932.

(2) In vol. IV, Part 8 of 11,265 stars only 7 triple stars were found.

(3) It is obvious that the stars there are always elongated and often deformed by the various lens aberrations. The writer believes, however, it is useful to extend measures and calculations to the range of 3 mm around the perimeter, as they can confirm the circumstances of stars contained in more favorable positions on adjacent plates. The utility of this extension of measures could not be better demonstrated than with the discovery of this quintuple.

(4) To distinguish stellar images the from those caused by defects during development it was decided to perform on each Plate a second exposure of two and a half minutes with the image offset from the original exposure at a convenient distance (20"). When a star was at the limit of visibility, the second exposure was usually nearly imperceptible.