IMPROVEMENT OF CORONAL EMISSION LINE PHOTOGRAPHS

(Research Note)

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In planetary photography with small to medium aperture telescopes the faintness of the sources requires the use of fast but grainy film for reasonably short exposures. The unfavorable signal to noise ratio attained from a single exposure can be improved by the photographic addition of two or more images. The improvement in image quality results from a reduction in graininess, and from the lower weight given to anomalous emulsion effects, as we increase the number of images in the composite — indeed, graininess is reduced proportionally to the square root of the number of images (Dollfus, 1961). The purpose of this note is to illustrate the application of such a composite technique to monochromatic photographs of the solar corona, and to suggest its use in extracting the maximum amount of information from the data.

Composite prints or transparencies are produced by projecting two or more images, in turn, onto a single piece of photographic paper or film. If the correct exposure for a single image is \( t \), then the correct exposure per image, for any number of images \( n \), is \( \frac{t}{n} \). It is, of course, imperative that registration of all images be carried out with extreme care. Special apparatus and/or enlargers are usually constructed to facilitate exact registration. Estar or Cronar based film should be used in the original photographs to eliminate dimensional changes.

A limit to the number of usable images in a composite is normally set by the requirement that all must be comparable in resolution. In addition, features must not have been displaced relatively either from planetary rotations or through proper motions. In practice, three to ten images are combined to form composites though as many as fifty have been used. Although the composite technique greatly increases the visibility of features, it clearly cannot increase the original resolution as fixed by the seeing or the instrumental characteristics. On the other hand, if all images are comparable and exact registration is achieved, it does not seriously degrade the resolution.

In Figure 1a, we show a single photograph of the green line corona as taken through an interference filter and the 4-inch coronagraph at Haleakala Observatory. A composite of four such images is shown in Figure 1b which exhibits the reduced graininess and general enhancement of detail made possible by this technique.

In planetary photography, the field of view is sufficiently small that adverse seeing may affect the entire image uniformly. However, when a large field is of interest, as in solar photography, the seeing effects may vary over the image. It would, therefore,
Fig. 1. Comparison of a single photograph (Figure 1a) with a four image composite (Figure 1b) of the \( \lambda \) 5303 solar corona. The photographs were obtained on 1 January, 1969, 0236 UT with the 4-in. coronagraph of the Mees Solar Laboratory of the Institute for Astronomy, University of Hawaii. The instrument was designed by Dr. F. Q. Orrall.

be expected that under high resolution conditions, composites of large fields would not be as successful as for planetary size fields. Of course, the longer the exposure, the less will be the differential seeing effect but this must be at the expense of an overall reduction in resolution. Since, however, monochromatic coronal photographs normally show a relatively low resolution, differential seeing effects may not result in a serious limitation to quality in that case.

In coronal composites the occulting disk image provides an excellent reference for registration. It should not be overlooked, however, that the occulting disk and solar