

This brochure describes the KATOPTARON system which is incorporated in all models.

KATOPTARON®

KA.TOP.TA.RON (kə top' tä rän) n. [Mod. Ger. *Katoptaron* (H. Makowsky, c. 1975); < Mod. Eng. *catoptric*, meaning all-mirror optics]

1. A revolutionary new type of all-mirror optical device.
2. A primary optical system of such versatility that it can be used as a telephoto lens, macro lens, spotting scope, telescope or long distance microscope.
3. The world's finest such optical system.

Ten years in design and development, KATOPTARON is the "brainchild" of world-famous optical innovator H. Makowsky of Cologne, West Germany. Now you may own this superb instrument.

The KATOPTARON is the first commercially-available 500mm *all-mirror* optical system with guaranteed *perfect* color rendition. Not "good." Not "excellent." PERFECT.



Model TS 500 EM

ALL-MIRROR DESIGN

KATOPTARON's all-mirror design not only guarantees perfect color rendition, it also means that *all light wavelengths—from UV through the visual spectrum, and on into the infrared—are faithfully reproduced*. This is a world-first.

KATOPTARON's mirrors are made of Carl Zeiss' Schott Zerodur®, a completely temperature-stable ceramic material. Zerodur will not expand or contract under any temperature or environmental conditions you will *ever* encounter—whether you use KATOPTARON in the Antarctic or in Death Valley.

KATOPTARON is also *the world's first and only mirror optic with variable f/stop (via iris diaphragm) from f/8 to f/32*. KATOPTARON is the *only* mirror optic (of any type) which *offers variable control of both exposure and depth-of-field*. Further still, KATOPTARON's unique all-mirror system *has no disc obstruction (common to all other mirror lenses)*. All these features add up to clearer, sharper images. KATOPTARON accomplishes all this in a compact, hand-holdable body—the solidity and precision of which belie the fact that KATOPTARON weighs a mere 35 ounces.



Model TS 500 EM

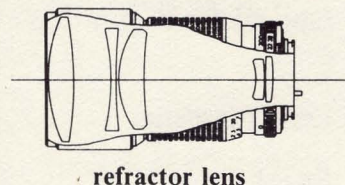
PERFECT COLOR RENDITION

In essence, perfect color rendition means the *ultimate* in contrast, fidelity and brilliance—whether used in 35mm photo, cine, video or visual applications.

Unless an optic is composed exclusively of reflecting surfaces, it cannot have perfect color rendition; some chromatic aberration is always present. Until KATOPTARON, color *correction* was the criterion upon which quality was defined. KATOPTARON sets a new definition of performance because its unique design eliminates the need for *any* color correction.

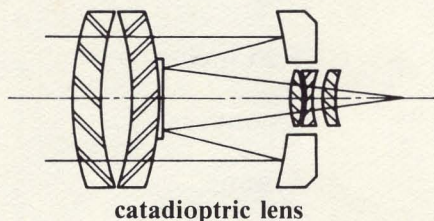
REFRACTOR LENSES

Whenever light goes through glass lens elements, it is refracted and diffracted. The light is “broken up” into its various component colors. Red and blue focus at different places, causing image deterioration and color fringing. By combining glasses with different characteristics, it is possible to correct one against the other so that the induced color is brought to within an “acceptable” limit. Lenses working this way are called *refractors* and, depending upon the glasses used and the tolerances, design, etc., it is possible to make refractors with “very good” to “excellent” color *correction*. Refractor lenses can, and almost always do, contain variable iris diaphragms for depth-of-field/exposure control—a prime advantage over *catadioptric* (“CAT”) mirror lenses which have no such controls. Refractors have typically been large and bulky, their advantages accomplished at the expense of size and weight. An excellent quality 500 mm refractor might be as much as two feet long and weigh several pounds.



