

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Technical Memorandum 33-586

*A Technique for Computation of Star Magnitudes
Relative to an Optical Sensor*

Jack W. Rhoads

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**JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA**

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PREFACE

The work described in this report was performed by the Guidance and Control Division of the Jet Propulsion Laboratory, in support of the Mariner Mars 1971 Canopus Star Tracker Calibration and Operational Software (celestial reference) Program.

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ABSTRACT

The theory and techniques used to compute star magnitudes relative to any optical detector (such as the Mariner Mars 1971 Canopus star tracker) are described here. Results are given relative to various star detectors.

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I. INTRODUCTION

Optical sensors are used on spacecraft to provide spacecraft attitude reference information. One such sensor, a star tracker, was used by the Mariner 9 spacecraft to acquire a star (usually Canopus) for use as the spacecraft roll attitude reference. In order to determine the orientation of the spacecraft, the information telemetered from the attitude reference sensor was compared to the output of an UNIVAC 1108 computer program. This program, CELREF (celestial reference), was written to simulate the voltage output of any optical sensor relative to celestial objects which appear within its field of view. Simulation of the output of an optical sensor is dependent upon knowledge of the magnitudes of stars relative to the optical sensor.

This report discusses the techniques used to compute for CELREF usage the magnitudes of stars relative to any desired optical sensor.

II. STAR MAGNITUDES AND FLUX RATIOS RELATIVE TO A STAR DETECTOR

A star magnitude relative to some detector, such as the Canopus star tracker, is an indication of the response of the detector to the star intensity. This relationship is given by

$$D = C_D - 2.5 \log_{10} \Phi_D \quad (1)$$

where D is the magnitude of the star relative to the detector, Φ_D is the response of the detector to the star intensity, and C_D is a constant associated with the photometric system of the detector. The response of the detector to a given luminous intensity is given by

$$\Phi_D = \int_0^{\infty} f(\lambda) D(\lambda) d\lambda \quad (2)$$

where $f(\lambda)$ is the monochromatic flux at wavelength λ of the radiating star, and $D(\lambda)$ is the relative response function (sensitivity function) of the detector. The relative response function defines the spectral region over which the detector is sensitive. This function is usually defined in terms of arbitrary units as a function of wavelength ($\text{cm} \times 10^4$). See Tables 1 and 2 for the relative response of two detectors (Mariner 1971 Canopus tracker and Pioneer F star sensor).

Combining Eqs. (1) and (2), we obtain

$$D = C_D - 2.5 \log_{10} \left[\int_0^{\infty} f(\lambda) D(\lambda) d\lambda \right] \quad (3)$$

Thus the magnitude of a celestial body relative to a given detector is dependent upon that spectral region over which the detector is sensitive. The magnitude of a given star, for instance, will differ depending upon the particular instrument to which it is referenced.

If the function $f(\lambda)$ was known for each object the detector would see during a specific mission, then the detector magnitudes could be determined using Eq. (3). This information is not always available and would not be desirable even if available, owing to the time-consuming process of computing $\int_0^{\infty} f(\lambda) D(\lambda) d\lambda$ for each star. It is advantageous to determine some relationship between the detector magnitude of a star and its magnitude relative to published photometric systems such as the Johnson-Morgan (JM) UBV system. The UBV system is singled out because of the large number of stars whose magnitudes in this system have been published.

The relationship between the detector system and the Johnson-Morgan system may be expressed in two forms:

$$\Phi_D = C_1 \Phi_U + C_2 \Phi_B + C_3 \Phi_V \quad (4)$$

or

$$D - V = C_4 (B - V) + C_5 (U - B) \quad (5)$$

where the C's in Eqs. (4) and (5) are coefficients relating parameters in the Johnson-Morgan system to that of the detector system; Φ_D , Φ_U , Φ_B , and Φ_V are responses of the detector, ultraviolet (U), blue (B), and visual (V) systems. The B - V (blue magnitude - visual magnitude) and B - U (ultraviolet magnitude - blue magnitude) are the Johnson-Morgan color indices. D - V is the color index relating detector magnitude and Johnson-Morgan V magnitude (Refs. 1-3).

Eq. 2 gives the general relationship of detector response to the luminous intensity of a star and the spectral response of the detector. Thus, the Johnson-Morgan response may be given as:

$$\Phi_U = \int_0^{\infty} f(\lambda)U(\lambda)d\lambda \quad (6)$$

$$\Phi_B = \int_0^{\infty} f(\lambda)B(\lambda)d\lambda \quad (7)$$

$$\Phi_V = \int_0^{\infty} f(\lambda)V(\lambda)d\lambda \quad (8)$$

where $f(\lambda)$ is the luminous intensity of some star, and $U(\lambda)$, $B(\lambda)$ and $V(\lambda)$ are the relative response functions of the Johnson-Morgan U, B, and V detectors, respectively. Tables 3, 4, and 5 present the tabulated data for the UBV relative response functions (Ref. 1).

Considering Eq. (1), we may write the Johnson-Morgan magnitudes as:

$$U = C_U - 2.5 \log_{10} \Phi_U \quad (9)$$

$$B = C_B - 2.5 \log_{10} \Phi_B \quad (10)$$

$$V = C_V - 2.5 \log_{10} \Phi_V \quad (11)$$

where C_U , C_B , and C_V are constants relating JM detector responses to magnitude. Table 6 presents the spectral characteristics (relative luminous intensity) of the star Canopus (Ref. 1). Knowing the JM magnitude of Canopus, $U = -0.52$, $B = -0.56$ and $V = -0.72$, and performing the integration of Eqs. 6, 7, and 8, we find the values of C_U , C_B , and C_V to be

$$C_U = -30.890600 \quad (12)$$

$$C_B = -29.283269 \quad (13)$$

$$C_V = -29.998474 \quad (14)$$

A. Flux Fit

In order to determine the best set of coefficients of Eq. (4), it is necessary to investigate a large number of stars covering the whole spectrum. This is not feasible, since sufficient spectral knowledge is known only for a limited number of stars. However, if it is assumed that a star may be approximated as a black body radiating at some temperature T , the "stars" covering that portion of the spectrum which includes the region of the detector and the defining JM filters may be used to derive a "best" set of coefficients to Eq. (4). Thus, using the method of weighted least squares, the coefficients C_1 , C_2 , and C_3 may be found using the family of equations generated by a discrete set of black body temperatures (T_i , $i = 1, 2, \dots$). The family of equations is represented by

$$\int_0^\infty BB_{T_i}(\lambda)D(\lambda)d\lambda = W_i \left[C_1 \int_0^\infty BB_{T_i}(\lambda)U(\lambda)d\lambda + C_2 \int_0^\infty BB_{T_i}(\lambda)B(\lambda)d\lambda + C_3 \int_0^\infty BB_{T_i}(\lambda)V(\lambda)d\lambda \right] \quad (15)$$

where

$$BB_{T_i}(\lambda) = \frac{E_1}{(\lambda T_i)^5 \left(e^{E_2/\lambda T_i} - 1 \right)} \quad (16)$$

is the normalized Planck function at temperature T_i and

$$W_i = \int_0^\infty BB_{T_i}(\lambda)D(\lambda)d\lambda$$

serves as the weighting factor for each equation. This weight, W_i , gives more importance to those "stars" whose radiating spectral region corresponds to that of the detector.

Finally, in order to relate detector flux to detector magnitude, Eq. (1), the constant C_D is evaluated using the definition that a "star" having a black-body temperature T_S will appear to have the same magnitude relative to the detector as it has with a given JM detector. The JM detector (U, B, or V) is selected such that

$$\int_0^{\infty} D(\lambda)JM(\lambda)d\lambda \quad (17)$$

is maximum. The black-body temperature T_S is now found such that

$$\frac{1}{D_{\max}} \int_0^{\infty} BB_{T_S}(\lambda)D(\lambda)d\lambda = \frac{1}{JM_{\max}} \int_0^{\infty} BB_{T_S}(\lambda)JM(\lambda)d\lambda \quad (18)$$

where

$$D_{\max} = \max \left[\int_0^{\infty} BB_T(\lambda)D(\lambda)d\lambda \right]$$

over all T, and

$$JM_{\max} = \max \left[\int_0^{\infty} BB_T(\lambda)JM(\lambda)d\lambda \right]$$

over all T. Thus, assume that the JM magnitude selected is the Blue magnitude, which is the case for the Canopus star tracker; then

$$\begin{aligned} C_D &= D + 2.5 \log_{10} \Phi_D \\ &= (C_B - 2.5 \log_{10} \Phi_B) + 2.5 \log_{10} (C_1 \Phi_U + C_2 \Phi_B + C_3 \Phi_V) \\ &= C_B + 2.5 \log_{10} \left(C_1 \frac{\Phi_U}{\Phi_B} + C_2 + C_3 \frac{\Phi_V}{\Phi_B} \right) \end{aligned} \quad (19)$$

where

$$\Phi_U = \int_0^{\infty} BB_{T_S}(\lambda)U(\lambda)d\lambda \quad (20)$$

$$\Phi_B = \int_0^{\infty} BB_{T_S}(\lambda)B(\lambda)d\lambda \quad (21)$$

$$\Phi_V = \int_0^{\infty} BB_{T_S}(\lambda)V(\lambda)d\lambda \quad (22)$$

The magnitude of a star having the Johnson-Morgan magnitudes U, B, and V is

$$D = C_D - 2.5 \log_{10} C_1 10^{0.4(C_U-U)} + C_2 10^{0.4(C_B-U)} + C_3 10^{0.4(C_V-V)} \quad (23)$$

A parameter used primarily with star trackers or sensors to indicate the brightness of a star is a value called the "Canopus ratio" of the star. The Canopus ratio of a star is defined to be the ratio of the flux of the star relative to the detector to that of the star Canopus relative to the same detector. Thus,

$$CR = \frac{\Phi_D(\text{star})}{\Phi_D(\text{Canopus})} \quad (24)$$

Equation (24) written in terms of the solution to Eq. (4) is

$$CR = \frac{C_1 10^{0.4(C_U-U_S)} + C_2 10^{0.4(C_B-B_S)} + C_3 10^{0.4(C_V-V_S)}}{C_1 10^{0.4(C_U-U_C)} + C_2 10^{0.4(C_B-B_C)} + C_3 10^{0.4(C_V-V_C)}} \quad (25)$$

B. Color Index Fit

The solution of the coefficients to Eq. (5) is found in a manner similar to that of Eq. (4). Rewriting Eq. (5), we obtain

$$\begin{aligned} C_D - 2.5 \log_{10}(\Phi_D) - C_V + 2.5 \log_{10}(\Phi_V) = \\ C_4 C_B - 2.5 \log_{10}(\Phi_B) - C_V + 2.5 \log_{10}(\Phi_V) \\ + C_5 C_U - 2.5 \log_{10}(\Phi_U) - C_B + 2.5 \log_{10}(\Phi_B) \end{aligned} \quad (26)$$

Collecting terms, we obtain

$$C_D - C_V - 2.5 \log_{10} \left(\frac{\Phi_D}{\Phi_V} \right) = C_4 C_B - C_V - 2.5 \log_{10} \left(\frac{\Phi_B}{\Phi_V} \right) + C_5 C_U - C_B - 2.5 \log_{10} \left(\frac{\Phi_U}{\Phi_B} \right) \quad (27)$$

If a "star" has a black-body temperature T_S (as previously defined), the magnitude of the "star" relative to the detector is equal to the magnitude of the "star" relative to the appropriate Johnson-Morgan detector. The parameter C_D is found through this definition. Thus, assuming that the appropriate JM detector was the Blue, then

$$D - B = 0 \quad (28)$$

which follows

$$C_D - 2.5 \log_{10} \left(\Phi_{D T_S} \right) = C_B - 2.5 \log_{10} \left(\Phi_{B T_S} \right) \quad (29)$$

and

$$C_D = C_B - 2.5 \log_{10} \left(\frac{\Phi_{B T_S}}{\Phi_{D T_S}} \right) \quad (30)$$

By use of Eq. (15) over a sufficient range of black-body temperatures and the method of weighted least squares (see Section II-A), a "best" set of coefficients may be found for Eq. (27).

Thus

$$D = C_4(B - V) + C_5(U - B) + V$$

and

$$CR = 10^{0.4(C_D - D_S - C_D + D_C)} = 10^{0.4(D_C - D_S)}$$

III. RESULTS AND CONCLUSIONS

In order to evaluate the relative merits of Eqs. (4) and (5) to represent any detector, the following detectors were simulated (in terms of relative response functions) to determine associated sets of coefficients for Eqs. (4) and (5):

- (1) Mariner 1971 Canopus tracker (CT).
- (2) Pioneer F star sensor (SS).
- (3) Johnson-Morgan ultraviolet (U) detector.
- (4) Johnson-Morgan blue (B) detector.
- (5) Johnson-Morgan visual (V) detector.

Using the derived detector relationships to Johnson-Morgan U, B, and V magnitudes, the detector Canopus ratios and detector magnitudes were calculated for 46 brightest stars for which Johnson-Morgan U, B, and V values were available.

