PHOTOGRAPHIC MATERIALS

For the partial phases, any film can be used. For the most interesting phases of an eclipse, those occurring during totality, a high-speed photographic material is desirable. The following films are recommended for eclipse photography. The ASA Speeds are listed for use with the Table of Approximate Exposures and with the formula on page 4.

KODAK Roll Films (Black-and-White)	ASA Speed
PANATOMIC-X	40
VERICHROME Pan	125
PLUS-X Pan (PX135 only)	125
TRI-X Pan	400
ROYAL-X Pan (RX120 only)	1250

KODAK Sheet Films (Black-and-White)	
PANATOMIC-X	64
PLUS-X Pan	125
SUPER-XX Panchromatic	200
Super Panchro-Press, Type B	250
ROYAL Pan	400
RS Pan	650
ROYAL-X Pan	1250

KODAK Color Films (Rolls and Sheet)	
KODACHROME II (KR135, KR828)	25
KODACHROME-X (KX126, KX135)	64
KODACOLOR	32
KODACOLOR-X (CX126, CX135)	64
EKTACHROME-X (Rolls)	64
EKTACHROME, Daylight Type (Process E-3) (Sheet)	50
High Speed EKTACHROME, Daylight Type (Rolls)	160

KODAK Movie Films (Black-and-White and Color)	
PLUS-X Reversal (16mm)	50
TRI-X Reversal (16mm)	200
ROYAL-X Pan Recording (16mm)	1250*
KODACHROME II, Daylight Type (16mm, 8mm)	25
EKTACHROME ER, Daylight Type (16mm)	160

*This speed number contains a slight safety factor. Therefore, an index of 1600 should be used with most exposure meters.

Sales Service Division

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Solar Eclipse Photography For the Amateur

The following survey has been prepared in response to a number of inquiries from photographers about the technique of eclipse photography with both still and motion-picture cameras. The data presented have been gathered from what are considered to be the most reliable descriptions of experiences during previous eclipses.

Information concerning this subject is somewhat limited in quantity. If you have been successful in this activity, we will welcome your contribution of information concerning ways and means of photographing the various phenomena which occur during an eclipse.

WARNING

THE SUN CAN BURN YOUR EYE WITHOUT YOUR KNOWLEDGE

Who hasn't seen the power of the sun to burn? Remember the fun you had, as a child, burning holes in paper with a magnifying glass? To look at the sun through any optical instrument — even the finder on your camera — can burn your eye and cause blindness. Galileo was so blinded. Therefore, never look at the sun through any optical device without adequate protection.

There are two important aims of such protection: The first is to reduce the visual intensity of the sun for comfort. The second, and more important, aim is to reduce the energy that you cannot see — namely, the ultraviolet and infrared radiation which can damage your eye instantaneously without your being aware of it.

Always use a filter which will absorb equally and sufficiently the ultraviolet, visible, and infrared energy of the sun. There have been some erroneous recommendations suggesting the use of materials which absorb the visible energy but do not absorb the dangerous, invisible infrared rays. One such suggestion involves the use of crossed-polarizing elements.

Medical authorities indicate that a neutral-density filter of metallic silver, such as developed photographic film, of at least 6.0 density will provide adequate protection, for VISUAL USE ONLY. Such filters are not suitable for photographic use. Place the filter IN FRONT OF your eyes before facing the sun. Such a filter can be made with two thicknesses of black-and-white (not color) photographic film, such as KODAK VERICHROME Pan Film, which has been completely exposed and developed to maximum density. The film can be completely exposed by unrolling it and subjecting it to daylight. Develop the exposed film fully, according to the manufacturer's recommendations.

FIRST CONSIDERATION – Focal Length

The high light-intensity of the sun permits the use of any camera. However, the size of the sun's image will depend upon the focal length of the camera lens. The actual image size on the film can be estimated by dividing the focal length by 100. For example: with a camera having a focal length of four inches, the image size would be 4/100 inch in diameter — the thickness of a dime. However, many good pictures of solar eclipses have been made with 35mm cameras equipped with lenses of 2-inch focal length. So don't put your camera away because you don't have a lens of long focal length.

