

PROFESSIONAL ASTRONOMY filters



▶ www.omegafilters.com

Omega Optical designs and manufactures precision astronomy filters for advanced imaging systems to meet the most demanding spectral requirements. In addition, we offer industry-defined photometric sets. Adhering to the highest image quality standards, our filters are used by astronomers, atmospheric scientists and aerospace companies worldwide. We actively collaborate with industry professionals to maintain and redefine our reputation as the leader of precision interference filters for cutting-edge science.

▶ Light and Shadow in the Carina Nebula (NGC 3372)

Previously unseen details of a mysterious, complex structure within the Carina Nebula, one of the outstanding features of the Southern-Hemisphere portion of the Milky Way, as revealed by NASA's Hubble Space Telescope image of the "Keyhole Nebula". The picture is a montage assembled from four telescope pointings with Hubble's Wide Field Planetary Camera 2, using six color filters, including Omega Optical's F439W, F555W, and F814W. Image courtesy of NASA's Jet Propulsion Laboratory.

▶ Custom Filters

Our ability to customize filters for imaging systems sets us apart from other filter companies. With over 25 deposition chambers in service employing a range of coating technologies from reactive sputtering and ion-assisted refractory oxide to physical vapor deposition, we have the most important capacity for a filter supplier, **design flexibility**. Below are general guidelines of our capabilities:

- ▶ **Wavelength Range:** 190nm – 2500nm
- ▶ **Bandwidths:** minimum 0.15nm
- ▶ **Design Considerations:** Critical throughput, band-shape and bandwidth requirements
- ▶ **Size:** 2mm – 210mm
- ▶ **Sets:** Matching physical and optical performance attributes
- ▶ **Materials:** Space-flight compatible

▶ High Spectral Performance

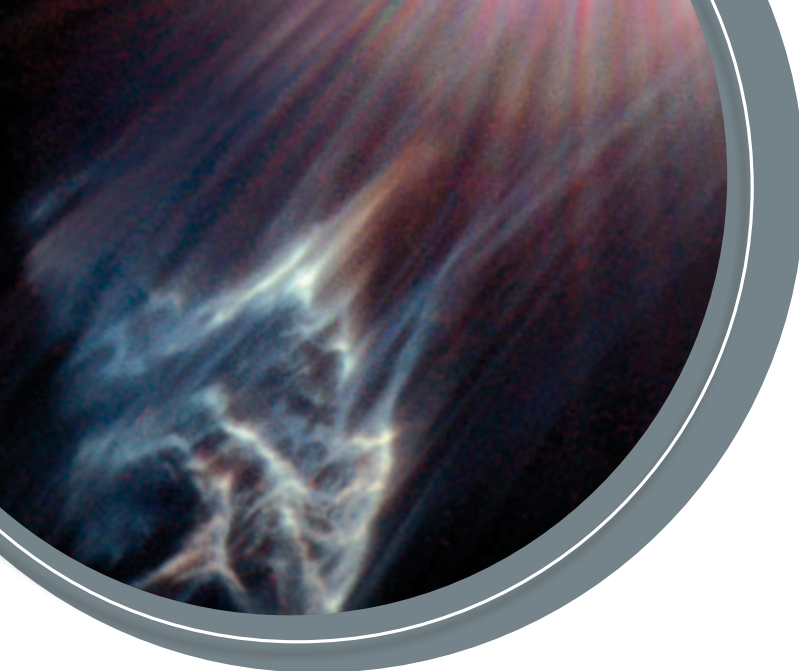
We achieve maximum throughput while adhering to critical band-shape tolerances from the UV to NIR. Placement of cut-on/cut-off edges are carefully controlled and optical densities in excess of OD6 ensure that adjacent spectral regions do not impart noise on one another through crosstalk.

▶ Optical Performance

As critical to the spectral performance of our filters is the preparation and care taken in the choice of substrates. Each filter is polished to guarantee optimum image quality.

▶ Large Format Filters

The use of CCD and other large format imaging detectors has revolutionized the study of astronomy. As both the size and sensitivity of these sensors have increased, Omega has pushed the envelope of coating technology to meet the need for large format filters up to 210mm. Our designs achieve the highest level of uniformity while maintaining the critical surface quality and transmitted wave-front requirements so critical to precision imaging.