The results of the study are present in Tables 7 through 17. The data included in each table is defined as follows:

- Column 1: Running number.
- Column 2: Proper name of star.
- Column 3: Star designation, see Tables 18 and 19 for explanation of terms.
- Columns 4-6: Johnson-Morgan UBV magnitudes.
- Columns 7-9: Canopus ratios relative to the UBV filters, respectively.
- Column 10: Canopus ratio of the star relative to the detector.
- Column 11: Deviation of the determined Canopus ratio (Column 9) from that of the standard value. Table 20 lists the standard Canopus ratio values for each detector studied.
- Column 12: Percentage Canopus ratio deviation.
$$CRPC = |CR - CRA| / CRA.$$
- Column 13: Magnitude of the star relative to the detector.

Column 14: Deviation of the determined magnitude (Column 12) from that of the standard value. Table 20 lists the standard magnitude values for each detector studied.

Column 15: Percentage magnitude deviation.

$$\text{DMPC} = \frac{|DM - DMA|}{|DMA|}.$$

The Mariner 1971 Canopus star tracker and the Pioneer F star sensor represent two spectral response regions which differ radically relative to the Johnson-Morgan U, B, and V filters. The region represented by the Mariner 1971 Canopus star tracker spans that covered by the UBV region, while that of the Pioneer F is outside the UBV region, in the infrared region. Tables 7 through 10 show the results of fitting the Mariner 1971 Canopus tracker in terms of the Johnson-Morgan UBV magnitudes. Tables 11 through 14 give the results of fitting the Pioneer F star sensor. In order to achieve the confidence of the Pioneer sensor fit similar to that obtained for the Mariner 1971 Canopus star tracker, it would be necessary to extend the relationship between the detector and the Johnson-Morgan UBV magnitudes to include measurements taken in the red and infrared regions such as R and I magnitudes. This would be possible by including the relative response functions representing the R and I magnitudes into Eqs. (4) and (5). Tables 15 through 17 present the results of fitting U-B, B-U, and V-U as a function of B-V, U-V, and U-B, respectively.

It should be added that the technique represented by Eq. (4) failed to provide a realistic fit (negative detector fluxes resulted) for those detectors whose spectral response range did not fall within the spectral range of the Johnson-Morgan filters used to represent the detector. Thus, as a general tool, Eq. (5) should be used to represent any detector and Eq. (4) saved only for those detectors whose spectral response regions are totally covered by the response regions of the defining Johnson-Morgan filters.

Finally, it should be noted that, in general, the more Johnson-Morgan or other photometric system magnitudes used to express the detector the better the results in the prediction of star magnitudes relative to the detector. Best results are obtained when the photometric system magnitudes chosen completely span the spectral response of the given detector. Thus for the Mariner 1971 Canopus tracker, the Johnson-Morgan UBV system is

fully adequate as a defining system. The Johnson UBVRI system or at least the VRI system would be needed to define the Pioneer star sensor to the degree that the Canopus tracker is defined by the UBV system.

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Table 1. Normalized relative response function for Canopus
tracker SN/003 - Tube S11

WAVELENGTH Cm x 10 ⁴	RELATIVE RESPONSE	WAVELENGTH Cm x 10 ⁴	RELATIVE RESPONSE
.29	0.0	.4480	1.000
.3321	.0916	.4708	.9616
.3242	.1442	.4836	.9136
.3265	.1923	.4927	.8655
.3298	.2404	.5019	.8174
.3320	.2885	.5093	.7693
.3341	.3366	.5166	.7212
.3366	.3847	.5241	.6731
.3403	.4327	.5317	.6251
.3448	.4808	.5378	.5770
.3504	.5289	.5440	.5289
.3568	.5770	.5504	.4808
.3657	.6251	.5580	.4327
.3748	.6731	.5643	.3847
.3819	.7212	.5720	.3366
.3898	.7693	.5792	.2885
.3979	.8174	.5864	.2404
.4063	.8655	.5942	.1923
.4145	.9136	.6002	.1442
.4200	.9464	.6083	.0962
.4251	.9616	.6600	0.0

Table 2. Normalized relative response function for Pioneer F
star sensor PN F

WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE	WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE
.34	0.000	.79	1.0
.40	.130	.90	.76
.46	.265	.95	.49
.50	.370	.975	.32
.60	.620	1.0	.20
.70	.850	1.1	.04

Table 3. Johnson-Morgan ultraviolet (U) bandpass relative response function

WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE	WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE
.2941	0.0	.3750	2.2351
.3030	.0660	.3800	1.9168
.3125	.3460	.3846	1.4260
.3226	.7770	.3850	1.3735
.3333	1.3000	.3900	1.0245
.3400	1.6191	.3950	.6244
.3448	1.8130	.4000	.1970
.3500	1.9905	.4050	.0967
.3571	2.1780	.4100	.0317
.3600	2.2326	.4150	.0020
.3700	2.3299	.4167	0.0
.3704	2.3300		

Table 4. Johnson-Morgan visual (V) bandpass relative response function

WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE	WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE
.4762	0.0	.5556	2.4860
.4800	.0344	.5600	2.3401
.4850	.0829	.5700	2.0319
.4878	.1120	.5714	1.9900
.4900	.1361	.5800	1.7584
.4950	.6109	.5882	1.5180
.5000	.9930	.5900	1.4626
.5100	1.8994	.6000	1.1109
.5128	2.1040	.6060	.9300
.5200	2.5502	.6250	.4730
.5263	2.7890	.6452	.1830
.5300	2.7976	.6667	.0990
.5400	2.8080	.6897	.0490
.5405	2.8080	.7143	.0210
.5500	2.6805	.7407	0.0

Table 5. Johnson-Morgan blue (B) bandpass relative response function

WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE	WAVELENGTH Cm X 10 ⁴	RELATIVE RESPONSE
.3571	0.0	.4545	2.6830
.3700	.0663	.4550	2.6713
.3704	.0750	.4600	2.5447
.3750	.2032	.4650	2.3652
.3800	.3339	.4700	2.2103
.3846	.6400	.4750	2.0531
.3850	.6722	.4762	2.0150
.3900	1.1497	.4800	1.8935
.3950	2.0717	.4850	1.7271
.4000	2.5230	.4878	1.6400
.4050	2.6345	.4900	1.5731
.4100	2.7509	.4950	1.4316
.4150	2.8725	.5000	1.2860
.4167	2.9150	.5100	.9929
.4200	2.9452	.5128	.9100
.4250	2.9793	.5200	.6800
.4300	2.9996	.5263	.5050
.4348	3.0060	.5300	.4136
.4350	3.0060	.5400	.2088
.4400	2.9835	.5405	.2000
.4450	2.9194	.5500	.0592
.4500	2.8137	.5556	0.0

Table 6. Relative spectral energy distribution (SED) of Canopus

WAVELENGTH Cm X 10 ⁴	RELATIVE SED	WAVELENGTH Cm X 10 ⁴	RELATIVE SED
.28	.250	.470	.839
.30	.263	.475	.818
.32	.275	.480	.787
.34	.289	.485	.713
.35	.296	.490	.722
.36	.307	.495	.763
.37	.393	.500	.761
.375	.539	.510	.735
.380	.690	.520	.709
.385	.897	.530	.682
.390	.960	.540	.660
.395	.935	.550	.638
.400	.914	.560	.617
.405	.993	.570	.597
.410	.945	.580	.577
.415	.959	.590	.558
.420	1.000	.600	.539
.425	.985	.620	.502
.430	.882	.640	.467
.435	.850	.660	.434
.440	.917	.680	.402
.445	.904	.700	.372
.450	.888	.720	.343
.455	.876	.740	.316
.460	.864	.760	.291
.465	.856	.780	.267

Table 7. Mariner 71 CT color index fit: $D - V = A*(B - V) + B*(U - B)$

MARINER 71 CT COLOR INDEX FIT: $C-V = A*(B-V) + B*(U-B)$
 $A = -.10962246$ $B = 1.00416450$ $C = .00000000$
 $CU = -.30.656610$ $CV = -.25.996474$ $CC = -.25.877784$

NO.	PROPER NAME	DESIGNATION	U	V	CRU	CRB	CRV	CR	CR-RA	CRPC	CM	CM-DMA	CMPC
1	SIFSIUS	5 ALP CRA	-1.459	-1.457	2.454	2.285	1.972	2.247	.00000	.00000	-1.457	.000	.00000
2	CANGRUS	5 ALP GAR	-.500	-.500	1.000	1.000	1.000	1.000	.00000	.00000	-.578	.000	.00000
3	ARCTURUS	16 ALP SOC	2.440	1.130	.055	.201	.540	.00000	.00000	.00000	1.040	.000	.00000
4	VEGA	3 ALP LYR	.054	.044	.644	.539	.495	.544	.00000	.00000	.044	.000	.00000
5	CAPELLA	15 ALP AUR	1.252	.642	.662	.188	.275	.487	.293	.00000	.755	.000	.00000
6	RIGEL	15 BET ORI	-.537	.133	1.016	.528	.448	.517	.00000	.00000	.138	.000	.00000
7	PROCYON	11 ALP CMG	.787	.777	.357	.292	.371	.310	.00000	.00000	.000	.000	.00000
8	ACHERNAR	ALP ERI	-.350	.320	.490	.445	.328	.429	.00000	.00000	.341	.000	.00000
9	HADAR	BET CMR	.610	.570	.610	.425	.294	.416	.00000	.00000	.400	.000	.00000
10	ALTAIR	55 ALP AQL	.053	.983	.753	.235	.241	.258	.243	.00000	.000	.000	.00000
11	BEI ELGEUSE	53 ALP ORI	2.660	.600	.052	.052	.247	.077	.00000	.00000	2.212	.000	.00000
12	ALDEBARAN	97 ALP TAU	4.279	2.383	.058	.012	.066	.234	.077	.00000	.000	.000	.00000
13	SPICA	67 ALP VIR	-.215	.728	.568	.723	.305	.211	.252	.00000	.758	.000	.00000
14	POLLUX	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.038	.00000	2.513	.000	.00000
15	ANTARES	78 DEL GEM	2.956	2.146	1.146	.039	.083	.179	.030	.00000	.000	.000	.00000
16	FOMALHAUT	24 ALP PSA	1.313	1.245	1.153	.195	.190	.178	.189	.00000	1.233	.000	.00000
17	DENEK	50 ALP CYG	1.658	1.238	1.248	.245	.174	.173	.173	.00000	1.325	.000	.00000
18	MINGSA	BET ORU	.005	1.015	1.265	.517	.234	.161	.234	.00000	1.047	.000	.00000
19	ACRUX	ALP CRU	-.450	.510	.790	.938	.373	.249	.356	.00000	.565	.000	.00000
20	REGULUS	52 ALP LEO	.871	1.241	1.351	.278	.190	.148	.195	.00000	1.255	.000	.00000
21	ADHARA	26 EPS CMA	1.280	1.500	1.500	.445	.184	.129	.166	.00000	1.308	.000	.00000
22	GASTOR	50 ALP GEM	1.620	1.510	1.580	.132	.136	.120	.134	.00000	1.607	.000	.00000
23	SHAULA	11 LAM SCC	.507	1.407	1.617	.330	.163	.116	.137	.00000	1.434	.000	.00000
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.156	.00000	1.443	.000	.00000
25	ELNATH	112 BET IAU	1.032	1.522	1.652	.239	.147	.113	.142	.00000	1.538	.000	.00000
26	GARUX	GAM ORU	5.040	3.280	1.660	.008	.029	.112	.034	.00000	3.095	.000	.00000
27	MIAPLACIDUS	BET CAR	1.658	1.678	1.678	.130	.127	.110	.125	.00000	1.678	.000	.00000
28	ALNIIAM	46 EPS ORI	4.74	1.514	1.694	.400	.148	.108	.142	.00000	1.538	.000	.00000
29	AL NAI'R	ALP ORU	1.133	1.533	1.743	.218	.138	.103	.133	.00000	1.611	.000	.00000
30	ALNITAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.139	.00000	1.566	.000	.00000
31	ALIGTH	77 EPS UKA	1.740	1.760	1.790	.120	.118	.099	.116	.00000	1.763	.000	.00000
32	DUBHE	50 ALP UMA	2.743	2.883	1.793	.020	.043	.099	.047	.00000	2.733	.000	.00000
33	MIRFAK	35 ALP PEP	2.663	2.283	1.803	.053	.073	.038	.075	.00000	2.223	.000	.00000
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.136	.00000	1.588	.000	.00000
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.095	.110	.00000	1.818	.000	.00000
36	WEZEN	25 DEL CMA	2.998	2.508	1.838	.032	.059	.095	.063	.00000	2.433	.000	.00000
37	SARGES	BET SCO	2.410	2.260	1.860	.067	.074	.091	.076	.00000	2.216	.000	.00000
38	AVIOR	EPS CAR	3.460	3.190	1.830	.025	.032	.091	.036	.00000	3.045	.000	.00000
39	ALKAID	65 ETA UMA	1.010	1.680	1.680	.244	.126	.051	.121	.00000	1.714	.000	.00000
40	KENKALININ	34 BET AUR	2.240	1.930	1.930	.079	.161	.090	.100	.00000	1.925	.000	.00000
41	PEACOCK	ALP PAV	1.400	1.750	1.520	.247	.122	.068	.118	.00000	1.745	.000	.00000
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.099	.00000	1.930	.000	.00000
43	ATRIA	48 URS	3.395	1.635	.067	.026	.026	.087	.030	.00000	3.225	.000	.00000
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.115	.00000	1.770	.000	.00000
45	ALPHARC	30 ALP HYA	5.151	3.421	1.581	.065	.026	.083	.029	.00000	3.256	.000	.00000
46	HAMAL	15 ALP ARI	4.279	3.159	2.009	.012	.035	.081	.036	.00000	3.028	.000	.00000