In the case of motion pictures, the image will be enlarged when projected on the screen. Assuming a magnification of 100 diameters on projection, the diameter of the image of the sun on the screen will be approximately equal to the focal length of the taking lens.

SECOND CONSIDERATION – Camera Protection

The sun will burn holes in focal-plane shutters, warp the leaves of between-the-lens shutters, and melt composition shutter blades. Use small lens openings and neutral-density filters that are made for photographic use. If the camera must be pointed toward the sun throughout the eclipse, shade it with a hat between exposures.

THIRD CONSIDERATION – Aiming the Camera

NEVER look at the sun through a camera finder without suitable filters. This is especially true with single-lens reflex cameras, both still and movie. The best policy is to "aim" the camera without using its finder. If you must use the finder, use filters (made from black-and-white film, as described in the warning at the start of this article) held in front of the finder or camera lens. Filters made for photographic use give NO VISUAL PROTECTION. Therefore, use exposed-film filters for visual aiming and change to dyed gelatin filters for photographing the eclipse.

FOURTH CONSIDERATION – Exposure

The sun is so intense that the light of the sun's surface must be reduced 10,000 to 100,000 times. Neutral-density filters (ND) provide the most convenient way of cutting down the light to allow normal camera exposures. During the partial phases, the intensity of the surface of the sun is the same as during any day. Therefore, to determine the best exposure of the partial phases for your equipment, make test pictures well in advance of the eclipse. Mr. Charles H. Coles, formerly of The American Museum of Natural History, evolved a simple formula for determining the correct exposure for the partial phases. This formula is:

$$f^2 = S \times t \times 10^{7-D}$$

where –

- f is the diaphragm setting
- S is the ASA Speed of the film
- t is the shutter speed in seconds
- D is the density of the neutral filter in use

For example, with a neutral-density filter of 5.0, KODAK PANATOMIC-X Roll Film (ASA Speed 40), and a shutter speed of 1/60 second, an aperture of f/8 would be required; with a shutter speed of 1/30 second, the aperture would be f/11.

Additional exposure information is tabulated on page 11. If you are using a box camera, use KODAK VERICHROME Pan Film and a 5.0 ND (neutral-density) filter during the partial phase. Remove the ND filter during totality.

WHAT TO PHOTOGRAPH DURING A SOLAR ECLIPSE

PARTIAL PHASES

Beginning about one hour before totality, the moon can be seen gradually encroaching on the sun's disk; for about one hour after totality, the shadow gradually retreats. An interesting record of the eclipse can be obtained by mounting the camera on a firm support and making a series of exposures at five-minute intervals on the same film, starting one-half hour before totality and continuing for one-half hour after. The period over which such a record can be made on a single film depends, of course, upon the angle subtended on the film by the lens. The position of the sun will change about fifteen degrees per hour. A normal camera lens will cover sufficient angle for a two-hour exposure. Watch your local newspaper for the timing of the progress of the moon across the sun's disk; then plan your camera position and exposure schedule accordingly.

SHADOWS UNDER TREES

All during the partial phases, the sunlight filtering through tree leaves forms "pinhole camera" images of the eclipsed sun on the ground. These crescents can be photographed easily with normal snapshot exposures for the film in use.

SHADOW BANDS

During the last few seconds of totality, wavelike shadows, called shadow bands, can usually be seen moving over the ground. They average from one to two inches in width and are five or six inches apart. They are most easily visible upon a white background, such as a bed sheet.

This phenomenon is very difficult to photograph because of the low illumination and the speed of the movement. With a white sheet on the ground (to obtain as high a reflectance as possible), and at 1/100 second exposure, you can use KODAK ROYAL Pan Film (Sheet) or KODAK TRI-X Pan Film (Rolls) with an f/2.0 lens. With an f/3.5 lens, KODAK ROYAL-X Pan Film may give a record of the shadow bands.

LANDSCAPING DURING TOTALITY

The intensity of the available illumination varies rapidly during the minute just before, and the minute just after, totality. At the darkest period (during totality), an exposure of about one-half second at f/8 on KODAK VERICHROME Pan Film (ASA Speed 125) should give good results for landscape photography.

