Johnson, Harold L. Magnitudes and magnitude systems.

Now that methods of photoelectric measures of magnitudes and colors have been developed which permit probable errors as small as .01 mag. to be attained for even faint stars, it has been found that certain difficulties have been introduced into our photometric systems by the stars themselves. Photoelectric measures are time-consuming and therefore have been applied for the most part to the physical characteristics of individual stars rather than to statistical investigations.

Although color indices are especially important in modern investigations it should be noted that a single (blue-yellow) color index is often inadequate and the value of an ultraviolet measure at about 3500Å has been demonstrated in many ways. An infrared color would undoubtedly also be of value. Spectral types and spectroscopic absolute magnitudes are essential in many investigations and the importance of this point cannot be overemphasized.

Recent photoelectric investigations (Johnson, 1952) have shown that the International System as defined by the North Polar Sequence is inadequate even when proper procedures are used to transfer this system to other parts of the sky. In general, relationships between different photoelectric blue-yellow color systems, and blue magnitude systems, are seriously non-linear and even multi-valued and this is especially true for the early-type stars. These discordances can be minimized if the ultraviolet energy shortward of 3800Å is removed by a proper choice of the blue filter; this cutoff can be accomplished with a Schott GG13 filter, 2 mm thick.

A standard system of stars all over the sky has been set up by Johnson and Morgan (1953). These standards have been observed in the ultraviolet, blue and visual regions and also serve as standards of spectral type and luminosity classification. These standards represent adequately all of the regions of the H-R diagram. Additional standards are being observed by D. L. Harris. Standard photoelectric sequences set up for the convenience of other observers now include the Pleiades, Praesepe and IC 4665, with others to be added later. Observations of non-stellar objects such as globular clusters and external galaxies are planned. Hardie at the Lowell Observatory plans to observe all the standard stars in the red (7000Å) and infrared (8250Å) system established by Kron.

Johnson, H. L. 1952, *Ap. J.* **116**, 272.

Johnson, H. L., and Morgan, W. W. 1953, *Ap. J.* **117**, 313.

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Harris, Daniel L., III. Color-magnitude arrays and color-system relations.

Although the first color-magnitude arrays were published by Hertzsprung in 1911, and photoelectric colors were observed for the brighter stars in the early 1920's, extensive application of the photoelectric method dates back only a few years. The observational data published to date for clusters and stars in general has already contributed greatly to our astronomical knowledge, and demonstrates the superiority of photoelectric techniques in all cases where high accuracy is desired.

If we restrict ourselves to problems that could be studied efficiently with a moderate-size telescope in a good climate, we eliminate the globular clusters from consideration. However, the fine results that are being obtained for these objects with the largest telescopes could well be supplemented by studies of cluster type Cepheids in the vicinity of the sun using much more moderate equipment.

It should be realized that for the photoelectric observer to obtain the greatest possible value from his efforts, he needs the help of the spectroscopist and the astrometrist. Examples of clusters where accurate proper motions enable one to eliminate the field stars are numerous—Hyades, Pleiades, Praesepe, NGC 752, etc. Examples of accurate spectral types assisting in the analysis of the photometric results by eliminating composite stars, peculiar stars, etc. are also found. However, the need for accurate spectral types in color-system relations is just being established with the advent of accurate photoelectric colors.

In discussing the observed scatter in color-magnitude and color-color arrays, the effects of double stars and differential reddening are very important. It was well established, by Haffner and Heckmann and others, that the scatter above the main sequence in Praesepe is due to double stars while considerable differential reddening has been found in the Perseus cluster, M29, etc. The use of the ultraviolet color in conjunction with the usual blue-yellow color index allows one to correct each star individually in certain B-star clusters such as M29 and thereby obtain far more information than is available from a single color-magnitude array.