AVERAGE RMS 1 SIGMA
 CR-CRA .00000
 (CR-CRA)/CRA .00000
 CM-DMA .00000
 (CM-DMA)/DMA .00000

Table 8. Mariner 71 CT color index fit: $D-V=A*(U-B)$

MARINER 71 CT COLOR INDEX FIT: $D-V=A*(U-B)$														
$A = -1.04509990$ $B = .00000000$ $C = .00000000$ $CU = -30.390600$ $CS = -29.283269$ $CV = -29.998474$ $CC = -23.809598$														
NO.	PROPER NAME	DESIGNATION	U	B	V	CR1	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.277	.02955	.01315	-1.455	.002	.01118
2	CANOPUS	ALP CAR	-2.520	-2.560	-2.560	1.000	1.000	1.000	1.000	.00000	.00000	-.562	.016	.02753
3	ARCTURUS	16 ALP 300	2.440	1.180	-.050	.055	.201	.540	.212	-.01356	.06010	1.123	.083	.08006
4	VEGA	3 ALP LYR	.054	.044	.044	.589	.573	.495	.573	.00854	.01514	.044	.000	.00931
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.280	-.01350	.04605	.022	.067	.08930
6	RIGEL	19 BET ORI	-5.577	-5.133	-5.133	1.016	.528	.448	.513	.00443	.00856	.163	.025	.18288
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.432	-.00809	.02701	.777	.046	.06243
8	ACHERNAR	ALP ERI	-3.350	.320	.490	.855	.445	.328	.432	.00282	.00657	.350	.009	.06243
9	MADARA	BET GEN	-5.520	.370	.610	1.086	.429	.294	.907	.00078	.03193	.414	.014	.03448
10	ALTAIR	53 ALP AGL	1.053	.983	.753	.235	.241	.258	.242	-.00144	.00592	.980	.022	.02334
11	BETELGEUSE	53 ALP ORI	2.660	.800	.800	.052	.052	.247	.247	.00000	.00000	.800	.000	.00000
12	ALDEBARAN	87 ALP TAU	4.278	2.388	.858	.012	.066	.234	.671	-.00507	.06627	2.303	.050	.04084
13	SPICA	67 ALP VIR	-2.212	.729	.958	.753	.305	.221	.293	.00101	.00344	.770	.012	.01605
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.651	-.00667	.14996	2.561	.148	.05909
15	POLLUX	78 BET GEM	2.995	2.146	1.146	.039	.083	.179	.086	-.00477	.05283	2.108	.075	.03681
16	FORMALHAUT	24 ALP PSA	1.515	1.243	1.153	.185	.190	.178	.190	.00155	.00823	1.240	.007	.00568
17	DENEBS	50 ALP CYG	1.093	1.338	1.248	.225	.174	.163	.172	-.00060	.00348	1.349	.020	.01481
18	MIMOSA	BET CRU	.000	1.015	1.265	.617	.234	.161	.224	.00041	.00181	1.061	.014	.01332
19	ACRUX	ALP CRU	-4.500	.510	.790	.938	.373	.249	.358	.00240	.00674	.553	.009	.01590
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.187	.00220	.01187	1.258	.003	.00246
21	ADHARA	26 EPS CMA	3.500	1.280	1.500	.445	.184	.129	.176	.00038	.00217	1.321	.014	.01035
22	CASTOR	60 ALP GEM	1.620	1.610	1.500	.136	.136	.120	.135	.00161	.00207	1.610	.003	.00179
23	SHAULA	32 LAM SCO	.507	1.407	1.517	.399	.163	.116	.157	.00030	.00192	1.498	.014	.00984
24	BELLATRIX	24 GEM ORI	.545	1.415	1.635	.375	.162	.114	.156	.00063	.00407	1.454	.011	.00797
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.233	.147	.113	.144	.00133	.00934	1.544	.006	.00378
26	GACRUX	60M CRU	5.040	3.260	1.560	.006	.029	.112	.031	-.00269	.07925	3.201	.106	.03410
27	MIAPLACIOLUS	BET CAR	1.529	1.573	1.573	.130	.127	.110	.127	.00194	.01952	1.677	.001	.00093
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.108	.142	-.00091	.00637	1.561	.023	.01465
29	AL NA'IR	ALP SRU	1.133	1.593	1.743	.218	.138	.103	.135	.00167	.01253	1.614	.002	.00148
30	ALNITAK	50 ZET ORI	.478	1.555	1.745	.358	.145	.105	.138	-.00057	.00411	1.597	.020	.01300
31	ALGIOTH	77 EPS UMA	1.780	1.760	1.790	.118	.099	.099	.118	.00215	.01850	1.759	.004	.00233
32	DUBHE	50 ALP UMA	2.743	2.353	1.793	.020	.043	.099	.045	-.00271	.05713	2.813	.080	.02919
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.074	-.00146	.01930	2.266	.037	.01653
34	REGOR	60M VEL	.633	1.593	1.833	.346	.143	.095	.127	.00112	.00826	1.594	.007	.00459
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.129	.112	.095	.112	.00143	.01298	1.820	.002	.00105
36	WEZEN	25 DEL CMA	2.950	2.508	1.838	.075	.059	.095	.060	-.00212	.03394	2.485	.053	.02195
37	SARGAS	THE SCO	2.410	2.260	1.850	.067	.074	.093	.075	-.00152	.01988	2.253	.038	.01702
38	AVIOR	EPS CAR	2.460	3.150	1.880	.026	.032	.091	.032	-.00362	.10187	3.178	.133	.04353
39	ALKAID	85 ETA UMA	1.010	1.690	1.990	.244	.126	.091	.122	.00100	.00823	1.721	.007	.00409
40	MERKALINAN	34 BET AUR	2.240	1.950	1.900	.079	.101	.090	.102	.00235	.02358	1.915	.009	.00468
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.089	.119	.00093	.00772	1.752	.008	.00433
42	ALHERFA	24 SAM CEM	1.960	1.930	1.930	.102	.101	.067	.101	.00158	.01590	1.925	.000	.00064
43	ATRIA	ALP TRA	4.505	3.395	1.935	.007	.036	.087	.028	-.00219	.07303	3.327	.098	.03043
44	MIRZAM	BET CVA	.750	1.740	1.580	.310	.120	.083	.115	.00018	.00155	1.785	.014	.00803
45	ALPHARD	30 ALP HVA	5.151	3.421	1.981	.005	.025	.083	.027	-.00186	.06342	3.343	.087	.02673
46	HAMAL	13 ALP ARI	4.275	3.155	2.009	.012	.033	.081	.034	-.00208	.05752	3.108	.080	.02649

AVERAGE		RMS		1 SIGMA	
CR-CRA	-.00027	CR-CRA	.00595	CR-CRA	.00535
(CR-CRA)/CRA	.03764	(CR-CRA)/CRA	.02842	(CR-CRA)/CRA	.02842
DM-DMA	.03307	DM-DMA	.05125	DM-DMA	.03915
(DM-DMA)/DMA	.03357	(DM-DMA)/DMA	.03357	(DM-DMA)/DMA	.03347

Table 9. Mariner 71 CT color index fit: D-V=A*(U-B)

MARINER 71 CT COLOR INDEX FIT: D-V=A*(U-B)														
NO.	PROPER NAME	DESIGNATION	U	B	V	CR1	CR2	CR3	CR	CP-CRA	CRPC	CM	CM-DMA	DMPC
1	SIRIUS	3 ALP CMA	-1.429	-1.457	2.454	2.285	1.972	2.193	-0.5446	.000000	.000000	-1.477	-0.220	.01388
2	CANCOPUS	ALP CAP	-1.520	-1.560	1.000	1.000	1.000	1.000	.00000	.00000	.00000	-0.625	-0.47	.08110
3	ARCTURUS	16 ALP 300	2.440	1.180	-0.50	.055	.201	.540	.197	-.02921	.12515	1.138	.098	.09453
4	VEGA	3 ALP LYR	0.54	0.44	0.59	.572	.455	.578	.578	-.02621	.04647	.048	.005	.10950
5	CAPPELLA	12 ALP AUR	1.222	.94	.062	.393	.275	.487	.309	.01532	.05566	.649	-0.106	.14903
6	RIGEL	19 BET ORI	-1.537	.133	1.016	.528	.448	.662	.14445	.14445	.27926	-1.178	-0.314	2.27746
7	PROCYON	10 ALP GMI	.757	.777	.357	.300	.292	.371	.335	.03559	.11879	.582	-0.169	.23084
8	ACHERNAR	ALP ER	-1.500	.520	.490	.855	.445	.328	.855	.03533	.20828	.085	-0.252	.73888
9	HADAR	BET GEN	-1.610	.370	.610	1.096	.425	.294	.549	.14212	.34936	.028	-0.373	.93052
10	ALTAIR	53 ALP AQL	1.053	.967	.753	.235	.241	.256	.246	.00327	.03343	.895	-0.061	.06400
11	BELEGEUSE	32 ALP ORI	2.550	.800	.800	.052	.247	.247	.247	.00000	.00000	.00000	.00000	.00000
12	ALDEBARAN	57 ALP TAU	4.276	2.598	.858	.012	.066	.234	.057	-.01978	.25833	2.490	.278	.12548
13	SPICA	97 ALP VIR	-2.212	.728	.968	.753	.305	.211	.387	.09528	.32613	.405	-0.353	.46598
14	ANTARES	21 ALP SCO	4.020	2.720	.880	.015	.049	.229	.663	.00488	.08405	2.378	-0.134	.05352
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.087	-.00349	.03869	2.029	-0.004	.00198
16	FOMALHAUT	24 ALP PSA	1.513	1.43	1.153	.165	.196	.178	.181	-.00739	.03915	1.225	-0.003	.00283
17	DENEBS	50 ALP CYG	1.028	1.333	1.248	.225	.174	.163	.190	.01769	.10241	1.175	-0.153	.11490
18	MIMOSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.315	.08126	.06273	.664	-0.383	.36583
19	ARCRUX	ALP GRU	-4.50	.510	.790	.375	.162	.114	.0495	.01521	.31773	.198	-0.345	.63599
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.196	.148	.210	.01521	.08223	1.122	-0.133	.10573
21	ACHARA	26 EPS CMA	.350	1.230	1.500	.445	.184	.129	.233	.05714	.32446	.956	.352	.26909
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.136	.120	.125	.125	-.00475	.03552	1.599	-0.008	.00472
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.393	.165	.116	.207	.04983	.31778	1.087	-0.346	.24164
24	BELLATRIX	24 GAM ORI	.545	1.425	1.635	.375	.162	.114	.0495	.01521	.08223	1.122	-0.133	.10573
25	ELNATH	112 BET TAU	1.032	1.922	1.652	.239	.147	.103	.161	.01990	.13271	1.356	-0.182	.11841
26	GACRUX	CMU CRU	5.040	3.260	1.660	.016	.029	.112	.128	-.00635	.16695	3.273	.178	.05746
27	MIAPLACIDUS	BET CAR	1.893	1.678	1.678	.130	.127	.110	.119	-.00635	.05069	1.688	.010	.00574
28	ALNILAM	40 EPS ORI	1.474	1.514	1.694	.400	.146	.108	.212	.05599	.4826	1.112	-0.426	.27713
29	AL NAIR	ALP GRU	1.133	1.593	1.743	.213	.138	.103	.148	.01455	.10927	1.452	-0.159	.09895
30	ALNITAK	51 ZET ORI	4.79	1.538	1.748	.358	.145	.103	.166	.05755	.44665	1.143	-0.423	.27074
31	ALIOTH	77 EPS UMA	1.736	1.760	1.790	.113	.099	.109	.109	-.00712	.06147	1.785	.022	.01249
32	DUBHE	51 ALP UMA	2.743	2.655	1.793	.020	.043	.099	.046	-.00160	.03377	2.724	-0.010	.00350
33	MIRFAK	33 ALP PER	2.653	2.283	1.803	.053	.075	.098	.073	-.00215	.02855	2.213	-0.015	.00691
34	REGOR	GM VEL	.633	1.533	1.833	.346	.143	.095	.176	.04009	.29457	1.260	-0.327	.20608
35	KAUS AUSTRALIS	20 EPS SER	1.715	1.915	1.935	.128	.112	.095	.109	-.00071	.05641	1.778	-0.040	.02194
36	WEZEN	25 CIL CMA	1.958	2.508	1.838	.039	.052	.095	.062	-.00134	.00541	2.392	-0.041	.01684
37	SARGAS	THE SCO	2.410	2.260	1.860	.087	.074	.091	.080	.00118	.04348	2.122	-0.093	.04201
38	AVICR	EPS CAP	3.450	3.150	1.880	.026	.032	.091	.050	.01418	.39887	2.634	-0.411	.13506
39	ALKAID	85 ETA UMA	1.020	1.690	1.890	.244	.126	.091	.146	.02478	.20445	1.465	-0.249	.14520
40	MENKALINAN	34 BET AUR	2.240	1.930	1.600	.078	.101	.090	.084	-.01552	.15564	2.062	.137	.07106
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.144	.02606	.22134	1.481	-0.264	.15125
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.054	-.00045	.05489	1.944	.014	.00748
43	MIRZAM	ALP TRA	4.965	3.395	1.935	.007	.026	.067	.056	.00436	.14530	3.352	-0.124	.03829
44	MIRZAM	2 BET CMA	.750	1.740	1.580	.310	.130	.083	.156	.00493	.35585	1.393	-0.377	.21316
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.025	.083	.023	-.00675	.23051	3.494	.238	.07303
46	HAMAL	17 ALP ARI	4.275	3.155	2.009	.012	.033	.081	.033	-.00350	.09704	3.092	.064	.02112

