13.2 Operational Definition of Beam Transmittance

We consider next some possible experimental means of determining the beam transmittance of a general path of sight in a natural hydrosol. The development in Sec. 3.14 of the concept of beam transmittance starting from the interaction principle exhibits the physical foundations and basic meaning of the beam transmittance concept,- and we now show how we can build on that development in several ways, so that beam transmittances can be obtained using standard radiance measuring equipment.

General Two-Path Method

Let Or (x_l , C)and (P (x_2, ~) be two parallel paths of length r as depicted in fig. 13.4. We now show how measurements of the radiances at the extremities of these paths can lead to a determination of Tr(x,O, the beam transmittance of the path Q_r (x, ~) . We need only arrange matters so that all three paths are in a regular neighborhood of paths (Def. 2, Sec. 9.5), i.e., so that:
and

T = =
$_x$. (x_1 ~) T_r (x_2 , ~) T_r (x J, 0 (1)

Nr (Y ~ =
N T C Y $_2$ ~ = (2)
•Lqr (Y ~

Such paths are often encountered in real optical media, so that what follows is of more than academic interest. By means of (5) of Sec. 3.13, the apparent radiances at the terminal
points of the paths Q_r(x~ (ID_r(x_2,) are expressible as
N(Y_1 s) = N(x_1 !~)T_r(x_1 1E) + N*CY_1'P0 (3)
N (Y_2) N (x_2) T . (x_2 s) + N* (Y_2) (4)

FIG. 13.4 The two-path method for beam transmittance.

Writing:
"AN (Y~ for N($y_1$9E) - N(Y_2~) (S)
„AN (x,) t' for N (x1) - N (x_2) (6) and subtracting (4) from (3), we have

T (x,) _ AN (E) r AN x,~

Now for theoretical or practical purposes it is possible to use either the natural radiances occurring, at x , x_2, y_1, Y_2
for computations with (7) or to place artificial. sources at the points x_1, x_2. In either case the method proceeds by measuring the four radiances

under such conditions, and then using (7) to determine T (x-, C)~:

In either case therefore, (7) will yield up numerical determinations of T_r(x,O so long as (1) and (2) hold. Equation (7) may thus provide an operational definition of T_r(x,0 .

General One-Path Method

The preceding development from (1) to ' (7) ma be reinterpreted so that there is only one Path, namely (x,0over ~

which at time t_1 there is an artificial or natural r radiance distribution such that (3) holds and a small time later at t_2, (4) holds. For example, a light beam along the path 0. (x, Q may change radiance arbitrarily or may blink periodically so that in any case it has two distinct radiances N(x,E,t_1) and N (x, ~ , t_2) with corresponding observable radiances N (y, E , t ,) ,

N(y,~,t_2). If (1) and (2) hold in the present case, i.e. , if 1-0

Tr(x,~,tI) =
Tr(x,~,t2) = (8)
T (x 0

Nr(Y,~,t_1) _
Nr(Y,~,t_2) Nr(Y,~) (9)

then:

T ON
= ,E,t) (10)
r (x,) AN x,~,t '

where now we have written:

"ON (Y, ~, t) " for N (Y, ~'t $_1$)-N (Y, ~, t2) (11)

"AN (x,~,t)t" for N(x,~,t_1) -
N(x,E,t_2) -(12)

Thus by either spatial modulation of radiances, as in (7), or temporal modulation of radiances, as in (10), the beam transmittance over the corresponding regular neighborhood of paths may be operationally defined.