



PHOTOMETRY

Standard Photometric Stars





Standard Photometric Stars

Overview

The central function of Photometry is accurate measurement of an object, typically a star, in terms of its brightness either overall magnitude/flux by dividing the flux into varying bands of the Electromagnetic Spectrum.

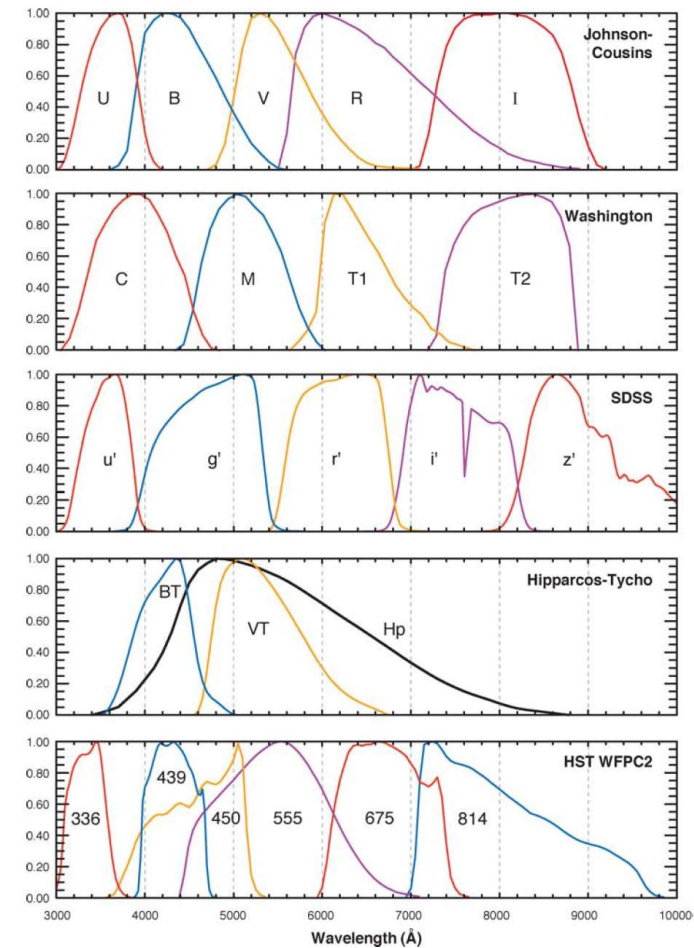
Whatever your location is on the Earth, you use a defined measurement system to determine the length of varying objects: Imperial and Metric.

When measuring stellar flux, what do you perform measurements and analysis against? This becomes the ultimate question so that there aren't multiple different measurements for a singular object.

Standard Photometric Stars provide a means to, not only calibrate your photometric system, but give a common "yardstick" from which all measurements can be compared.

IMPORTANT: This focuses on standard stars, not standard filter types.

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Standard Photometric Stars

What is a Standard Star

Photometric-standard stars are stars that have had their light output in various passbands of photometric system measured very carefully.

Thus the flux measured through your imaging system can be compared to a photometric-standard star to determine the exact brightness, or stellar magnitude, of the object and to calibrate your imaging system. From this you can develop Transform Coefficients.

Use such stars if your science goal requires a calibrated measurement of a flux or surface brightness of a particular object. Doing so places your project on a standardized scale that is both repeatable by others and is standardized against a meaningful scale.

Selection of standard stars will have to span the range of colors of your target and need to be observed them over a range of airmasses that will cover the target you will measure.

It is best to observe at least a dozen standards with a $SNR > 100$ without saturating the CCD. The fainter stars will require longer exposures; therefore it may be best to use the brighter standards when possible.



Standard Photometric Stars

Standard Star Sets

Landolt:

Arlo Landolt measured a number of stars using the UBVRI filter set. The list of primary standards can be found here:

http://adsbit.harvard.edu/cgi-bin/nph-iarticle_query?bibcode=1983AJ.....88..439L.

There is a second list of fainter standards with V magnitudes between 11.5 and 16.0 in fields close to the primary standards: http://adsbit.harvard.edu/cgi-bin/nph-iarticle_query?bibcode=1992AJ....104..340L

APASS: AAVSO Photometric All-Sky Survey

The AAVSO all-sky photometric survey was conducted in five filters: Johnson B and V, plus Sloan g' , r' , i' .

The magnitude ranges are from 7 to 17th.



Standard Photometric Stars

Landolt Stars

In 1973, Landolt published a list of stars carefully transformed to the Johnson UBV system. He extended that list to include stars in the Cousins RC and IC bands in 1983. This was further refined in 1992.

This includes fields near the celestial equator as well as regions farther north and south of the equator.

The Landolt catalog has become the de facto standard for transforming to the $UBVR_C I_C$ system.

Table 2. *UBVRI* Photometry of Standard Stars.