AVERAGE			RMS			1 SIGMA		
CR-CRA	.02237	.04833	.04284	.04284	.04284			
(CR-CRA)/CRA	.16569	.13063	.13063	.13063	.13063			
CM-DMA	-1.2750	.22028	.18935	.18935	.18935			
(CM-DMA)/DMA	.20643	.42233	.36945	.36945	.36945			

Table 10. Mariner 71 CT color index fit: D-V=A*(B-V)

MARINER 71 CT COLOR INDEX FIT: D-V=A*(B-V)												
A= -0.1169033 B= .0000000 C= .0000000												
CU= -30.890500 CV= -29.233259 CR= -29.938474 CD= -29.880755												
NG.	PROPER NAME	DESIGNATION	U	V	CRU	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.457	-1.457	2.464	2.285	1.972	2.248	.00013	-1.457	-.000	.00012
2	GARGPUS	ALP CAR	-5.520	-5.520	1.000	1.000	1.000	1.000	.00000	-.578	-.000	.00006
3	ARCTURUS	16 ALP B00	2.440	2.440	-0.050	-0.050	.540	.540	.00355	1.044	.004	.00355
4	VEGA	3 ALP LYR	.054	.054	.589	.573	.495	.495	.00070	.044	.000	.00095
5	CAPELLA	17 ALP AUR	1.292	.842	.032	.188	.487	.293	.00025	.0095	.756	.00117
6	RIGEL	15 SET ORI	-5.577	-5.577	1.016	.528	.448	.519	.00130	.00252	1.355	.00004
7	PROCYON	10 ALP CMA	.787	.777	.357	.300	.371	.300	.00013	.00042	.730	.00067
8	ACHERNAR	ALP ERI	-.350	.320	.490	.655	.445	.430	.00100	.00234	.339	.00754
9	HADAR	BET GEM	.510	.570	.630	1.095	.325	.294	.00140	.00345	.597	.00343
10	ALTAIR	57 ALP AGL	1.053	.983	.753	.235	.241	.258	.00040	.00345	.597	.00343
11	BE TELGEUSE	53 ALP ORI	2.650	.900	.052	.052	.247	.247	.00001	.00001	.957	.00000
12	ALDEBARAN	67 ALP TAU	4.278	2.586	.853	.012	.066	.234	.076	-.00042	.00548	2.218
13	SPICA	07 ALP VIR	-2.12	.723	.953	.753	.505	.211	.293	.00096	.00339	.755
14	ANTARES	21 ALP SCC	4.020	2.720	.680	.015	.045	.229	.058	-.00017	.00267	2.511
15	POLLUX	78 BET GEM	2.925	2.146	1.195	.039	.083	.179	.090	-.00019	.00212	2.035
16	FOHALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.169	-.00004	.00020	1.233
17	DENEK	50 ALP CYG	1.098	1.338	1.248	.225	.173	.173	.173	.00017	.00099	1.328
18	MIMUSA	BET CRU	.015	1.255	.617	.374	.151	.225	.00060	.00355	1.043	-.004
19	ACRUX	ALP CRU	-.450	.510	.730	.933	.573	.243	.357	.00118	.00333	.541
20	REGULUS	32 ALP LEO	.871	1.241	1.551	.278	.148	.185	.00023	.00126	1.253	-.001
21	ACHARA	26 EPS CMA	.350	1.280	1.500	.445	.184	.129	.177	.00057	.00324	1.304
22	CASTOR	60 ALP GEM	1.620	1.610	1.530	.139	.136	.120	.134	-.00000	.00004	1.607
23	SHADJA	31 LAM SCC	.507	1.407	.617	.393	.183	.116	.157	.00050	.00318	1.430
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.161	.114	.156	.00047	.00305	1.439
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.232	.147	.113	.143	.00024	.00170	1.536
26	GARUX	GAM CPU	5.040	3.260	1.660	.016	.025	.112	.034	-.00017	.00468	3.100
27	MICHELLEUS	BET CAR	1.658	1.678	1.678	.130	.127	.110	.125	-.00001	.00011	1.678
28	ALNILAM	46 EFS ORI	.474	1.514	1.694	.478	.148	.108	.143	.00053	.00375	1.534
29	AL NA'IR	ALP ORU	1.133	1.592	1.743	.213	.138	.103	.133	.00021	.00155	1.610
30	ALNITAK	50 ZET ORI	.475	1.535	1.743	.358	.145	.103	.139	.00053	.00379	1.562
31	ALGITH	77 EPS UMA	1.730	1.760	1.750	.120	.113	.099	.116	-.00002	.00015	1.763
32	DURHE	50 ALP UMA	3.742	2.853	1.793	.020	.043	.099	.047	-.00010	.00221	2.735
33	MIRFAK	33 ALP PER	2.653	2.283	1.803	.053	.073	.098	.075	-.00007	.00093	2.230
34	REGOR	GAM VEL	.633	1.855	1.833	.346	.143	.105	.137	.00043	.00317	1.584
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.123	.112	.095	.110	.00004	.00033	1.817
36	MEZEN	25 DEL CMA	2.958	2.508	1.838	.039	.059	.085	.062	-.00007	.00113	2.434
37	SARGAS	THE SCC	2.410	2.260	1.860	.057	.074	.093	.076	-.00001	.00014	2.216
38	AVTOR	EPS CAR	3.460	3.150	1.680	.026	.032	.051	.036	.00002	.00046	3.045
39	ALMAID	35 STA UMA	1.010	1.690	1.980	.126	.091	.121	.121	.00000	.00235	1.711
40	MENKALINAN	34 BET AUR	2.240	1.930	1.500	.079	.101	.090	.100	-.00012	.00119	1.927
41	PELCOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.118	.00023	.00250	1.742
42	ALHENA	24 GAM GEM	1.950	1.930	1.530	.102	.101	.087	.089	-.00001	.00015	1.930
43	ATRIA	ALP IRA	4.905	3.395	1.935	.007	.026	.087	.030	-.00012	.00411	3.233
44	MIRZAM	2 BET CMA	.750	1.740	1.980	.310	.120	.083	.115	.00040	.00349	1.767
45	ALPHARD	30 ALP AYA	5.151	3.421	1.931	.005	.026	.083	.029	-.00015	.00498	3.281
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.035	.081	.036	-.00011	.00298	3.031

AVERAGE			RMS	1 SIGMA
CR-CRA	.00020	.00049	.00045	
(CS-CRA)/CRA	.00204	.00257	.00356	
CM-CMA	-.00041	.00280	.00277	
(CM-CMA)/CMA	.00216	.00399	.00335	

Table 11. Pioneer F SS color index fit: $D - V = A * (B - V) + B * (U - B)$

PIONEER F SS COLOR INDEX FIT: $D - V = A * (B - V) + B * (U - B)$													
A = -1.16119530 B = -1.68567900 C = .00000000													
CU = -30.890600 CB = -29.233269 CV = -29.998474 CC = -29.673412													
NO.	PROPER NAME	DESIGNATION	U	V	CR1	CR5	CRV	CR	CR-CRA	CRPC	DM	DM-CMA	DMPC
1	SIRIUS	9 ALP CMA	-1.493	-1.457	2.464	2.235	1.972	1.328	.00000	.00000	-1.428	.000	.00000
2	CANGRUS	ALP CAR	-5.520	-7.220	1.060	1.000	1.000	1.000	.00000	.00000	-7.772	.000	.00000
3	ARCIURUS	16 ALP SCO	2.440	1.180	-0.50	.201	.540	1.366	.00000	.00000	-1.112	.000	.00000
4	VEGA	3 ALP LYR	.034	.044	.533	.573	.455	.474	.00000	.00000	.037	.000	.00000
5	CAPELLA	13 ALP AUR	1.292	.342	.062	.439	.275	.487	.00000	.00000	-3.72	.000	.00000
6	RIGEL	15 BET ORI	-5.37	.133	.153	1.016	.528	.448	.00000	.00000	.616	.000	.00000
7	PROCYON	10 ALP CMI	.737	.777	.357	.300	.292	.371	.00000	.00000	.282	.000	.00000
8	ACHERNAR	ALP CRI	-3.50	.320	.855	.445	.328	.210	.00000	.00000	.977	.000	.00000
9	HADAR	BET GEN	-6.10	.370	.610	1.086	.425	.294	.00000	.00000	1.321	.000	.00000
10	ALTAIR	53 ALP AGL	1.053	.982	.753	.235	.241	.256	.00000	.00000	.666	.000	.00000
11	BETELGEUSE	52 ALP CRI	2.660	.900	.052	.247	.052	.247	.00000	.00000	.685	.000	.00000
12	ALDEBARAN	67 ALP TAU	4.278	2.365	.658	.012	.066	.234	.00000	.00000	-6.85	.000	.00000
13	SPICA	67 ALP VIR	-2.12	.728	.968	.753	.305	.211	.00000	.00000	1.651	.000	.00000
14	ANTARES	21 ALP SCO	4.620	2.720	.680	.015	.045	.225	.00000	.00000	-3.08	.000	.00000
15	POLLUX	73 BET GCM	2.996	2.146	1.146	.039	.085	.179	.00000	.00000	.402	.000	.00000
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.150	.178	.00000	.00000	1.080	.000	.00000
17	DENEK	50 ALP CYG	1.023	1.338	1.243	.225	.174	.163	.00000	.00000	1.399	.000	.00000
18	MIMOSA	BET CRU	.002	1.015	1.265	.617	.234	.161	.00000	.00000	1.998	.000	.00000
19	ARUX	ALP CRU	-4.50	.510	.790	.373	.249	.124	.00000	.00000	1.493	.000	.00000
20	REGULUS	52 ALP LEO	.671	1.241	1.351	.276	.150	.148	.00000	.00000	1.622	.000	.00000
21	ADHARA	26 EPS CMA	1.280	1.500	.445	.194	.129	.067	.00000	.00000	2.166	.000	.00000
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.125	.136	.120	.00000	.00000	1.568	.000	.00000
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.163	.116	.00000	.00000	2.268	.000	.00000
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.00000	.00000	2.267	.000	.00000
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.00000	.00000	2.009	.000	.00000
26	GARUX	64M CRU	5.040	3.280	1.660	.016	.029	.411	.00000	.00000	.192	.000	.00000
27	MEAPLACIDUS	BET CAR	1.598	1.573	1.673	.330	.127	.110	.00000	.00000	1.664	.000	.00000
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.108	.00000	.00000	2.43E	.000	.00000
29	AL NATH	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.00000	.00000	2.083	.000	.00000
30	ALNIYAK	50 ZET ORI	.475	1.535	1.749	.358	.145	.103	.00000	.00000	2.510	.000	.00000
31	ALIOTH	77 EPS UMA	1.730	1.760	1.790	.320	.118	.099	.00000	.00000	1.781	.000	.00000
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.00000	.00000	1.012	.000	.00000
33	MIRFAK	33 ALP PER	2.853	2.283	1.303	.053	.073	.098	.00000	.00000	1.465	.000	.00000
34	REGOR	GAM VEL	.023	1.553	1.833	.346	.143	.095	.00000	.00000	2.509	.000	.00000
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.915	1.835	.429	.112	.095	.00000	.00000	1.907	.000	.00000
36	WEZEN	25 DEL CMA	2.926	2.506	1.836	.039	.056	.095	.00000	.00000	1.394	.000	.00000
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.00000	.00000	1.693	.000	.00000
38	AVIOR	EPS CAR	3.460	3.190	1.880	.026	.032	.051	.00000	.00000	1.484	.000	.00000
39	ENKALID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.055	.00000	2.377	.000	.00000
40	MENKALINAN	34 BET AUR	2.240	1.900	.079	.101	.090	.164	.00000	.00000	1.683	.000	.00000
41	PEACOCK	ALP PAV	1.090	1.720	1.920	.247	.122	.088	.052	.00000	2.446	.000	.00000
42	ALHENA	24 GAM GEM	1.960	1.930	1.630	.102	.101	.087	.065	.00000	1.905	.000	.00000
43	ATHRIA	ALP IRA	4.905	3.395	1.935	.007	.026	.087	.065	.00000	.664	.000	.00000
44	MIRZAM	2 BET CMA	.750	1.740	1.580	.310	.120	.083	.041	.00000	2.698	.000	.00000
45	ALPHARD	30 ALP HYA	5.151	3.421	1.961	.005	.026	.083	.029	.00000	.563	.000	.00000
46	HAMAL	13 ALP ARI	4.275	3.155	2.005	.012	.033	.081	.166	.00000	1.05E	.000	.00000

