equipment is apt to be more constant than the absolute sensitivity; therefore, it is possible to group the measures, from which k_c will be derived, over several nights of observations, using the condition that the stars' color indices, outside the atmosphere, are constant. (Such a method would also be available for the magnitude coefficient, it has been pointed out, if the absolute sensitivity of the equipment were constant or measurable.)

The conventional determination of the color extinction coefficient, k_c, is entirely analogous to that for the magnitude coefficient, k. A plot of the observed

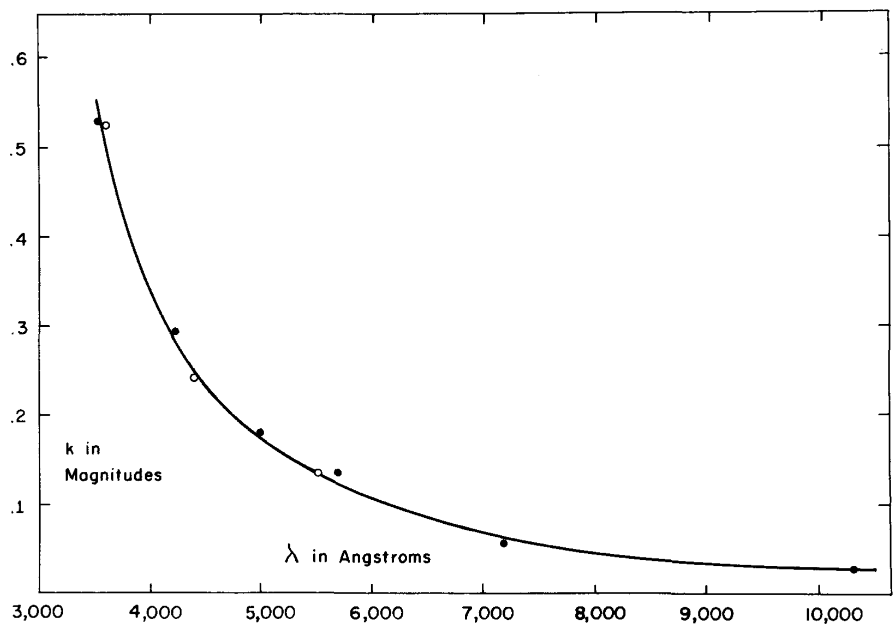

FIG. 3.—The variation of the extinction coefficient, k, with wave length, λ. The closed circles are for Mount Wilson (Abbott), and the open circles are for McDonald (Hiltner). The wave-length dependence is a function of sky conditions and altitude of the observatory, and the illustrated values are not to be considered as applicable to other locations.

color index, C, is made against air mass, X, for a single star measured at various zenith distances and on several nights. Figure 4 presents the method graphically.

2.5. Extinction as a Function of Color Index

Since the light received in any photometric band is not monochromatic, the actual coefficients used are essentially those for a monochromatic beam at some predominant wave length (although not at the *effective* wave length) which is somewhat dependent on the stellar energy distribution. In the empirical determination of the coefficients for the various bands, then, it is to be noted that the values are dependent on the color index of the object (King 1952*b*, and further references contained in this paper). Generally it will be found possible to determine the manner in which the extinction varies with the color index of different stars and to express the results, in the case of the magnitude coefficient, k, by a linear relation:

$$k = k' + k''C\,, \tag{4}$$

where C is the color index for the star, uncorrected for extinction, k' is the magnitude extinction coefficient for a star of zero color index, and k'' is the increment in the coefficient for a star of color index $C = 1.0$. In the case of the color coefficient, k_c, a similar situation is found if either or both of the bands used to form a color index are subject to an appreciable change in the predominant wave length according to the stellar energy distribution. As in the former case, it is, in general, possible to define a linear relation:

$$k_c = k_c' + k_c''C\,, \tag{5}$$

where k_c' is the color extinction coefficient for a star of zero color index, and the correction term k_c'' is the increment in the coefficient for a star of color index $C = 1.0$. We shall refer to k' and k_c' as the "principal coefficients" and to k'' and k_c'' as the "second-order coefficients" hereafter.

