# ADAPTING A 10-INCH ASTROGRAPH FOR SHEET FILM

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**Abstract**

The Link Observatory 10-inch photographic refractor is designed to use 8x10-inch glass plates. Inexpensive sheet film can be used by holding the film flat behind a sheet of clear glass in the plateholder. Experiments with panchromatic film and yellow or red filters were not very satisfactory, due to the blue-corrected objective's steep focal gradient at longer wavelengths. However, blue-sensitive Kodak SB-5 X-ray film produces excellent images.

One of the instruments at Indiana University's Goethe Link Observatory is a 10-inch (25-cm) photographic refractor with an f/6.3 Cooke triplet objective. This telescope is designed for photography in the blue spectral region on 8x10-inch glass plates, which capture a field of 6.4 by 8.0 degrees. A photograph of the instrument and examples of its imaging on 103a-O and IIIa-J plates appear in Wood (1982).

When I was given the opportunity to use this instrument, my first thought was to apply it to variable star work. However, I wanted to keep things simple - to use the astrograph as it stood, without modifications or new accessories, and to use common photographic materials that did not require advance hypersensitization or special processing.

Blue-sensitive 8x10 glass plates would be the ideal photographic medium, but plates are now prohibitively expensive. I therefore decided to try sheet film, which I could order through a local camera store in boxes of 25 at a unit cost of about $2.00 per 8x10 sheet. The choice of sheet film raised the problem of how to keep the film flat during exposure. I solved this difficulty very simply, by buying a $4.00 picture frame, removing the 8x10 piece of clear glass, and throwing away the frame. I placed this glass in the plateholder and placed the sheet film behind it. The back of the plateholder is a pressure plate, which holds the film flat against the glass.

Adding flat glass to a telescope's optical path extends the focal length by a distance of about 0.3 times the thickness of the glass. I had to determine a new focus setting to compensate for this effect and for the physical displacement of the emulsion in the plateholder by the thickness of the glass. There is some light loss by reflection, but it is less than 5 percent from each surface of the glass. Care must be taken, of course, to keep the glass clean.

Ideally, I wanted a fast, blue-sensitive emulsion, but Kodak's commercial film catalogue only listed a couple of very slow graphic arts films that are strictly blue-sensitive. The only fast emulsions available were the common panchromatic types such as Tri-X and T-Max. So I began tests with T-Max 400, which has finer grain than Tri-X and a convenient, quick-mix liquid developer.

Test exposures through a deep blue Wratten 47B filter produced stellar images that were small, black, and sharp-edged, demonstrating that the Link astrograph has excellent optical qualities in the blue spectral region. However, the 47B filter is very dense, and 30-minute exposures only reached 13th magnitude. A 30-minute exposure through a Schott GG14 yellow filter, which passes a broad band of longer wavelengths, reached 15th magnitude, but image quality was unsatisfactory. A series of focus exposures showed that the smallest images consisted of a black core and a fainter penumbra of extrafocal light. Images were improved with a red filter, but this filter narrowed the effective passband to such an extent that 30-minute exposures again reached only 13th magnitude.

The focal gradient of a blue-corrected objective is essentially flat in the blue spectral region, so the objective's focal length is the same for all wavelengths of blue light, which combine to form a sharp stellar image. Strictly blue-sensitive emulsions do not record the out-of-focus light of longer wavelengths. But the objective's focal length is progressively longer for yellow and red wavelengths of light, to which panchromatic film is sensitized. In order to record equally sharp images at longer wavelengths, the instrument's focus setting must be extended. In addition, because of the increasingly steep focal gradient at longer wavelengths, light reaching the emulsion must be restricted to increasingly narrow passbands. This reduces the large objective's ability to reach faint magnitudes.

In search of an alternate solution, I found a clue in a *Sky & Telescope* News Note (1986), which mentioned that Kodak SB X-ray film is sensitive only to blue light and is similar in grain and contrast to 103a-O, the blue emulsion that was standard in astronomy for decades. By chance, I soon met an actual user, Dr. William Penhallow, host of the 1991 AAVSO Spring Meeting in Rhode Island. He very generously gave me some 8x10 sheets of Kodak SB-5 to test.

The results were excellent. Image quality is good even in the corners of the 8x10 sheet. A 30-minute exposure, developed in D-19 for 5 minutes, reaches 15th magnitude. SB-5 is obtained from X-ray supply companies in boxes of 100 at a unit cost of about $2.00 per 8x10 sheet. According to the *Sky & Telescope* article, this film responds well to hypersensitization in forming gas. Other X-ray films are also blue-sensitive but, unlike SB-5, many are coated on both sides.

I am now using the Link astrograph to photograph fields of eclipsing binaries with unknown periods and variables of unknown types. It is particularly useful to be able to obtain observations on the photographic magnitude scale, since my new data are compatible with old photographic observations in the literature and observations that can be obtained from archival sources such as the Harvard patrol plates. Many observatories have photographic instruments that have fallen into disuse because of the high cost of glass plates. With SB-5 X-ray film held flat behind clear glass, these instruments could be returned to service at very reasonable cost.

**References**

News Notes. 1986, *Sky & Telescope,* **71**, 356.
Wood, H. J. 1982, *Amer. Astron. Soc. Photo-Bulletin,* No. 30.