AVERAGE RMS 1 SIGMA
 CR-CRA .00000
 (CR-CRA)/CRA .00000
 DM-CMA .00000
 (DM-CMA)/CMA .00000

Table 12. Pioneer F SS color index fit: $D-V=A*(B-V)$

PIONEER F SS COLOR INDEX FIT: $D-V=A*(B-V)$														
AE-1.59663080 B= .00000000 CF .00100000														
CU= -30.890600 CG= -23.283269 CV= -23.998474 CC= -30.104093														
NO.	PROPER NAME	DESIGNATION	U	E	V	CRU	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	DMP
1	SIRIUS		-1.499	-1.457	-1.457	2.464	2.285	1.972	1.805	-0.2250	0.1231	-1.457	-0.29	0.2016
2	CANOPUS		-5.20	-5.60	-7.20	1.600	1.600	1.600	1.600	.00000	0.0000	-0.815	-0.42	0.5453
3	ARCTURUS		2.449	1.890	-0.50	0.65	0.201	0.540	0.71	-0.39517	0.2819	-1.74	0.28	0.2924
4	VEGA		0.54	0.44	0.44	0.58	0.57	0.495	0.453	-0.2096	0.4421	0.44	0.07	0.1846
5	CAPELLA		1.292	0.842	0.62	1.88	0.25	0.87	0.84	-0.0707	0.1222	-0.93	-0.31	0.8383
6	RIGEL		1.537	1.33	1.53	1.016	0.528	0.448	0.423	0.12709	0.45674	0.65	-0.451	0.73209
7	PROCYON		0.787	0.777	0.777	0.300	0.232	0.371	0.423	0.49360	0.13113	0.106	-0.175	0.23233
8	ACHERNAR		3.350	3.20	4.90	0.95	0.445	0.326	0.274	0.7416	0.37169	0.91	-0.385	0.39453
9	HADAR		6.10	3.70	6.10	1.032	0.425	0.294	0.236	0.9044	0.2214	0.753	-0.567	0.42983
10	ALTAIR		1.053	0.983	0.753	0.235	0.241	0.258	0.268	0.0243	0.60917	0.616	-0.552	0.7808
11	BETELGEUSE		4.278	2.560	8.00	0.52	0.52	0.247	0.247	0.0243	0.60917	0.616	-0.552	0.7808
12	ALDEBARAN		4.278	2.568	8.08	0.12	0.66	0.247	0.247	0.0243	0.60917	0.616	-0.552	0.7808
13	SPICA		2.212	2.20	3.69	0.753	0.305	0.211	0.170	0.6236	0.59167	1.111	-0.540	0.32705
14	ANTARES		4.020	2.720	4.80	0.15	0.49	0.229	0.170	0.6236	0.59167	1.111	-0.540	0.32705
15	POLLUX		2.996	2.146	1.146	0.39	0.93	0.179	0.294	-0.0429	0.16026	0.549	0.147	0.36657
16	FCMHAIHUT		1.313	1.247	1.153	1.05	1.90	0.178	0.171	-0.0925	0.4593	1.099	0.09	0.0809
17	DENEBO		1.098	1.333	1.243	2.25	1.74	1.63	1.57	0.2171	0.16039	1.134	-0.204	1.4574
18	MIMOSA		0.005	1.015	1.165	0.617	0.234	0.161	0.128	0.6037	0.64655	1.414	-0.584	0.29215
19	ACRUX		4.450	4.50	7.90	0.33	0.33	0.249	0.195	0.7145	0.57629	0.957	-0.536	0.35914
20	REGULUS		0.871	1.241	1.551	0.78	1.90	0.148	0.128	0.1790	0.16258	1.417	-0.206	1.2655
21	ADHARA		3.60	1.280	1.500	0.445	1.94	0.129	0.105	0.3932	0.37440	1.531	-0.535	0.24639
22	CASTOR		1.620	1.610	1.580	1.19	1.16	1.12	1.12	-0.00378	0.52655	1.562	-0.06	0.03956
23	SHAULA		5.07	1.407	1.617	0.383	0.163	0.116	0.095	0.3407	0.56088	1.742	-0.526	0.23178
24	BELLATRIX		5.45	1.415	1.635	0.75	0.162	0.114	0.093	0.3195	0.52546	1.166	-0.501	0.22068
25	ELNATH		1.032	1.522	1.652	0.239	1.17	0.113	0.096	0.1882	0.24439	1.730	-0.279	1.13907
26	GACRUX		5.040	3.260	1.660	0.06	0.25	0.112	0.248	-0.16191	0.39390	0.693	0.501	2.61047
27	MIAPLACIUS		1.698	1.678	1.678	1.30	1.27	1.10	1.01	-0.00532	0.5023	1.678	0.14	0.0824
28	ALNILAM		4.74	1.514	1.694	4.00	1.48	1.08	0.80	0.3777	0.72581	1.801	-0.635	0.26055
29	AL NA'IR		1.333	1.593	1.743	2.18	1.33	1.03	0.87	0.1520	0.21099	1.832	-0.250	1.2009
30	ALNITAK		4.75	1.535	1.745	3.98	1.45	1.03	0.84	0.3534	0.72685	1.874	-0.635	0.25317
31	ALITH		1.780	1.760	1.790	1.20	1.18	0.99	0.89	-0.00386	0.6159	1.808	0.27	0.1503
32	DUBHE		3.743	2.853	1.793	0.20	0.43	0.99	1.62	-0.3115	0.16126	1.161	0.149	0.14695
33	MIRFAK		2.663	2.283	1.903	0.53	0.73	0.98	1.17	-0.1053	0.8276	1.517	0.52	0.3519
34	REGOR		6.33	1.553	1.833	3.46	1.43	0.95	0.75	0.2613	0.53697	2.000	-0.509	0.20283
35	KAUS AUSTRALIS		1.715	1.315	1.935	1.28	1.12	0.95	0.86	0.0139	0.21636	1.847	-0.060	0.3139
36	WEZEN		2.998	2.505	1.838	0.39	0.85	0.95	1.25	-0.1040	0.7656	1.438	0.44	0.3174
37	SARGAS		2.410	2.360	1.860	0.67	0.74	0.93	1.06	0.0280	0.2715	1.621	-0.071	0.4214
38	AVICOR		3.460	3.150	1.880	0.26	0.32	0.91	0.72	0.4648	0.37157	1.095	-0.385	0.25668
39	ALKAIC		1.010	1.690	1.880	2.44	1.16	0.91	0.75	0.2030	0.36335	1.933	-0.384	0.16136
40	MENKALINAN		2.240	1.930	1.900	0.79	1.01	0.90	0.83	-0.2079	0.19961	1.882	-0.199	0.11856
41	FEACOCK		1.000	1.720	1.920	1.22	0.88	0.72	0.68	0.2056	0.39876	2.039	-0.407	0.16624
42	ALHENA		1.580	1.930	1.930	1.02	1.01	0.87	0.80	-0.00475	0.65221	1.930	0.21	0.1077
43	ATRA		4.905	3.335	1.935	0.07	0.26	0.67	0.77	-0.08896	0.33435	1.064	0.400	0.60161
44	MIRZAM		1.740	1.980	3.10	0.26	0.83	0.83	0.67	0.2586	0.63241	2.123	-0.574	0.21995
45	MIRZAM		5.151	3.421	1.981	0.05	0.26	0.83	1.68	-0.12427	0.42532	1.122	-0.559	0.93961
46	HAMAL		4.275	3.159	2.009	0.12	0.93	0.81	1.40	-0.4601	0.24800	1.323	-0.267	0.25312
AVERAGE														
RMS														
1 SIGMA														
CR-CRA														
-0.1332														
0.1066														
0.9977														
CR-CRA/CR														
0.2867														
DM-CMA														
-0.13593														
0.36664														
DM-CMA/DM														
0.29139														
0.41667														

Table 13. Pioneer F SS color index fit: D-V=A*(U-B)

PIONEER F SS COLOR INDEX FIT: D-V=A*(U-B)

A=-2.51738060 B=.00000000 C=.60000000
 CU=-30.890600 CB=-29.283269 CV=-29.999474 CC=-29.616467

NO.	PROPER NAME	DESIGNATION	U	B	V	CRL	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CHA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	2.464	2.285	1.972	1.977	1.600	1.600	.00000	.00000	-1.376	.052
2	CANOPUS	ALP CAR	-.520	-.560	1.000	1.000	1.000	1.000	1.000	.00000	.00000	-.637	.137	.17656
3	ARCTURUS	15 ALP BGO	2.440	1.130	-.950	.095	.201	.540	1.737	.37005	.27090	-1.236	-.124	1.11119
4	VEGA	3 ALP LYR	0.054	0.044	0.585	.573	.495	.544	.544	.06966	.14653	.025	-.012	.33161
5	CAPELLA	13 ALP AUR	1.292	.642	.062	.133	.275	.497	.567	-.12415	.17961	-.021	.351	.94907
6	RIGEL	19 BET ORI	-.537	.133	1.016	.528	.448	1.151	1.12751	.45825	.45825	1.418	.862	1.30276
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.327	-.10140	.26909	.758	.475	1.68313
9	ACHERNAR	ALP ERI	-.350	.320	.490	.855	.445	.328	.127	-.07262	.36397	1.605	.628	.64274
9	HADAR	BET GEN	-.610	.370	.510	1.093	.425	.234	.070	-.07526	.51777	2.249	.928	.70237
10	ALTAIR	53 ALP AGL	1.033	.983	.753	.235	.241	.258	.255	-.01661	.04001	.845	.181	.27077
11	BE TELGEUSE	53 ALP ORI		.800		.052		.247						
12	ALCEBARAN	87 ALP TAU	4.278	2.388	.858	.012	.066	.234	1.736	.01486	.88419	-1.236	-.551	.80531
13	SPICA	67 ALP VIR	-.212	.728	.368	.753	.305	.211	.054	-.05311	.49538	2.530	.879	.53240
14	ANTARES	21 ALP SCO	4.020	2.720	.680	.015	.045	.229	.451	-.20030	.30744	.227	.535	1.73837
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.082	1.129	.346	.00702	.02073	.516	.114	.28422
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.105	.190	1.178	.200	.02067	.11505	1.109	.418	.01677
17	DENEUB	50 ALP CYG	1.098	1.338	1.248	.225	.174	.163	.106	-.02918	.21555	1.798	.400	.28619
18	MEMOSA	BET CRU	.065	1.015	1.265	.617	.234	.181	.637	-.04120	.52889	2.952	.954	.47738
19	ARUX	ALP CRU	-.450	.510	.730	.938	.373	.249	.064	-.08015	.48514	2.351	.857	.57405
20	REGULUS	32 ALP LEO	.671	1.241	1.851	.278	.190	1.498	.652	-.01780	.16168	1.950	.328	.20216
21	ABARA	26 EPS CMA	.360	1.280	1.500	.445	.184	1.129	.034	-.03300	.49472	3.044	.878	.40516
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.136	1.120	.129	.01281	.11071	1.591	.023	.01436
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.383	.163	1.116	.031	-.02968	.43863	3.133	.855	.38126
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	1.114	.033	-.02829	.46524	3.083	.816	.36000
25	ELNATH	112 BET IAU	1.032	1.522	1.852	.233	.147	1.113	.059	-.01948	.25256	2.462	.453	.22523
26	GARUX	GAM CRU	5.040	3.260	1.660	.006	.029	1.126	.667	.19592	.47663	-.095	-.287	1.49248
27	MCAPLACIUS	BET CAR	1.698	1.678	1.678	.130	.127	1.110	.123	.01695	.16001	1.640	-.025	.01480
28	ANILAM	46 EPS ORI	.474	1.514	1.654	.400	.146	1.068	.022	-.03005	.57750	3.508	1.072	.44003
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	.249	.139	1.033	.057	-.01513	.20936	2.475	.352	1.9842
30	ALNITAK	50 ZET ORI	.479	1.539	1.745	.366	.145	1.037	.021	-.02789	.57351	3.571	1.062	.42306
31	ALLOIH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.039	.114	.01832	.19784	1.722	-.959	.03339
32	DOBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.793	.00033	.00172	1.147	.155	.13307
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.133	.00565	.04443	1.554	.099	.06097
34	REGOR	GAM VEL	.623	1.553	1.833	.346	.143	.095	.026	-.02244	.46124	3.317	.808	.32206
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.039	.089	.00290	.03426	2.007	.100	.05242
36	HEZEN	25 DEL CMA	2.958	2.508	1.838	.039	.059	.095	.131	-.00467	.03434	1.568	.174	1.25115
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.090	-.01275	.12356	1.972	.280	1.65266
38	ATOK	EPS CAR	3.460	3.190	1.880	.026	.032	.031	.647	-.07763	.62084	2.672	1.189	.80111
39	ALNAID	85 ETA UMA	1.010	1.690	1.880	.244	.126	.091	.035	-.01965	.35759	2.994	.617	.25935
40	PENKALANAN	54 BET AUR	2.240	1.530	1.900	.079	.101	.050	.163	-.05843	.56101	1.336	-.347	.20622
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.032	-.01957	.37945	3.101	.655	.26762
42	ALPENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.099	.01464	.17325	1.872	-.137	.01935
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.351	-.08502	.31953	.500	-.165	.24767
44	MIRZAM	BET CTA	.750	1.740	1.560	.310	.120	.093	.020	-.02140	.52321	3.638	.941	.34873
45	ALPHARP	30 ALP HVA	5.151	3.421	1.981	.005	.026	.037	.506	.21335	.73021	1.104	-.459	.81528
46	HAWAI	13 ALP ARI	4.279	3.159	2.009	.012	.033	.061	.219	.03359	.18103	1.012	-.644	.04180

