



ASTRONOMICAL LEAGUE

**A FEDERATION OF ASTRONOMICAL SOCIETIES
A NON-PROFIT ORGANIZATION**

- ★ *To promote the science of astronomy;*
- ★ *By fostering astronomical education;*
- ★ *By providing incentives for astronomical observation and research;*
- ★ *By assisting communication among amateur astronomical societies.*

ASTRO NOTES

Produced by the Astronomical League

Note 16: Astrophotography I - Star Trails

The Earth's rotation makes the stars appear to move from east to west in the sky. For a stationary, unguided camera of focal length F , a star having declination δ , will photograph as a trail of linear length, L , in an exposure time of t seconds:

$$L = \frac{t \times F \times \cos \delta}{13750}$$

Note that the units of length, L , will be the same as the units of F .

Shorter exposures will result in shorter trail lengths. Assuming an 8x enlargement of a print and "normal" viewing distances, a trail of 0.1 mm or less will be virtually unnoticeable. The following table indicates maximum unguided exposures which will meet this criterion with several common 35 mm camera lenses:

lens focal length	35 mm field	maximum exposure in seconds at declination (degrees + or -)			
		0	30	45	60
28 mm	49 x 73	49	56	70*	98*
35 mm	39 x 59	39	45	55	78*
50 mm	25 x 37	26	31	37	52
100 mm	14 x 21	14	16	20	28
135 mm	10 x 15	10	12	14	20
200 mm	7 x 10	7	8	10	14
300 mm	4.6 x 7	4.6	5.3	6.5	9
400 mm	3.5 x 5	3.5	4	5	7

*Note: exposures over 60 seconds with "fast" lenses (f/2 or better) will show sky fog.

The angle of sky coverage, β , of any film having linear dimension s used with a lens of focal length F is given by (s and F must have the same units):

$$\beta = 2 \tan^{-1} \frac{s}{2F}$$

Instrument Requirements for Various Objects

Object Type	Lens	Focal Length	f/ratio	Comments
Star Trails	as available	50mm - 400mm	f/2.8 - f/8	f/4 lens having 40° coverage best
Moon	telescope	50" or greater; use amplification	f/8 - f/80	35mm SLR on telescope with projection
Sun	telescope	same as Moon	same as Moon	Use proper filters to avoid eye and equipment damage!
Planets	telescope	100" or greater	f/16 - f/80	projection necessary to enlarge image
Stars (general)	25mm diameter minimum	any, but 100mm - 300mm best	f/4 - f/8	Use medium speed f/ for best definition.
Star Clusters	50mm diameter minimum for open clusters	400mm or longer	f/4 - f/16	Use longer focus for smaller clusters
Nebulae	50mm diameter minimum	150mm lens or short focus telescopes	f/2 - f/8	need greatest possible light collection
Comets	25mm diameter minimum	100mm lens or short focus telescopes	f/2 - f/5.6	wide angle for tail coverage; long focal length for coma
Aurora	25mm diameter minimum, fast	28mm - 100mm	wide open, f/2 - f/4	wide angle; short exposures to minimize motion
Meteors and Satellites	as available	50mm - 100mm	f/2 - f/4	40° - 60° sky coverage