THE ECLIPSE ITSELF

The time from the first instant prior to totality to the last instant at the end of totality is very short for all that happens — rarely more than a minute or two. Therefore, plan well in advance and be prepared.

BAILY'S BEADS

For a second or two, just before totality and again just as the sun emerges, light breaks through the valleys on the rim of the moon, forming what looks like a beaded necklace along the edge of the moon. This is very spectacular and very short-lived.

For still cameras, use 1/10-second shutter speed and the same lens opening and ND filter recommended for partial phases in the exposure table on page 11. For movie cameras, open the lens three settings (for example: f/11 to f/4).

CORONA

At totality, the corona appears around the sun as a beautiful halo, decreasing in brightness from the moon's rim outward. Points of interest to observe and photograph in the outer corona are the equatorial streamers, which may extend several diameters from the sun. In the inner corona, the chief point of interest is the phenomenon of solar prominences. These prominences are scarlet, tongue-like jets shooting outwards from behind the moon's rim.

Since the intensity of the corona fades rapidly away from the solar limb, the distance to which the photograph will show the corona depends upon the exposure — the longer the exposure, the greater the extension. However, if one attempts to record the faint outer streamers, then the inner white corona will be overexposed. For most purposes, the most spectacular results are usually obtained with the shorter exposure, gauged to record the inner corona.

EQUIPMENT

THE USE OF SMALL TELESCOPES AND BINOCULARS

A small telescope or binocular can be used in conjunction with an ordinary camera. The image size obtained with such a combination will be equal to that obtained with the camera alone, multiplied by the power of the telescope or binocular. It is best to build some type of rigid support to hold the telescope and camera in alignment. It is also desirable to arrive at the best focus and exposure for the partial phases experimentally by photographing the sun prior to the eclipse. An approximate setting can be made by focusing both the telescope (or binocular) and the camera lens on an object at a great distance before joining them. The diaphragm of the camera lens should be opened to its widest aperture, to avoid possible vignetting at the corners or sides; a black cloth should cover the space between the camera lens and eyepiece, to cut out stray light.

Exposure will depend upon the "Effective f-value" of the combination. To calculate the effective f-value of the combination, determine the diameter of the exit pupil of the telescope or binocular and divide its value into the focal length of the camera lens. For example: Assume we have a camera, with a lens of 4-inch focal length, and a pair of 7 x 50 binoculars. The "7" is the magnifying power of the binoculars and the "50" is the diameter of the objective lens (the front lens) expressed in millimeters (mm). The diameter of the exit pupil of any telescope or binocular can be found by dividing the diameter of the objective lens by the magnifying power.

Step 1. Find the diameter of the exit pupil.
50 ÷ 7 = 7mm

Step 2. Find the effective f-value of the combination.
4 inches focal length = 102mm (4 x 25.4mm per inch)
102 ÷ 7 = 15
The effective f-value is f/15, for all practical purposes.

CAMERA SUPPORT

For a series of pictures of the partial phases, the camera should be mounted on a tripod or other rigid support, to prevent movement between exposures. Also, with long focal-length lenses, or when the camera is used with a telescope or binocular, a solid support is essential, to avoid loss of definition from camera motion. Because of the earth's rotation, solar images one inch in diameter or greater will show significant movement on the film during exposures of one second or more. For such exposures, an equatorial mounting with a clock drive may be desirable. Refer to amateur books on astronomy. Thus, if the equipment to be used necessitates exposures exceeding one second, and no drive mechanism is available, the diameter of the solar image should not exceed one-half inch, for satisfactory detail resolution.

FILTERS

The use of neutral-density filters is a convenient way of cutting down the excessive light-intensity during the partial phases. They can be quickly removed from in front of the lens at totality.

KODAK WRATTEN Neutral Density Filters, No. 96 (Gelatin Film) are available in the following densities — 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 1.00, 2.00, 3.00, and 4.00. Intermediate densities or higher densities, such as 4.50 or 5.00, can be obtained by combining two of the standard densities. However, loss of definition will result if more than two are used at one time. These are available through Kodak dealers.

WARNING

Gelatin filters transmit infrared energy.