◀ **Barnard's Merope Nebula, IC 349**
 Image Credit: NASA and The Hubble Heritage Team (STScI/AURA)
 Acknowledgment: George Herbig and Theodore Simon (Institute for Astronomy, University of Hawaii)

PHOTOMETRIC SETS

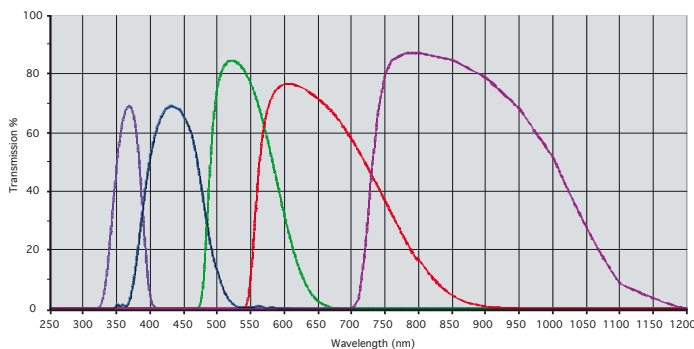
Common to the astronomy community is the need for precision photometric sets. Omega manufactures a wide range of interference filters for color imaging such as Bessell, SDSS, and Johnson/Cousins. All filters can be made in custom configurations to accommodate specific detector sensitivities. In addition to the materials and construction of our photometric sets, filter matching is an important consideration. Consistency between filters in relation to band shape, cut-on/cut-off, placement of adjacent spectral regions, throughput, attenuation, sensitivity to system focal ratio, as well as operating temperature, is controlled within strict tolerances.

- ▶ **TWD** ¼ wave (or better) per inch
- ▶ **Parallelism** <30 arc seconds
- ▶ **Surface Quality:** E/E as defined by Mil-C-48497A
- ▶ **Anti-Reflective Coating:** multi-layer dielectric AR coating on both surface. R typically <0.5% for optimal transmission
- ▶ **Anti-Reflective Coating Durability:** to moderate abrasion as defined by Mil-48497A

BESSELL SETS

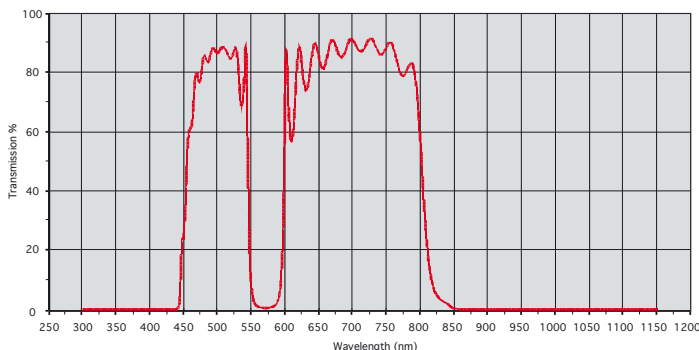
Omega Optical Bessell Photometric Sets are manufactured to the highest optical standards as defined by M. Bessell. In addition to our stock filter sets, custom filters are available to compensate for such aberrations as atmospheric light pollution and dedicated imaging applications.

Improved Bessell Filter Sets



Curves, left to right: U, B, V, R, I

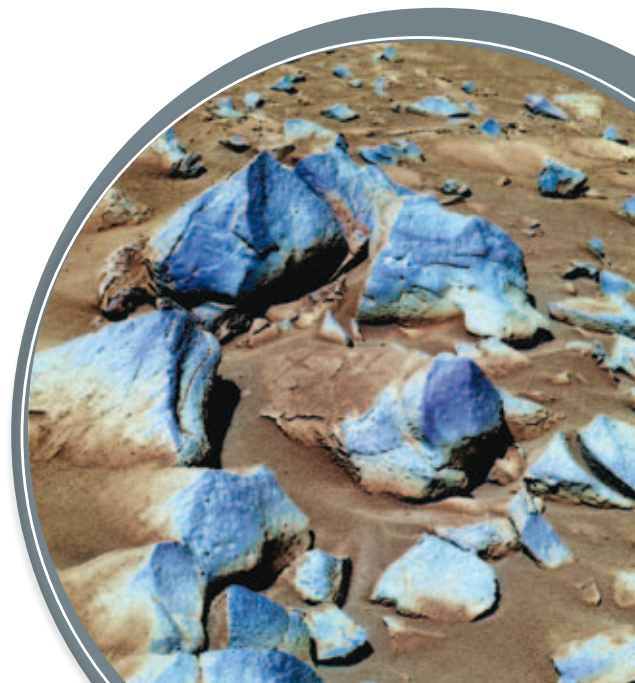
NEW Omega Optical V+R Dual Band Bessell Filter with light pollution suppression