CATADIOPTRIC (“CAT”) MIRROR LENSES

While they vary somewhat in design, the diagram at the left shows the construction of a typical catadioptric mirror lens. They all have a front glass element with a silvered central disc (the secondary mirror). Light enters around the disc, passes through the glass elements, and reflects off the primary mirror to the secondary. The reflection from the secondary mirror is, in turn, imaged onto the film plane through still another system composed of negative lens elements (essentially, a built-in teleconverter, or Barlow system). This enables the unit to be more compact. However, because of the inherent “CAT” design, it is impossible to directly control the incoming light with an iris diaphragm. Thus, depth-of-field and exposure are not controllable. “CAT” lenses are limited to one f/stop and



one fixed amount of depth-of-field. This makes focusing extremely difficult, since there is little focus-error tolerance at full aperture.

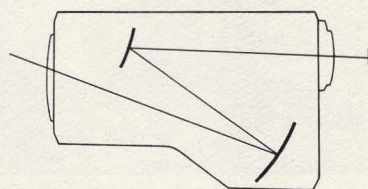
The most detrimental feature of catadioptric lenses is that the central disc obstruction inevitably produces all kinds of *aberrations and unwanted effects* in the portions of the image not in perfect focus. These optical artifacts (“doughnuts”) are part and parcel of the catadioptric design, and no matter what the quality or “brand name,” they cannot be alleviated. Further, since the center of the mirror in a “CAT” is nothing less than an obstruction, “CAT” lenses can (and usually do) produce “hot spots,” i.e., the center of the photo is not exposed the same as the outer parts. “CAT” lenses always show these “signatures” on close examination.

Essentially, catadioptric lenses have as many compromises as do refractors. "CAT's" offer hand-holdability and compactness, but compromise depth-of-field and exposure control. Exactly the opposite is true with refractors. They have excellent depth-of-field and exposure control, but compromise compactness and ease of portability. With either type of lens, one advantage is sacrificed for another.

KATOPTARON SACRIFICES NOTHING. With KATOPTARON, the user can control aperture and depth-of-field as proficiently as with the finest refractors. Yet, it renders the best color fidelity physically possible. It is compact in size and light in weight.

THE KATOPTARON DIFFERENCE

Unlike catadioptric mirror lenses, KATOPTARON's design is *catoptric*, with the secondary mirror placed 23 degrees off-axis for an unobstructed light path—a KATOPTARON exclusive. Light enters the aperture and passes through an iris diaphragm in front of the primary mirror. The light reflects off the primary to the secondary mirror and then goes *directly* to the film plane. This innovative design is the result of years of research by H. Makowsky into precise mirror curvatures, off-set angles and collimation. Thus, KATOPTARON "does it all with mirrors"—literally. And since the mirrors are made of Zerodur, KATOPTARON is actually "the glassless lens," capable of transmitting all wavelengths of light. KATOPTARON's unique optical system has no "hot spots" or "doughnuts." Moreover, KATOPTARON cannot vignette or produce image cut-offs. Special anti-flare baffling and multi-coatings limit all unwanted reflections to a theoretically undetectable limit.



EXCELLENCE BY DESIGN

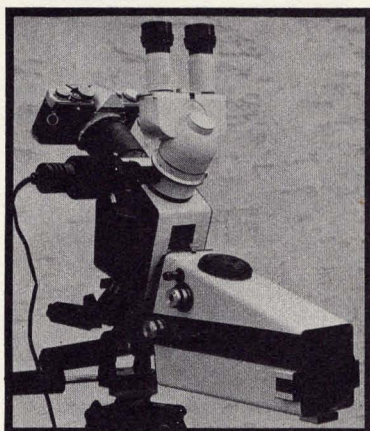
Literally hand-crafted and constructed, only the finest materials are used in each KATOPTARON. The die-cast aluminum housing is machined to precise tolerances. Zeiss' Zerodur ceramic is more expensive than glass mirror blanks, but it is vastly superior because of its temperature stability. Even large changes in temperature will not affect image quality. The KATOPTARON's mirror curvatures always maintain their critical focus.

Each KATOPTARON is optically bench-tested a total of nearly four hours during its construction. Assembly is performed by technicians trained in the finest West German optical tradition.