AVERAGE		RMS	1 SIGMA
CR-CRA	.01809	.15205	.35098
(CR-CRA)/CRA	.31319	.37980	.21485
CM-CHA	.35728	.57308	.44808
(CM-CHA)/CHA	.42141	.60079	.42821

Table 14. Pioneer F SS color index fit: $D-V=A*(U-V)$

PIONEER F SS COLOR INDEX FIT: $C-V=A*(U-V)$														
A=-1.38675250 B=.00000000 C=.00000000														
CU=-30.890600 CB=-29.283269 CV=-29.998474 CC=-29.887875														
NO.	PROPER NAME	DESIGNATION	U	V	CR1	CR2	CRV	CR	CR-CRA	CRPC	DM	DM-CMA	CMPC	
1	SIRIUS	9 ALP CMA	-1.499	-1.457	2.464	2.285	1.972	1.809	-0.1939	.01061	-1.441	-0.13	.00879	
2	CANOPUS	ALP CAR	-5.520	-7.720	1.000	1.000	1.000	1.000	.00000	.00000	-0.797	-0.24	.03121	
3	ARCTURUS	15 ALP BCC	2.440	1.180	-0.50	.201	.540	1.220	-0.14674	.10739	-1.013	.099	.09920	
4	VEGA	3 ALP LYR	.054	.044	.589	.573	.495	.462	-0.11170	.02467	.040	.003	.08048	
5	CAPELLA	12 ALP AUR	1.292	.842	.662	.489	.702	.702	.01100	.01605	-.041	-.041	.11125	
6	RIGEL	16 BET ORI	-5.37	-3.33	1.016	.528	.442	.326	-.04766	.17426	.420	-1.96	.31800	
7	PROCYON	10 ALP CMI	.787	.777	.300	.292	.371	.403	-.02430	.06825	.191	-.092	.32483	
8	ACHERNAR	ALP ERZ	-3.50	.320	.490	.955	.445	.328	-.02700	.13533	.815	-1.62	.16578	
9	HADAR	BET CMA	-6.10	.370	.610	1.086	.425	.294	.177	-.03178	2.1863	1.082	-2.239	.18083
10	ALTAIR	53 ALP ACL	1.053	.565	.753	.235	.241	.258	.267	.00167	.00630	.637	-.031	.04634
11	DEILGEMUS	52 ALP ORI	2.660	.800	.012	.032	.247	.736	-0.18549	.20127	-0.465	.220	.22118	
12	ALDEBARAN	67 ALP TAU	4.278	2.380	.858	.012	.060	.234	.129	-.02201	2.0529	1.424	-2.227	.13739
13	SPICA	57 ALP VIR	-2.12	.723	.968	.753	.305	.129	.653	.00137	.00211	-.334	-.026	.08579
14	ANTARES	2 ALP SCC	4.020	2.720	.880	.015	.045	.229	.323	-.01604	.04735	.431	.029	.07097
15	POULUX	78 BET GEM	2.996	2.146	1.146	.039	.085	.179	.176	-0.00405	.02254	1.091	.001	.00057
16	FGALHAUT	24 ALP PSA	1.313	1.243	1.153	.195	.190	.178	.144	-.00874	.06955	1.306	-.092	.06584
17	DENEK	50 ALP CYC	1.098	1.339	1.243	.225	.174	.163	.144	-.00874	.06955	1.306	-.092	.06584
18	MINGSA	BET CRU	.005	1.015	1.265	.617	.234	.161	.096	-.01762	.22619	1.752	-.246	.12290
19	ARCRUX	ALP CRU	-.450	.510	.790	.373	.249	.149	.049	-.02503	.20191	1.270	-.224	.14987
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.148	.117	-.00643	.06843	1.537	-.086	.05288
21	ADHARA	26 EPS CMA	.360	1.280	1.450	.445	.184	.129	.080	-.01359	.20366	1.941	-.225	.10404
22	CASTOR	66 ALP GEM	1.620	1.610	1.580	.139	.136	.120	.114	-0.02145	.01857	1.565	-.004	.00241
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.162	.116	.073	-.01212	.19954	2.046	-.222	.09774
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.072	-.01136	.18120	2.057	-.210	.09283
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.113	.084	-.00690	.08945	1.892	-.117	.09832
26	GACRUX	GAM CRU	5.040	3.280	1.660	.006	.029	.112	.347	-.06434	.16654	.353	.161	.09672
27	MIAPLACIUS	BET CAR	1.698	1.678	1.678	.130	.127	.110	.103	-.00290	.02735	1.670	.006	.00359
28	ALNILAM	46 EPS ORI	.474	1.514	1.694	.400	.148	.106	.065	-.01324	.25447	2.166	-.270	.11095
29	AL NAI'R	ALP GRU	1.133	1.593	1.743	.218	.138	.103	.078	-.00548	.07601	1.979	-.104	.04978
30	ALNIYAK	50 ZET ORI	.479	1.539	1.749	.398	.145	.103	.061	-.01233	.26356	2.240	-.269	.10738
31	ALIOTH	77 EPS UMA	1.780	1.760	1.790	.120	.118	.099	.092	-.00318	.03339	1.794	.013	.00716
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.099	.184	-.00888	.04596	1.039	.027	.02664
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.124	-.00341	.02677	1.470	.005	.00363
34	REGOR	GAM VEL	.633	1.553	1.833	.346	.143	.095	.058	-.00938	.16875	2.297	-.212	.08444
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.835	.128	.112	.095	.085	-.00010	.00115	1.881	-.025	.01331
36	WEZEN	25 DEL CMA	2.998	2.506	1.638	.038	.055	.095	.133	-.00242	.01778	1.385	-.005	.00334
37	SARGAS	THE SCO	2.810	2.260	1.860	.067	.074	.093	.105	-.00204	.01977	1.647	-.045	.02681
38	AVICR	EPS CAR	3.460	3.190	1.680	.026	.032	.091	.149	-.02401	.19194	1.269	-.215	.14475
39	ALKAIC	65 EIA UMA	1.010	1.590	1.880	.244	.126	.091	.062	-.00735	.13374	2.215	-1.160	.06749
40	MENKALINAN	34 BET AUR	2.240	1.530	1.900	.079	.101	.090	.094	-.01004	.09638	1.765	-.086	.05105
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.098	.059	-.00742	.14391	2.276	-1.70	.06955
42	ALHENA	24 GAM GEM	1.960	1.930	1.930	.102	.101	.087	.082	-.00254	.03003	1.910	.009	.00470
43	ATRIA	ALP IKA	4.905	3.395	1.935	.007	.026	.087	.233	-.03352	.12598	.786	-1.22	.18376
44	MIRZAM	2 BET CMA	1.750	1.740	1.580	.310	.126	.083	.050	-.00908	.22199	2.456	-.242	.08964
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.239	-.05281	.18076	.755	-1.92	.34184
46	HAMAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.169	-.01625	.08760	1.131	-.075	.07143
AVERAGE RMS 1 SIGMA														
CR-CRA .04035														
(CR-CRA)/CRA .13443														
DM-CMA .14786														
(DM-CMA)/CMA .17891														

Table 15. Ultraviolet (U) color index fit: D-B=A*(B-V)

NO.	PROPER NAME	DESIGNATION	U	B	V	CPL	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	DMPC
1	SIRIUS	2 ALP CMA	-1.499	-1.457	-1.464	2.484	2.285	1.972	2.386	-0.9748	0.3956	-1.457	0.042	0.2802
2	CANOPUS	ALP CAR	-0.520	-0.560	-0.720	1.000	1.000	1.000	1.000	0.0000	0.0000	-0.522	-0.002	0.0392
3	ARCTURUS	16 ALP SGO	2.440	1.390	0.950	0.953	0.214	0.540	0.559	0.9372	1.43159	1.473	0.967	0.39613
4	VEGA	3 ALP LYR	0.654	0.644	0.589	0.73	0.445	0.594	0.594	0.00445	0.0755	0.44	0.010	0.19519
5	CAPELLA	13 ALP AUR	1.292	0.842	0.62	0.180	0.275	0.487	0.5145	0.2302	0.2302	1.028	-0.264	0.20427
6	RIGEL	15 BET ORI	-0.537	-0.532	0.55	1.016	0.50	0.448	0.50	-0.4627	0.45902	0.128	0.665	1.23879
7	PROCYON	10 ALP GMI	-0.737	-0.777	-0.777	0.300	0.292	0.371	0.276	-0.02439	0.08127	0.877	0.090	1.1461
8	ACHERNAR	ALP ERI	-0.550	-0.520	-0.490	0.855	0.445	0.328	0.476	-0.37700	0.4090	0.275	0.629	1.79841
9	HADAR	BET CEN	-0.610	-0.370	-0.610	1.036	0.425	0.294	0.64	-0.62800	0.57325	0.313	0.223	1.51289
10	ALTAIR	51 ALP AGL	1.013	0.983	0.753	0.235	0.241	0.258	0.238	0.00289	0.0232	1.038	-0.015	0.01437
11	BETELGEUSE	53 ALP ORI	2.660	0.800	0.052	0.247	0.052	0.247	0.052	0.052	0.052	2.753	-1.525	0.25647
12	ALDEBARAN	67 ALF TAU	4.278	2.366	0.58	0.12	0.066	0.34	0.49	0.3694	0.56688	2.753	-1.525	0.25647
13	SPICA	57 ALP VIR	-2.12	-2.28	0.68	0.753	0.303	0.211	0.333	-0.41960	0.55724	0.671	0.883	4.16388
14	ANTARES	21 ALP SCO	4.020	2.720	1.890	0.15	0.045	0.229	0.34	0.1843	1.20637	3.159	-0.861	0.21419
15	POLLUX	78 BET GEM	2.996	2.146	1.146	0.339	0.085	0.179	0.069	0.2955	0.75323	2.385	-0.611	0.20409
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	1.65	1.190	1.178	1.183	0.00812	0.4395	1.264	-0.049	0.03656
17	DENEK	50 ALP CYS	1.039	1.339	1.249	2.225	1.174	1.63	0.77	-0.4932	2.1534	1.359	0.261	0.23813
18	MIMOSA	BET CRU	0.05	1.015	1.265	0.17	0.24	0.161	0.57	-0.36007	0.58397	0.955	0.950	190.67132
19	ACRUX	ALP CRU	-0.450	-0.510	-0.790	0.938	0.373	0.249	0.411	-0.52542	0.56148	0.443	0.893	1.98489
20	REGULUS	32 ALP LEO	0.871	1.241	1.351	0.278	0.190	0.148	0.202	-0.07371	0.27261	1.215	0.344	0.39467
21	ADHARA	26 EPS OMA	0.360	1.290	1.500	0.445	0.194	0.129	0.200	-0.24498	0.55098	1.228	0.968	2.40976
22	GASTOR	66 ALP GEM	1.620	1.610	1.580	1.19	1.136	1.120	1.139	0.00113	0.0093	1.617	-0.003	0.0175
23	SHAULA	31 LAM SCO	0.507	1.407	1.617	3.38	1.63	1.16	1.177	-0.21111	0.54364	1.357	0.850	1.67633
24	BELLATRIX	24 GEM ORI	0.545	1.415	1.635	0.75	0.162	0.114	0.176	-0.19867	0.82982	1.363	0.818	1.50003
25	ELNATH	112 BET TAU	1.032	1.522	1.652	2.39	1.47	1.133	1.357	-0.08281	0.34585	1.491	0.459	0.44475
26	GACRUX	GAM CRU	0.040	3.280	3.660	0.06	0.029	0.112	0.021	0.01515	2.53731	3.660	-1.374	0.27252
27	MIAPLACIUS	BET CAR	1.699	1.578	1.578	1.30	1.127	1.10	1.132	0.00219	0.16898	1.578	-0.020	0.11178
28	ALNILAM	46 EPS ORI	4.74	1.514	1.694	4.00	1.48	1.06	1.60	-0.24078	0.60146	1.471	0.957	2.10350
29	AL NA'IR	ALP GRU	1.133	1.593	1.743	2.19	1.38	1.03	1.47	-0.07081	0.32457	1.557	0.424	0.37442
30	ALNIJAK	51 ZET ORI	4.79	1.532	1.745	3.58	1.45	1.03	1.57	-0.24154	0.60617	1.485	1.010	2.10835
31	ALDIATH	77 EPS UMA	1.780	1.760	1.790	1.20	1.138	0.99	1.23	0.02344	0.02360	1.753	-0.027	0.01526
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	0.20	0.043	0.059	0.35	0.01568	0.79520	3.101	-0.637	0.17021
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	0.53	0.073	0.098	0.068	0.1465	0.27486	2.398	-0.265	0.09969
34	REGOR	GAM VEL	6.32	1.553	1.833	3.46	1.43	0.95	1.57	-0.18446	0.54502	1.486	0.653	1.34787
35	KAUS AUSTRALIS	20 EPS SGR	2.715	2.815	1.835	1.23	1.12	0.95	1.17	0.01022	0.98551	1.810	0.095	0.05537
36	WEZEN	25 DEL CMA	2.958	2.856	1.856	0.39	0.05	0.053	0.053	0.0383	0.35310	2.668	-0.330	0.11013
37	SARGAS	THE SCO	2.410	2.060	1.860	0.67	0.074	0.093	0.071	0.00335	0.04978	2.355	-0.055	0.02264
38	AVICR	EPS CAR	3.450	3.190	1.880	0.26	0.032	0.091	0.025	-0.00102	0.04003	3.503	0.642	0.61299
39	ALKAID	85 ETA UMA	1.010	1.690	1.890	2.44	1.26	0.91	1.36	-0.10939	0.43358	1.845	0.635	0.62939
40	MENKALINAN	34 DEL AUR	2.240	1.950	1.560	0.79	0.101	0.090	0.104	0.02515	0.1949	1.937	-0.303	0.13520
41	PEACOCK	ALP PAV	1.000	1.720	1.920	0.247	0.122	0.098	0.133	-0.11406	0.46253	1.672	0.672	0.67229
42	ALHENA	24 CMA GEM	1.960	1.930	1.62	1.02	1.01	0.687	1.05	0.02268	0.02629	1.930	0.030	0.1551
43	ATRIA	ALP IRA	4.905	3.395	1.935	0.07	0.026	0.026	0.020	0.01292	1.91033	3.743	-1.162	0.23684
44	MIRZAM	2 BET CMA	0.750	1.740	1.580	0.310	0.120	0.063	0.131	-0.17318	0.57716	1.683	0.933	1.24366
45	ALPHARC	30 ALP HYA	5.151	3.421	1.981	0.005	0.026	0.083	0.019	0.1791	2.57973	3.755	-1.386	0.26916
46	HAMAL	13 ALP ARI	4.275	3.155	2.005	0.12	0.035	0.081	0.026	0.01414	1.17533	3.433	-0.246	0.19763
<p>AVERAGE RMS SIGNA</p> <p>CR-CRA -1.0064 1.9604 1.6823</p> <p>(CR-CRA)/CRA 0.18442 0.91080 0.69658</p> <p>DM-DMA 0.07991 0.70524 0.70070</p> <p>(DM-DMA)/DMA 4.67324 28.35518 27.93327</p>														