DO NOT USE FOR VISUAL USE

for observing the solar eclipse.

Although the gelatin-film filter is protected by a thin lacquer coating, the filter should be handled only by its edges or at its extreme corners. The KODAK Gelatin Filter Frame, a two-part metal frame, is a convenient accessory for handling gelatin filters. Although the filter frame is normally used with the KODAK Gelatin Filter Frame Holder — attached to the lens by an appropriate KODAK Adapter Ring — the frame, or even the plain filters, can be attached with small strips of pressure-sensitive tape.

EXPOSURE TABLE

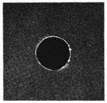
The values given in the following exposure table have been calculated from those which have given satisfactory results in the past, based on information supplied by a number of scientists who have made satisfactory photographs of eclipses. So much depends on atmospheric conditions, however, that these values should be regarded only as forming an approximate guide.

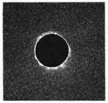
For f-values other than those given in the table, the exposure time can be calculated. Multiply the time given in the table by the square of the ratio between the f-value to be used and that given in the table. The calculator of a photoelectric exposure meter, or a KODAK Snapshot Dial, provides a convenient tool for this conversion.

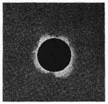
EXAMPLE: Suppose the lens to be used has an f-value of 64. Compare this with the f-value of 4.5 given in the table — dividing 64 by 4.5 gives roughly 14; squaring 14 gives approximately 200. The f/64 lens will therefore require an exposure 200 times longer than that required by the f/4.5 lens.

The exposure time for movie cameras operating at 16 frames per second is about 1/30 second.


PARTIAL PHASE


BAILY'S BEADS


PROMINENCES


INNER CORONA


OUTER CORONA

SOLAR ECLIPSE PHOTOGRAPHY FOR THE AMATEUR

Approximate Exposures

For Still and Movie Cameras

ASA SPEED		Partial Phases		Totality (Prominences)		Totality (Inner Corona)		Totality (Outer Corona)	
		STILL	MOVIE	STILL	MOVIE	STILL	MOVIE	STILL	MOVIE
25-32	Lens Opening	f/5.6	f/11	f/4.5	f/8	f/4.5	f/2.8	f/4.5	f/1.4
	ND Filter	5.00	5.00	none		none		none	
	Time (seconds)	1/100	16FPS	1/100	16FPS	1/10	16FPS	1/2	16FPS
40-50	Lens Opening	f/6.3	f/13	f/5.6	f/11	f/5.6	f/3.5	f/5.6	f/1.9
	ND Filter	5.00	5.00	none		none		none	
	Time (seconds)	1/100	16FPS	1/100	16FPS	1/10	16FPS	1/2	16FPS
64	Lens Opening	f/8	f/16	f/6.3	f/13	f/6.3	f/4	f/6.3	f/2
	ND Filter	5.00	5.00	none		none		none	
	Time (seconds)	1/100	16FPS	1/100	16FPS	1/10	16FPS	1/2	16FPS
125-160	Lens Opening	f/11	f/22	f/8	f/16	f/8	f/4.5	f/8	f/2
	ND Filter	5.00	5.00	none		none		none	
	Time (seconds)	1/100	16FPS	1/100	16FPS	1/10	16FPS	1/2	16FPS
200-250	Lens Opening	f/16	f/9.5	f/11	f/22	f/11	f/6.3	f/11	f/2.8
	ND Filter	5.00	6.00	none		none		none	
	Time (seconds)	1/100	16FPS	1/100	16FPS	1/10	16FPS	1/2	16FPS
400-650	Lens Opening	f/22	f/11	f/16	f/11	f/16	f/9.5	f/16	f/4
	ND Filter	5.00	6.00	none	1.00	none		none	
	Time (seconds)	1/100	16FPS	1/100	16FPS	1/10	16FPS	1/2	16FPS
1250	Lens Opening	f/32	f/16	f/22	f/16	f/22	f/13	f/22	f/5.6
	ND Filter	5.00	6.00	none	1.00	none		none	
	Time (seconds)	1/100	16FPS	1/100	16FPS	1/10	16FPS	1/2	16FPS

FPS = Frames Per Second