	Filter U	Filter B	Filter V	Filter R	Filter I	Complete Set
Part #	XBSSL/U	XBSSL/B	XBSSL/V	XBSSL/R	XBSSL/I	XBSSL
25 mm Round	\$100	\$100	\$100	\$100	\$100	\$430
25 mm Square	\$100	\$100	\$100	\$100	\$100	\$430
28 mm Round	\$125	\$125	\$125	\$125	\$125	\$530
32 mm Round	\$125	\$125	\$125	\$125	\$125	\$530
38 mm Round	\$150	\$150	\$150	\$150	\$150	\$630
50 mm Round	\$250	\$250	\$250	\$250	\$250	\$1050
50 mm Square	\$250	\$250	\$250	\$250	\$250	\$1050

Martian surface ▶

Obtained using 13-filter, 11-color multispectral composites of selected soil, outcrop, and loose rock targets, such as those in the picture, the visible to near-IR images reveal mineralogical detail through characteristic reflectance signatures. Images were obtained by Spirit at the Gusev Crater and Opportunity at the Meridiani Planum. Photo courtesy of NASA/JPL/Cornell.



SDSS PHOTOMETRIC SET

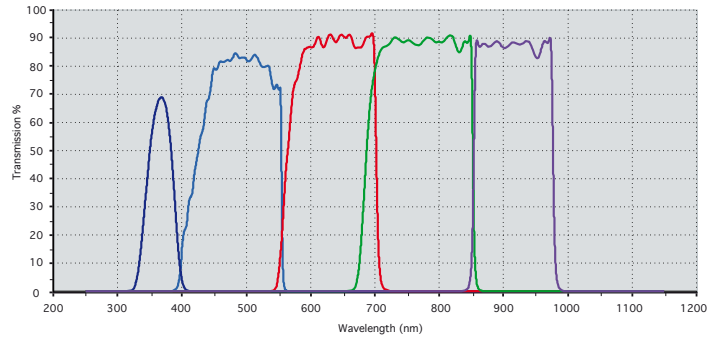
(Sloan Digital Sky Survey)

Omega introduces a new photometric filter set matching the specifications set forth by the Sloan Digital Sky Survey. These filters, comprising the u' g' r' i' z' (ultraviolet, green, red, near infrared, and infrared) spectrum, cover wavelengths from 3543 to 9134 angstroms. Our new set takes advantage of new glass types to provide higher transmission and sharper edges.

	Filter u'	Filter g'	Filter r'	Filter i'	Filter z'	Complete Set
Part #	XSDSS/u	XSDSS/g	XSDSS/r	XSDSS/i	XSDSS/z	XSDSS
25 mm Round	\$200	\$200	\$200	\$200	\$200	\$860
25 mm Square	\$200	\$200	\$200	\$200	\$200	\$860
28 mm Round	\$250	\$250	\$250	\$250	\$250	\$1060
32 mm Round	\$250	\$250	\$250	\$250	\$250	\$1060
38 mm Round	\$300	\$300	\$300	\$300	\$300	\$1260
50 mm Round	\$500	\$500	\$500	\$500	\$500	\$2100
50 mm Square	\$500	\$500	\$500	\$500	\$500	\$2100

and infrared) spectrum, cover wavelengths from 3543 to 9134 angstroms. Our new set takes advantage of new glass types to provide higher transmission and sharper edges.

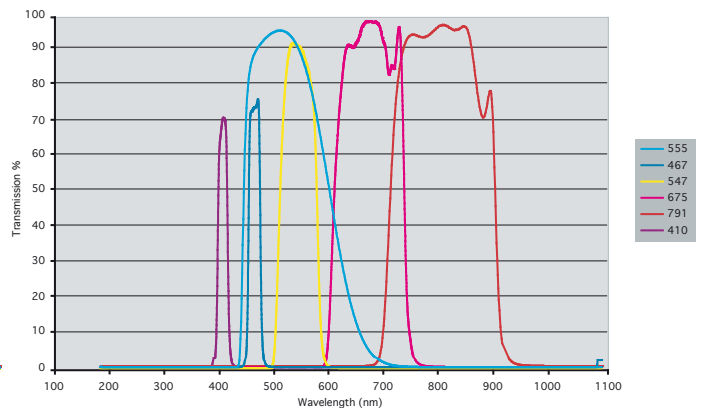
NEW SDSS Photometric Set



HUBBLE SPACE TELESCOPE (HST)

Omega Optical played a key role as the supplier of interference filters for the Wide Field Planetary Camera 2 (WFPC2) in service from 1993 – 2009. Our contribution of broad-band and medium band filters, covering the ultraviolet to near infrared spectrum, helped extend the world's view to the furthest reaches of space through observations of the Hubble Deep and Ultra-Deep Fields. Closer to home, the now iconic "Pillars of Creation" in the Eagle Nebula, demonstrating star birth in stellar nurseries, was a major achievement in astronomical imaging. We are pleased to have been instrumental in the investigation of countless phenomena from galactic super clusters to intricate nebulas and the first direct observation of an extra-solar planet. As a supplier of filters for the next generation WFPC3 we are proud to continue our support as NASA extends its reach to the edge of the visible universe.