Table 16. Blue (B) color index fit: $D-U=A*(U-V)$

		BLUE (B) COLOR INDEX FIT: $D-U=A*(U-V)$												
		A = -.46998501 B = .00000000 C = .00000000												
		CU = -30.890600 CB = -29.283269 CV = -29.998474 CC = -30.980290												
NO.	PROPER NAME	DESIGNATION	U	V	B	CRL	CRB	CRV	CR	CR-CRA	CRPC	CM	CM-CMA	CMPC
1	SIRIUS	9 ALP CMA	-1.499	-1.457	-1.457	2.464	2.285	1.972	2.219	-0.6581	.02881	-1.479	-0.022	.01528
2	CANOPUS	ALP CAR	-.520	-.560	-.720	1.060	1.000	1.000	1.000	.00000	.00000	-.614	-.054	.09642
3	ARCTURUS	16 ALP 800	2.940	1.180	-.050	.065	.073	.540	1.176	-.02497	.12400	1.270	.090	.07605
4	VEGA	3 ALP LYR	.044	.044	.044	.588	.573	.495	.543	-.03047	.05315	.048	.005	.12046
5	CAPELLA	13 ALP AUR	1.292	.842	.062	.188	.275	.487	.294	-.01941	.07062	.714	-.128	.15212
6	RIGEL	16 BET ORI	-.537	.133	.016	1.016	.528	.448	.691	.16281	.30823	-.213	-.346	2.59933
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.371	.331	-.03959	.13563	.585	-.192	.24722
8	ACHERNAR	ALP ERI	-.350	.320	.490	.885	.445	.328	.545	.10048	.22599	.045	-.275	.86004
9	MADAR	9ET CEN	-.510	.370	.610	1.068	.425	.234	.588	.16294	.38372	-.037	-.907	1.09897
10	ALTAIR	53 ALP AGL	1.053	.963	.753	.235	.241	.258	.245	.00381	.01578	.912	-.071	.07222
11	BETELGEUSE	53 ALP ORI		2.660	.800		.052	.247						
12	ALDEBARAN	87 ALP TAU	4.276	2.388	.858	.012	.066	.234	.049	-.01765	.26660	2.671	.283	.11836
13	SPICA	67 ALP VIR	-.212	.728	.968	.753	.305	.211	.414	.10900	.35696	.343	-.385	.52942
14	ANTARES	21 ALP SCO	4.020	2.720	.680	.035	.045	.229	.055	-.00579	.11867	2.544	-.176	.66462
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.033	.083	.179	.080	-.00259	.03130	2.127	-.019	.00907
16	FORMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.182	-.00635	.04395	1.238	-.005	.00418
17	DENEBO	50 ALP CYG	1.098	1.338	1.248	.223	.174	.163	.194	-.01954	.11425	1.168	-.170	.12668
18	MIMOSA	BET CRU	.065	1.015	1.265	.617	.234	.161	.328	-.09332	.39607	.597	-.418	.41164
19	ARUX	ALP CRU	-.450	.510	.790	.933	.373	.249	.503	.12943	.34676	.133	-.377	.73964
20	REGULUS	32 ALP LEO	.671	1.241	1.351	.278	.190	.148	.207	.08684	.08684	1.097	-.144	.11636
21	ACHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	.249	.06528	.35546	.896	-.384	.30017
22	CASTOR	66 ALP GEM	1.620	1.610	1.560	.175	.136	.120	.130	-.00593	.04077	1.601	-.009	.00547
23	SHAULA	31 LAM SCO	.907	1.407	1.617	.388	.162	.114	.220	.05688	.34812	1.029	-.378	.26888
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.378	.162	.114	.215	.05235	.32278	1.057	-.358	.25280
25	ELNAH	112 BET IAU	1.032	1.522	1.652	.239	.147	.113	.168	.02034	.14247	1.323	-.199	.13049
26	GARUX	GAM CRU	5.040	3.260	1.660	.016	.029	.112	.024	-.00546	.18750	3.451	.171	.05227
27	MIAPLACIDUS	BET CAR	1.678	1.670	1.670	.130	.127	.110	.120	-.00735	.05776	1.689	.011	.001632
28	ALNILAM	46 EFS ORI	.474	1.514	1.694	.400	.148	.108	.216	.06845	.46234	1.047	-.467	.30820
29	AL NA'IR	ALP ORU	1.333	1.593	1.743	.213	.139	.103	.154	.01599	.11616	1.420	-.173	.10979
30	ALNITAK	5C ZET ORI	.475	1.535	1.749	.358	.145	.103	.211	.06621	.45764	1.076	-.463	.30092
31	ALGIH	77 EPS UMA	1.730	1.760	1.790	.120	.113	.099	.110	-.00825	.06992	1.785	.025	.01403
32	DUBHE	5C ALP UMA	3.743	2.853	1.793	.020	.043	.099	.042	-.00108	.02503	2.827	-.026	.00928
33	MIRFAK	33 ALP PER	2.553	2.283	1.803	.052	.073	.098	.071	-.00197	.02709	2.259	-.024	.01059
34	REGOR	GAM VEL	.633	1.553	1.633	.346	.143	.095	.189	.04581	.32071	1.197	-.356	.22925
35	KAUS AUSIRALIS	20 EPS SGR	1.715	1.815	1.835	.173	.112	.095	.111	-.00107	.00953	1.771	-.044	.02402
36	WEZEN	25 DEL CMA	2.958	2.508	1.838	.059	.055	.035	.055	.00006	.00109	2.453	-.055	.02200
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.078	-.00383	.05147	2.152	-.108	.04801
38	AVIGR	EPS CAR	3.460	3.190	1.680	.026	.032	.091	.046	.01487	.47039	2.717	-.473	.14814
39	ALKAID	85 EIA UMA	1.010	1.690	1.880	.244	.126	.091	.154	.02787	.22137	1.419	-.271	.15042
40	MENKALINAN	24 BET AUR	2.240	1.930	1.900	.079	.101	.090	.084	-.001730	.17145	2.080	.150	.07783
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.152	.02940	.24007	1.432	-.288	.16722
42	ALHENA	24 GAM GEM	1.960	1.950	1.930	.162	.101	.087	.095	-.00629	.06235	1.946	.016	.00824
43	ATRIA	ALP TRA	4.905	3.395	1.935	.007	.026	.087	.022	-.00376	.14347	3.509	.114	.03362
44	MIRZAM	2 BET CMA	.750	1.740	1.680	.310	.120	.083	.167	.04695	.35049	1.328	-.412	.23673
45	ALPHARC	30 ALP HYA	5.151	3.421	1.931	.005	.026	.083	.019	-.00607	.23732	3.661	.240	.07020
46	MAHAL	13 ALP ARI	4.275	3.159	2.009	.012	.033	.061	.025	-.00306	.09356	3.212	-.053	.01682
		AVERAGE												
		RMS							1	SIGMA				
		CR-CRA	.02579	.05501	.04859									
		(CR-CRA)/CRA	.18076	.23144	.14454									
		CM-CMA	-.14488	.24933	.20292									
		(CM-CMA)/CMA	-.32264	.46332	.42365									

Table 17. Visual (V) color index fit: D-U=A*(U-B)