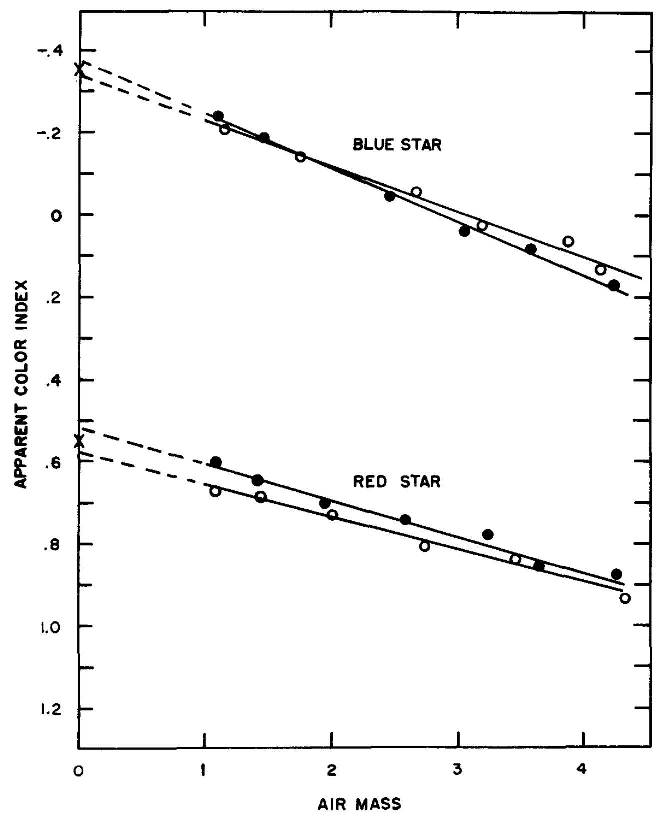

FIG. 4.—The color extinction coefficient dependence on the color index of the star. Measures on several nights serve to give added weight by providing effectively an additional value at $X = 0$.

In place of the color index inside the atmosphere, C, the extra-atmosphere value, C_0, is often used in these expressions in the second-order term thus:

$$k = k_1 + k_2 C_0 \,, \tag{4a}$$

$$k_c = k_{c1} + k_{c2} C_0 \,, \tag{5a}$$

where the coefficients are analogous to, but not identical with, those in equations (4) and (5). Although the matter is of little consequence in empirical work, expressions (4) and (5) are to be preferred to (4a) and (5a). The reason is that both the stellar energy distribution and the air mass affect the shape of the observed band of radiation and hence define an effective extinction coefficient. In using C_0, we assign a second-order color term to the extinction coefficient which depends only on the first of these two factors, while in using C we account to a better degree for both of them. Nevertheless, forms (4a) and (5a) are in more common usage, probably because it is thought that k_2 and k_{c2} are easier to determine than k'' and k_c''. That this is not necessarily the case will be shown presently. Neither of the two formulations of the second-order term rigorously describes the variation of extinction with color index. They are justified solely on the grounds that higher-order terms have not been measurable with present methods.

It is found that the second-order coefficient, k'', for the magnitude extinction is negligibly small or indeterminate for bands located in the yellow and red, as would be expected from the general shape of the curve in Figure 3 and from the relative absence of strong spectral features which affect the predominant wave length. In the blue region it commonly has a value in the range -0.02 to -0.04 (depending on band width) when the color index, C, has a scale and a zero point close to the International or $B - V$ system. Fortunately, it appears to be relatively constant compared with the principal coefficient, k'. Likewise the second-order coefficient, k_c'', for the color extinction is customarily small and not subject to much variation.

2.6. Measurement of the Second-Order Coefficients

In order to account for the second-order terms in equations (4) and (5), let us now modify equations (1) and (3) as follows:

$$m_0 = m - k'X - k''CX \,, \tag{6}$$

$$\begin{aligned} C_0 &= C - k_c'X - k_c''CX \\ &= C(1 - k''X) - k_c'X \,, \end{aligned} \tag{7}$$

or, according to the alternative expressions (4a) and (5a),

$$m_0 = m - k_1X - k_2C_0X \,, \tag{6a}$$

$$\begin{aligned} C_0 &= C - k_{c1}X - k_{c2}C_0X \\ &= \frac{C - k_{c1}X}{1 + k_{c2}X} \,. \end{aligned} \tag{7a}$$