THE UNIVERSAL SYSTEM

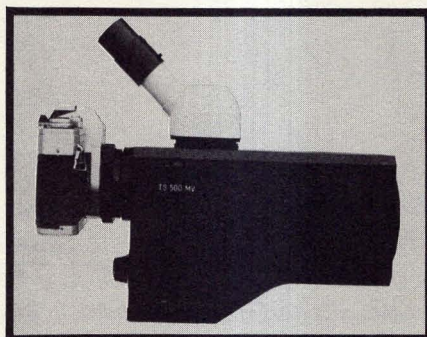
Key to the KATOPTARON's optical performance is a unique "*floating mirror*" design. "Floating mirrors" permit the KATOPTARON to be a universal system capable of optimizing its focus for both the near and far ranges. Other such systems can optimize focus *either* at infinity *or* at close range. Because the KATOPTARON system is so versatile, it can be made to optimally focus from the moon to within 28 inches—and everywhere in between. Furthermore, the KATOPTARON optimizes focus even when accessories are used. Simply dial-in the proper setting by using the controls on the back of each KATOPTARON.

Model LDM-1



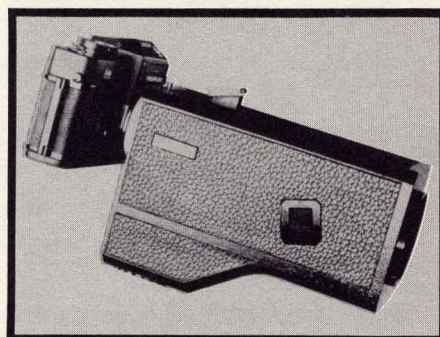
Shown with PB unit, camera, binocular and vertical illuminator

Model TS 500 MV



Shown with camera and monocular

Model TS 500 EM



Shown with 35mm SLR

KATOPTARON Fits Virtually Every SLR, Cine or Video Camera

KATOPTARON will fit virtually all 35mm SLR's, cine and video cameras. The universal "T"mount system is used on all KATOPTARON models.

Standard 67mm Filter Size

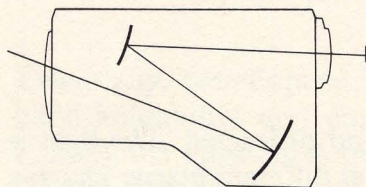
KATOPTARON is the only mirror optic which mounts 67mm filters and front lens accessories externally—just as refractors do. 67mm filters are readily available from most photographic dealers at moderate cost.

KATOPTARON IN SPECIAL APPLICATIONS

The unique optical design of the KATOPTARON permits a multitude of suggested "off the shelf" applications from *one* stock unit:

solar research ★ spectroscopy ★ collimation ★ laser research ★ observation of dangerous materials ★ long distance microscopy ★ photomicrography ★ photomacrography ★ underwater photography ★ cinematography ★ photography in the IR & UV ★ low light level detection systems ★ closed circuit television ★ security and surveillance

— ASK US ABOUT YOUR SPECIAL REQUIREMENTS —



SPECIFICATIONS

	KATOPTARON TS 500 EM	KATOPTARON TS 500 MV	KATOPTARON LDM-1
Optical Configuration	MAKOWSKY Cassegrain	MAKOWSKY Cassegrain	MAKOWSKY Cassegrain
Lens Elements	None	None	None
Focal Length	500mm	500mm	500mm
Aperture Range	f/8-32	f/8-32	f/8-32
Clear Aperture	2.0 inches	2.0 inches	2.0 inches
Central Obstruction	None	None	None
Field of View	5°	5°	5°
Near Focus	6.25 feet (macro)	6.25 feet (macro)	6.25 feet (macro) 27.6 inches (micro)
Mirrors	Schott* Zerodur®	Schott* Zerodur®	Schott* Zerodur®
Special Coatings	Yes	Yes	Yes
Length	8.25 inches	8.25 inches	8.25 inches
Weight	35 ounces	35 ounces	35 ounces
Filter Provision	67mm	67mm	67mm
Accessory Shoe	Yes	No	Yes (3)

* Division of Carl Zeiss

In line with our commitment to continuous research and development, H & R Optical Systems, Inc., reserves the right to change specifications without notice.

H&R Optical Systems, Inc.

971 Arapahoe Ave., Boulder, Colorado 80302
(303) 440-4057