VISUAL (V) COLOR INDEX FIT: D-U=A*(U-B)														
A=-1.60468540 B=.00000000 C=.60000000 CUF=-30.890600 CB=-29.283288 CV=-29.998474 CC=-30.245220														
NO.	PROPER NAME	DESIGNATION	U	V	CRL	CRB	CRV	CR	CR-CRA	CRPC	DM	DM-DMA	CMPC	
1	SIRIUS	2 ALP CMA	-1.457	-1.457	2.464	2.285	1.912	2.150	-1.7829	.0903	-1.423	.034	.02320	
2	CANOPUS	ALP CAR	-5.60	-5.60	1.010	1.000	1.000	1.000	.00000	.0000	-.592	.128	.17751	
3	ARCTURUS	16 ALP BOO	2.440	1.180	-.950	.065	.201	.540	.497	.07789	.166	4.21689	4.21689	
4	VEGA	3 ALP LVR	.054	.044	.585	.573	.465	.561	-.06595	.13329	.036	-.008	.18293	
5	CAPPELLA	13 ALP AUR	1.232	.842	.062	.183	.487	.373	-.11407	.23440	.480	.418	5.73973	
6	RIGEL	19 BET ORI	-.537	.133	1.016	.528	.448	.312	-.13547	.30271	.672	.519	3.29399	
7	PROCYON	10 ALP CMI	.787	.777	.357	.300	.292	.285	-.08539	.23026	.769	.412	1.15392	
8	ACHERNAR	ALP ERI	-.350	.320	.855	.445	.328	.263	-.06542	.19941	.855	.369	.75362	
9	HADAR	BET CEN	.610	.370	1.085	.425	.294	.199	-.09442	.32441	1.159	.543	.89965	
10	ALTAIR	53 ALP AGL	1.053	.983	.753	.235	.241	.256	-.01065	.04125	.927	.174	.23062	
11	BETELGEUSE	53 ALP ORI	2.660	.800	.052	.052	.247	.261	.02709	.11587	.867	.609	.01022	
12	ALDEBARAN	67 ALP TAU	4.276	2.388	.658	.012	.066	.234	.02709	.11587	.867	.609	.01022	
13	SPICA	67 ALP VIR	-.212	.729	.983	.753	.505	.211	-.06358	.30993	1.485	.517	.53367	
14	ANTARES	21 ALP SCO	4.020	2.720	.860	.015	.045	.229	.124	-.10502	.45842	1.674	.754	.90187
15	POLLUX	78 BET GEM	2.996	2.146	1.146	.039	.083	.179	.151	-.02851	.15923	1.462	.316	.27561
16	FOMALHAUT	24 ALP PSA	1.313	1.243	1.153	.185	.190	.178	.194	-.01614	.59058	1.187	.634	.02919
17	DENEK	50 ALP CYG	1.099	1.338	1.548	.225	.174	.141	-.02175	.13333	1.531	.293	.22690	
18	MIMOSA	BET CRU	.065	1.015	1.265	.617	.265	.168	-.05306	.33030	1.828	.563	.44501	
19	ACRUX	ALP GRU	-.450	.510	.918	.173	.149	.178	-.07104	.28543	1.283	.493	.62366	
20	REGULUS	32 ALP LEO	.871	1.241	1.351	.278	.190	.140	-.00798	.05377	1.539	.188	.13901	
21	ADHARA	26 EPS CMA	.360	1.280	1.500	.445	.184	.129	-.03928	.30352	2.020	.520	.34700	
22	CASTOR	66 ALP GEM	1.620	1.610	1.560	.139	.136	.133	-.01231	.10241	1.602	.622	.01389	
23	SHAULA	31 LAM SCO	.507	1.407	1.617	.388	.163	.116	-.03481	.29987	2.131	.514	.31912	
24	BELLATRIX	24 GAM ORI	.545	1.415	1.635	.375	.162	.114	.083	-.03168	.27719	2.115	.480	.29372
25	ELNATH	112 BET TAU	1.032	1.522	1.652	.239	.147	.133	.099	-.01330	.11821	1.915	.264	.16004
26	GACRUX	GAM CRU	5.090	3.280	1.660	.065	.025	.112	.104	-.00751	.06726	1.863	.203	.12253
27	MAPLACIDUS	BET CAR	1.693	1.678	1.679	.130	.127	.125	-.01597	.14172	1.662	.216	.03959	
28	ALNILAM	40 EPS ORI	1.474	1.514	1.694	.400	.148	.108	-.04176	.38583	2.351	.657	.38789	
29	ALNATH	ALP GRU	1.133	1.593	1.743	.213	.138	.103	.095	-.00844	.08162	1.963	.220	1.26374
30	ALNATH	50 ZET ORI	1.479	1.539	1.749	.358	.145	.103	.064	-.03889	.37751	2.392	.643	.36774
31	ALNATH	77 EPS UMA	1.780	1.760	1.790	.120	.113	.099	.116	-.01721	.17371	1.744	-.048	.02575
32	DUBHE	50 ALP UMA	3.743	2.853	1.793	.020	.043	.059	.681	-.01781	.18029	2.137	.344	.19166
33	MIRFAK	33 ALP PER	2.663	2.283	1.803	.053	.073	.098	.094	-.00409	.04178	1.977	.174	.09659
34	REGOR	GAM VEL	1.633	1.552	1.633	.346	.143	.095	.070	-.02513	.26322	2.293	.460	.25122
35	KAUS AUSTRALIS	20 EPS SGR	1.715	1.815	1.935	.129	.112	.099	.101	.00608	.06396	1.895	.060	.03295
36	MEZEN	25 DEL CMA	2.958	2.505	1.838	.639	.655	.663	-.01207	.12727	2.114	.276	.14995	
37	SARGAS	THE SCO	2.410	2.260	1.860	.067	.074	.093	.081	-.01210	.13021	2.139	.279	.15014
38	ATJUR	EPS CAR	3.460	3.150	1.980	.026	.032	.031	.038	-.00570	.08860	2.573	1.693	.56121
39	ALKAID	85 ETA UMA	1.010	1.690	1.990	.244	.126	.091	.074	-.01738	.19094	2.237	.357	.19006
40	MENKALINAN	34 BET AUR	2.240	1.930	1.500	.076	.101	.090	.123	.03575	.37658	1.680	-.220	.11553
41	PEACOCK	ALP PAV	1.000	1.720	1.920	.247	.122	.088	.070	-.01819	.20692	2.300	.380	.19767
42	ALHENA	24 GAM GEM	1.900	1.930	1.930	.102	.101	.087	.078	.01308	.15022	1.906	-.024	.01251
43	ATRIA	ALP TRA	4.909	3.795	1.935	.007	.026	.037	.078	-.00884	.10201	2.180	.245	.12642
44	MIRZAF	2 BET CMA	7.50	1.740	1.980	.310	.120	.083	.056	-.02715	.32642	2.537	.557	.29123
45	ALPHARD	30 ALP HYA	5.151	3.421	1.981	.005	.026	.083	.089	-.00638	.07672	2.029	.048	.02400
46	HANAL	13 ALP ARI	4.279	3.159	2.009	.012	.033	.081	.072	-.00852	.10523	2.258	.249	.12371

AVERAGE			RMS	1 SICMA
CR-CRA	-.02060	.05379	.04969	
(CR-CRA)/CRA	.19598	.23272	.12550	
DM-DMA	.30546	.39607	.25213	
(DM-DMA)/DMA	.57230	1.34635	1.21665	

Table 18. Computer abbreviations of Greek alphabet and lower case letters

Greek		Lower case	
Abbreviation	Symbol	Abbreviation	Letter
ALP	α	-A	a
BET	β	-B	b
GAM	γ	-C	c
DEL	δ	-D	d
EPS	ϵ	-E	e
ZET	ζ	-F	f
ETA	η	-G	g
THE	θ	-H	h
IOT	ι	-I	i
KAP	κ	-J	j
LAM	λ	-K	k
MU	μ	-L	l
NU	ν	-M	m
XI	ξ	-N	n
OMI	\omicron	-O	o
PI	π	-P	p
RHO	ρ	-Q	q
SIG	σ	-R	r
TAU	τ	-S	s
UPS	υ	-T	t
PHI	ϕ	-U	u
CHI	χ	-V	v
PSI	ψ	-W	w
OME	ω	-X	x
		-Y	y
		-Z	z

^aSuperscripts are denoted as follows: ALP-1 implies α^1
 -H-2 implies h^2

Table 19. Constellations

1. AND	-	ANDROMEDA	46. LEO	-	LEO
2. ANT	-	ANTLIA	47. LMI	-	LEO MINOR
3. APS	-	APUS	48. LEP	-	LEPUS
4. AQR	-	AQUARIUS	49. LIB	-	LIBRA
5. AQL	-	AQUILA	50. LUP	-	LUPUS
6. ARA	-	ARA	51. LYN	-	LYNX
7. ARI	-	ARIES	52. LYN	-	LYNX
8. AUR	-	AURIGA	52. LYN	-	LYNX
9. BOO	-	BOOTES	53. MEN	-	MENSA
10. CAE	-	CAELUM	54. MIC	-	MICROSCOPIUM
11. CAM	-	CAMELOPARDALIS	55. MON	-	MONOCEROS
12. CNC	-	CANCER	56. MUS	-	MUSCA
13. CVN	-	CANES VENATICI	57. NOR	-	NORMA
14. CMA	-	CANIS MAJOR	58. OCT	-	OCTANS
15. CMI	-	CANIS MINOR	59. OPH	-	OPHIUCHUS
16. CAP	-	CAPRICORNUS	60. ORI	-	ORION
17. CAR	-	CARINA	61. PAV	-	PAVO
18. CAS	-	CASSIOPEIA	62. PEG	-	PEGASUS
19. CEN	-	CENTAURUS	63. PER	-	PERSEUS
20. CEP	-	CEPHEUS	64. PHE	-	PHOENIX
21. CET	-	CETUS	65. PIC	-	PICTOR
22. CHA	-	CHAMAELEON	66. PSC	-	PISCES
23. CIR	-	CIRCINUS	67. PSA	-	PISCIS AUSTRINUS
24. COL	-	COLUMBA	68. PUP	-	PUPPIS
25. COM	-	COMA BERENICES	69. PYX	-	PYXIS
26. CRA	-	CORONA AUSTRALIS	70. RET	-	RETICULUM
27. CRB	-	CORONA BOREALIS	71. SGE	-	SAGITTA
28. CRV	-	CORVUS	72. SGR	-	SAGITTARIUS
29. CRT	-	CRATER	73. SCO	-	SCORPIUS
30. CRU	-	CRUX	74. SCL	-	SCULPTOR
31. CYG	-	CYGNUS	75. SCT	-	SCUTUM
32. DEL	-	DELPHINUS	76. SCP	-	SERPENS CAPUT
33. DOR	-	DORADO	77. SCA	-	SERPENS CAUDA
34. DRA	-	DRACO	78. SEX	-	SEXTANS
35. EQU	-	EQUULEUS	79. TAU	-	TAURUS
36. ERI	-	ERIDANUS	80. TEL	-	TELESCOPIUM
37. FOR	-	FORNAX	81. TRI	-	TRIANGULUM
38. GEM	-	GEMINI	82. TRA	-	TRIANGULUM AUSTRALE
39. GRU	-	GRUS	83. TUC	-	TUCANA
40. HER	-	HERCULES	84. UMA	-	URSA MAJOR
41. HOR	-	HOROLOGIUM	85. UMI	-	URSA MINOR
42. HYA	-	HYDRA	86. VEL	-	VELA
43. HYI	-	HYDRUS	87. VIR	-	VIRGO
44. IND	-	INDUS	88. VOL	-	VOLANS
45. LAC	-	LACERTA	89. VUL	-	VULPECULA

Table 20. Standard Canopus ratios and magnitudes of stars used in conjunction with Tables 7 through 17

STAR NO.	MARINER '71 CT		PIONEER F SS		ULTRAVIOLET		BLUE		VISUAL	
	CR	MAGNITUDE	CR	MAGNITUDE	CR	MAGNITUDE	CR	MAGNITUDE	CR	MAGNITUDE
1	2.247	-1.457	1.828	-1.428	2.464	-1.499	2.285	-1.457	1.972	-1.457
2	1.000	-.578	1.000	-.773	1.000	-.520	1.000	-.560	1.000	-.720
3	.225	1.040	1.366	-1.112	.065	2.440	.201	1.180	.540	-.050
4	.564	.044	.474	.037	.589	.054	.573	.044	.495	.044
5	.293	.755	.691	-.372	.188	1.292	.275	.842	.487	.062
6	.517	.138	.278	.616	1.016	.537	.528	.133	.448	.153
7	.300	.731	.378	.282	.300	.787	.292	.777	.371	.357
8	.429	.341	.200	.977	.855	-.350	.445	.320	.328	.490
9	.406	.400	.145	1.321	1.086	-.610	.425	.370	.294	.610
10	.243	.957	.265	.668	.235	1.053	.241	.983	.258	.753
11	-	-	-	-	-	-	.052	2.660	.247	.800
12	.077	2.212	.922	-.685	.012	4.278	.066	2.388	.234	.858
13	.292	.758	.107	1.651	.753	-.212	.305	.728	.211	.968
14	.058	2.513	.651	-.308	.015	4.020	.049	2.720	.229	.880
15	.090	2.033	.339	.402	.039	2.996	.083	2.146	.179	1.146
16	.189	1.233	.180	1.090	.185	1.313	.190	1.243	.178	1.153
17	.173	1.329	.135	1.398	.225	1.098	.174	1.338	.163	1.248
18	.224	1.047	.078	1.998	.617	.005	.234	1.015	.161	1.265
19	.356	.545	.124	1.493	.938	-.450	.373	.510	.249	.790
20	.185	1.255	.110	1.622	.278	.871	.190	1.241	.148	1.351
21	.176	1.308	.067	2.166	.445	.360	.184	1.280	.129	1.500
22	.134	1.607	.116	1.568	.139	1.620	.136	1.610	.120	1.580
23	.157	1.434	.061	2.268	.388	.507	.163	1.407	.116	1.617
24	.156	1.443	.061	2.267	.375	.545	.162	1.415	.114	1.635
25	.142	1.538	.077	2.009	.239	1.032	.147	1.522	.113	1.652
26	.034	3.095	.411	.192	.006	5.040	.029	3.280	.112	1.660
27	.125	1.678	.106	1.664	.130	1.698	.127	1.678	.110	1.678
28	.142	1.538	.052	2.436	.400	.474	.148	1.514	.108	1.694
29	.133	1.611	.072	2.083	.218	1.133	.138	1.593	.103	1.743
30	.139	1.566	.049	2.510	.398	.479	.145	1.539	.103	1.749
31	.116	1.763	.095	1.781	.120	1.780	.118	1.760	.099	1.790
32	.047	2.733	.193	1.012	.020	3.743	.043	2.853	.099	1.793
33	.075	2.229	.127	1.465	.053	2.663	.073	2.283	.098	1.803
34	.136	1.588	.049	2.509	.346	.633	.143	1.553	.095	1.833
35	.110	1.818	.085	1.907	.128	1.715	.112	1.815	.095	1.835
36	.063	2.433	.136	1.394	.039	2.998	.059	2.508	.095	1.838
37	.076	2.216	.103	1.693	.067	2.410	.074	2.260	.093	1.860
38	.036	3.045	.125	1.484	.026	3.460	.032	3.190	.091	1.880
39	.121	1.714	.055	2.377	.244	1.010	.126	1.690	.091	1.880
40	.100	1.925	.104	1.683	.079	2.240	.101	1.930	.090	1.900
41	.118	1.745	.052	2.446	.247	1.000	.122	1.720	.088	1.920
42	.099	1.930	.085	1.909	.102	1.960	.101	1.930	.087	1.930
43	.030	3.229	.266	.664	.007	4.905	.026	3.395	.087	1.935
44	.115	1.770	.041	2.698	.310	.750	.120	1.740	.083	1.980
45	.029	3.256	.292	.563	.005	5.151	.026	3.421	.083	1.981
46	.036	3.028	.186	1.056	.012	4.279	.033	3.159	.081	2.009