Suggested procedure for determination of microscope luminance

A critical specification of a microscope system is the luminous flux per unit area in the image. Many visual functions such as resolution, stereo-acuity, intensity discrimination, etc. . . are determined primarily by luminance, making this specification one of the most valuable single predictors of performance.

However, it is not ordinarily possible to utilize conventional photometric techniques which are designed for use with a diffusing surface.* An alternative is to make a binocular brightness match between the microscope image and a conventional diffuse surface. With the system, one eye views a semicircle (a square or rectangle may also be used) through the microscope while the other views the other half of the circle directly. The two are juxtaposed in binocular vision and matched in brightness (Fig. 1).

Because the accuracy of a photometric match falls off rapidly as the fields to be compared are separated, it is desirable to bring the two halves as close to each other as possible in the binocular visual field. They should also be the same size to avoid complications due to spatial summation and should, as nearly as possible, be of the same color temperature. Different sized semicircles may be useful depending on the task.

A convenient device for providing the comparison field is diagrammed in Fig. 2.

The operator positions the comparator so that the two semicircles are juxtaposed in the binocular field (it may be hand-held or a jig provided), adjusts the accommodation to be equal in the two eyes, and makes a brightness

*Two conditions must be satisfied: (1) The entrance pupil of the photometer must be placed in precisely the same position as is normally occupied by the entrance pupil of the eye and (2) the aperture stop of the photometer must be equal to or smaller than the exit pupil of the microscope.

match by rotating the polaroid. As a check, the eyes can be switched. When the mean matching position of the polarizer has been determined, the lower half of the comparator is unscrewed, the mask removed, and a conventional photometric measurement taken from the ground glass surface.

If necessary, a color balancing filter can be inserted in the system. It is also helpful to provide for voltage control of the light source as an aid in color balance.

Since the spectral transmission of polaroid varies near the extinction point, no settings within 10° to 12° of extinction should be allowed (the exact position will depend upon the type of polaroid used). If greater attenuation is required, fixed density filters are recommended.

An alternative procedure would be to maintain the ground glass surface at a constant known luminance and take readings directly from a scale attached to the polaroid (can be converted to density by the $\cos^2$ function). If this method is used, the voltage drawn by the bulb should be continuously monitored.

The effect of luminance depends, of course, on the size of the entrance pupil of the eye. In ordinary photometry, this is rarely a problem because the two fields to be compared are seen with the same eye. With the binocular technique, it is imperative that the entrance pupils of the two eyes be the same. If the size of the natural pupil is less than either the exit pupil of the microscope or the entrance pupil of the eye, this condition is satisfied. However, pupil size fluctuates not only with general luminance level, but varies systematically as a function of age. Although the minimum pupil diameter is 2.0 mms., the maximum is strongly dependent on age, varying from approximately 8.0 mms. in the early twenties to 3.0 to 4.0 mms. in middle age. In addition, the exit pupil of the microscope will depend on the magnification. A preferred procedure is to first determine the size of the effective exit pupil of the microscope and insert the same size pupil in the comparator. If the natural

pupil of the eye should become smaller than the exit and artificial pupils, no problem will arise since in a normal observer the two pupils are the same size as a result of the consensual pupil reflex.

It is important that this procedure not be omitted or shortcutted by, for example, the apparently logical and often used method of computing the effective pupil area in the two eyes. Because of the Stiles-Crawford effect, retinal illuminance is not a linear function of pupil area. In order to make a meaningful photometric match, both the exit pupil of the microscope and the entrance pupil of the photometer must be physically equal.

If it is desired to make measurements for different sized exit pupils of the microscope, this procedure must be repeated since the effect of luminous flux is not a linear function of pupil area.

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See Also "The use and calibration of the 'Maxwellian View' in visual instrumentation", American J. Psychol., 1954, 67, 530-532.

Figure 1. The subject's view of the visual field. The two components are positioned as close together as possible.