Wide Field and Planetary Camera (WFPC2) Medium Band Filters

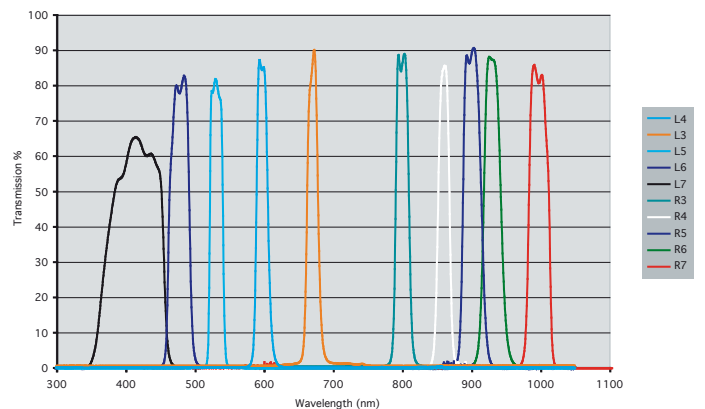


MARS ROVERS

Omega Optical's filters continue to explore the Martian landscape on both the Spirit and Opportunity Rovers.

Exclusively using Omega filters, a total of 3 sensor systems including the Navigation Camera, Hazard Avoidance Camera, and most importantly, the Panoramic Stereo Camera (Pancam) have imaged Mars in unprecedented clarity. Since 2004 the Pancam has delivered high resolution multispectral images using a total of 16 filters divided between two detectors. Among the many mineralogical discoveries, our filters helped prove that water was present on the surface of Mars, furthering the consideration that life may have once existed on the red planet.

Mars Exploration Rover Panoramic Camera Filters



Spectral profiles are actual measured filters from Rovers Spirit and Opportunity, which have been imaging the Martian surface since 2004.



◀ This color-composite image was created from seven images taken with three different Hubble cameras: the Faint Object Camera (FOC), the Wide Field and Planetary Camera 2 (WFPC2), and the Near Infrared Camera and Multi-Object Spectrometer (NICMOS).
Credit: NASA, ESA, and D. Maoz (Tel-Aviv University and Columbia University)

PROJECTS

Omega Optical has years of experience designing and manufacturing imaging system filters critical to astronomy and aerospace applications for organization such as:

- ▶ **AURA** - Association of **U**niversities for **R**esearch in **A**stronomy
- ▶ **Canadian-France-Hawaii Telescope**
- ▶ **ESA Giotto Mission**
- ▶ **European Southern Observatory Very Large Telescope**
 - **CONICA** - **CO**udé **N**ear **I**nfrared **CA**mera (VLT)
 - **OSIRIS**
- ▶ **Canadian Space Agency**
 - **BRITE- BR**Ight **T**arget **E**xplorer Constellation
- ▶ **GRANTECAN**
- ▶ **NASA JPL Star Dust Project**
- ▶ **NASA JPL Hubble Space Telescope**
WFPC2 & WFPC3
- ▶ **NASA JPL Martian Rovers**
Spirit and Opportunity
- ▶ **Observatories of the Carnegie Institute of Washington**
- ▶ **US Naval Observatory**

OPTICAL FILTER CAPABILITIES

Omega's filters are used for a wide range of astronomy studies. Following is a partial list of filters, supplied to researchers, universities, observatories and government agencies.

▶ **Solar Observation:**

- H-alpha
- H-beta

▶ **Nebula and Cometary Studies:**

- OII
- OIII
- SII
- CII
- CIII

▶ **IR Astronomy:**

- J, H, K Bands

▶ **Photometric Sets**

- Bessell (UBVRI)
- Johnson/Cousins (UBVRI)
- Stromgren (UBVY) – Beta Wide & Narrow
- SDSS (u', g', r', l', z')
- Thuan-Gunn

▶ **Other**

- Detector Compensation
- Harris R
- Mould R-I



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