STAR (1)	α (J2000.0) (2)	δ (J2000.0) (3)	V (4)	$B - V$ (5)	$U - B$ (6)	$V - R$ (7)	$R - I$ (8)	$V - I$ (9)	n (10)	m (11)	MEAN ERROR OF THE MEAN					
											V (12)	$B - V$ (13)	$U - B$ (14)	$V - R$ (15)	$R - I$ (16)	$V - I$ (17)
TPhe I	00 30 04.593	-46 28 10.17	14.820	+0.764	+0.338	+0.422	+0.395	+0.817	25	13	0.0026	0.0032	0.0072	0.0036	0.0098	0.0110
TPhe A	00 30 09.594	-46 31 28.91	14.651	+0.793	+0.380	+0.435	+0.405	+0.841	29	12	0.0028	0.0046	0.0071	0.0019	0.0035	0.0032
TPhe H	00 30 09.683	-46 27 24.30	14.942	+0.740	+0.225	+0.425	+0.425	+0.851	23	12	0.0029	0.0029	0.0071	0.0035	0.0077	0.0098
TPhe B	00 30 16.313	-46 27 58.57	12.334	+0.405	+0.156	+0.262	+0.271	+0.535	29	17	0.0115	0.0026	0.0039	0.0020	0.0019	0.0035
TPhe C	00 30 16.98	-46 32 21.4	14.376	-0.298	-1.217	-0.148	-0.211	-0.360	39	23	0.0022	0.0024	0.0043	0.0038	0.0133	0.0149
TPhe D	00 30 18.342	-46 31 19.85	13.118	+1.551	+1.871	+0.849	+0.810	+1.663	37	23	0.0033	0.0030	0.0118	0.0015	0.0023	0.0030
TPhe E	00 30 19.768	-46 24 35.60	11.631	+0.443	-0.103	+0.276	+0.283	+0.564	38	10	0.0017	0.0013	0.0025	0.0007	0.0016	0.0020
TPhe J	00 30 23.02	-46 23 51.6	13.434	+1.465	+1.229	+0.980	+1.063	+2.043	28	15	0.0023	0.0043	0.0059	0.0011	0.0015	0.0011
TPhe F	00 30 49.820	-46 33 24.07	12.475	+0.853	+0.534	+0.492	+0.437	+0.929	19	10	0.0008	0.0024	0.0095	0.0005	0.0014	0.0029
TPhe K	00 30 56.315	-46 23 26.04	12.935	+0.806	+0.402	+0.473	+0.429	+0.909	2	2	0.0007	0.0007	0.0163	0.0007	0.0001	0.0007



Standard Photometric Stars

APASS

The AAVSO Photometric All-Sky Survey (APASS) performed an all-sky photometric survey in five filters: Johnson B and V, plus Sloan g' , r' , i' . The magnitudes range from 7th magnitude to about 17th magnitude.

This catalog helps various research programs establish transformation between different filter systems and achieve conversion of photometry to more fundamental physical properties as it bridges the gap between Tycho2 and SDSS.

The screenshot shows the AAVSO website header with the logo and navigation links: Home, Contact Us, FAQ, AAVSO Store, CCD School Videos, CHOICE Courses, and Donate. The main content area features a blue link for "APASS: The AAVSO Photometric All-Sky Survey". Below this, a section titled "Data Release 9 is now available." provides details about the survey's progress and data releases.

AAVSO
American Association of Variable Star Observers

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Home » Data

[APASS: The AAVSO Photometric All-Sky Survey](#)

Data Release 9 is now available.

Through a grant from the Robert Martin Ayers Sciences Fund, the AAVSO is performing an **all-sky photometric survey**. This survey is conducted in five filters: **Johnson B and V**, plus **Sloan g' , r' , i'** . It is valid from about 7th magnitude to about 17th magnitude. Precise, reliable standardized photometry in this magnitude range is in high demand, both from our observers and from the professional community. Such a catalog will allow many research programs to quickly establish transformation between systems and efficiently achieve conversion of photometry to more fundamental physical properties. It will bridge the gap between *Tycho2* and *SDSS*, plus cover the entire sky at the same depth as *UCAC*. The survey will take approximately one more year to complete.

Data release 1 of APASS occurred on 2010 September 10, and contained photometry for approximately four million stars distributed among several hundred discrete fields between $-10.15 < \text{Dec} < +87.35$. There have been 8 additional data releases in the intervening years, with the latest, **Data Release 9**, occurring on July 29, 2015. DR9 is primarily a southern release, incorporating 170 photometric nights through September 30, 2013. We expect the next data release in late-2015, covering the ~300 additional north/south nights acquired through the end of 2014. The catalog now contains photometry for 60 million objects in about 99% of the sky. About 400,000 images have been taken so far!



Standard Photometric Stars

Other Surveys & Standard Systems

SDSS: Sloan Digital Sky Survey ([http:// www.sdss.org/](http://www.sdss.org/)) used a set of five filters to survey more than 8000 square degrees of sky. This is the choice for the professional surveys.

2MASS: Two-Micron All-Sky Survey (2MASS) is a system focused on the infrared using the JHK system. The J and K magnitudes are often used to derive magnitudes in rich Milky Way fields, as the stars may suffer extreme reddening due to dust in the line of sight that scatters blue light.



Standard Photometric Stars

How to Select Standard Stars

When selecting a catalog, read the paper/s or other documentation accompanying the catalogue. These will contain details of the limitations, applicability and use of the catalogue which you should be aware of in order to use it effectively.

Do not mix different catalogs within a particular observation program. For example, if you are observing in the Johnson-Morgan system (UBVRI), then Landolt's catalogues are probably the most useful.

The desirable properties for a set of standard stars include the following:

- Range of zenith distances/airmass similar to the catalog stars
- Range of celestial coordinates similar to the catalog stars
- Range of colours and magnitudes similar to the catalog stars



Standard Photometric Stars

Observing Standard Stars

Due to transient variations in atmospheric extinction, it is advisable to regularly monitor the standard stars throughout a night's observing. Passing high clouds can affect this.

A typical strategy might be to start the night's observing with a series of observations of standard stars, covering a range of zenith distances.

These can be used to make a preliminary estimate of the atmospheric extinction. As the night progresses observations of standards are regularly interspersed amongst the observations of catalog stars.



Standard Photometric Stars

Summary

Standard stars place photometric observations on a common platform.

Using these stars allows you to calibrate your photometric system against these well-defined systems and establish Transform Coefficients for each of your filters.

From these coefficients, you can make photometric measurements, apply the coefficient to achieve standardized measurements that are useful for others and other projects.



Standard Photometric Stars

Questions?