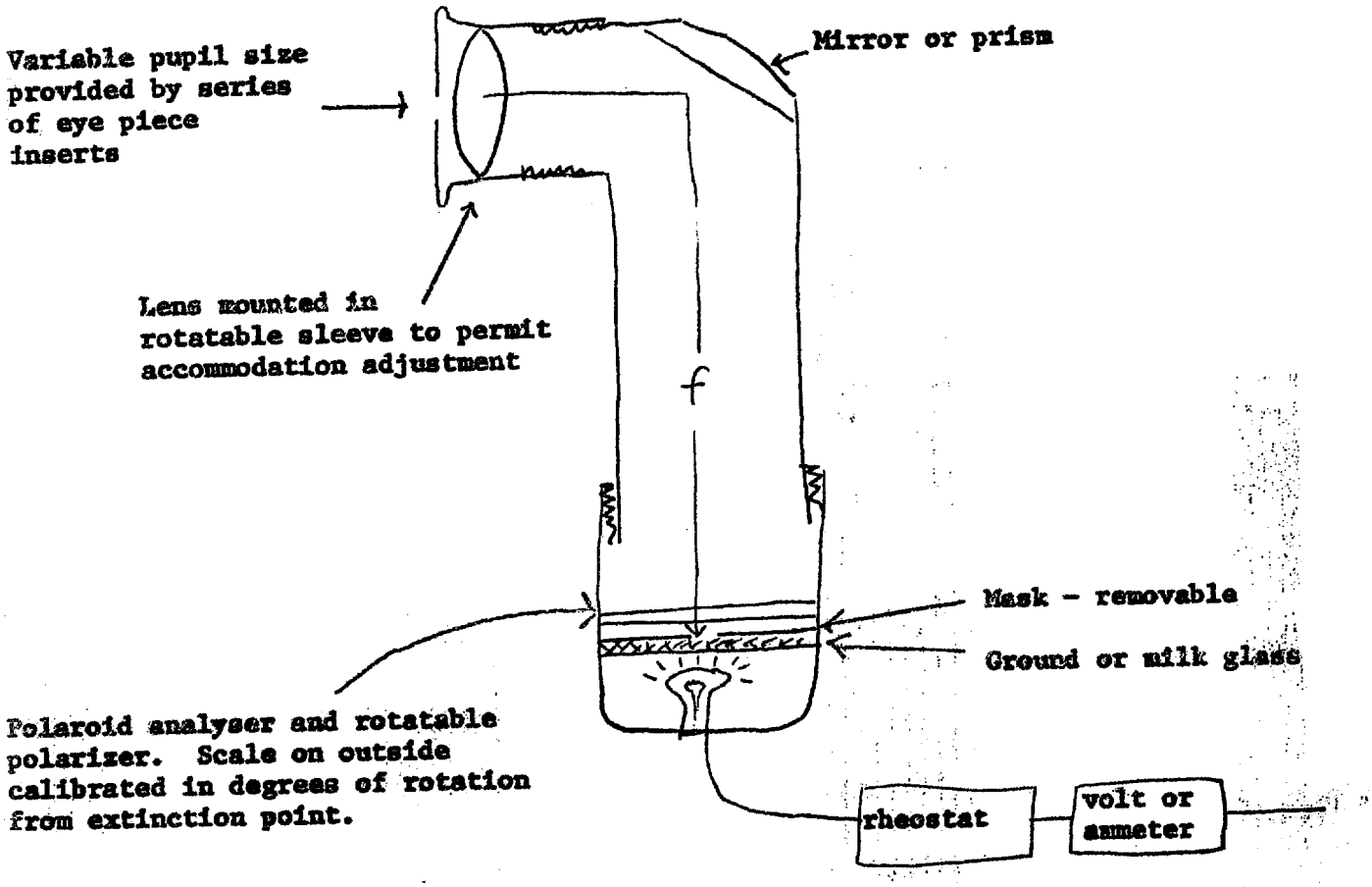

Figure 2. Suggested design for photometer.

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