of the classical equation of transfer (7) from its exact counterpart (17) within polarized light fields. It follows that the classical equation of transfer in real light fields exhibiting polarization, is only an approximate equation. To the author's knowledge, no systematic test of the conditions (16) nor any estimate of the magnitude of $\bar{N}_*$ in (17) has been made at the time of publication [1976]. An important question for the classical unpolarized theory of radiative transfer now rests in the practical applicability of (7) to the study of light fields in natural hydrosols: *while (2) generates a mathematically self-consistent theory of unpolarized light fields, how well (in a quantitative sense) does it describe $N(= {}_1N + {}_2N)$ within actual (polarized) light fields found in nature?*

As anticipated above, the denouement of this problem still stands at this late date in the history of the theory, and awaits a definitive answer from those who are the only ones who can definitively answer it: the experimenters. Theoretical reasoning, such as that above, can be carried only so far. There eventually comes a time in the construction of any physical theory when all the theorizing must momentarily stop, and the court of last appeal be faced: Nature herself.

13.12 Bibliographic Notes for Chapter 13

The development of the operational formulation for beam transmittance in Sec. 13.2 is based on the work in Ref. [238]. The operational formulations of path function and path radiance, as given in Sec. 13.3, are patterned in part on the theory of Sec. 3.12. The K-method of determining the path function was developed in Ref. [219]. Path function calculations using the integral method (6) of Sec. 13.3 were explored in Ref. [214]. The operational definition of volume attenuation function in Sec. 13.4 is based in part on Sec. 3.11 and the work of Ref. [238]. Interesting and useful parallels of the methods of Sec. 13.4 as developed in meteorologic optics may be found in Ref. [231]. Further parallels with α measurements in meteorologic optics may be found in Ref. [177] and Ref. [80]. The theory of Sec. 13.5 is based directly on Ref. [217]. The developments of the volume scattering function in (11)-(25) of Sec. 13.6 are for the most part new, with basic points of view developed in Sec. 18 of Ref. [251]. Some rudimentary forms of σ-definitions may be found in Ref. [177] and which are recognizable as early forms of (4) of Sec. 13.6. The discussion of the general empirical properties of σ, as given from (5) to (10) of Sec. 13.6 is based in part on observations in Ref. [229]. The theory of the volume total scattering function in Sec. 13.7 is drawn from Ref. [241], while that of Sec. 13.8 is based on Ref. [241] and Ref. [220]. An experimental device based on this theory is described in Ref. [299]. Alternate means of measuring s are discussed in Sec. 9.4.4 of Ref. [177]. The remarks in Sec. 13.9 are a consolidation of those on apparent optical properties found in Ref. [305].

The discussions of Sec. 13.10 are based in part on Ref. [243] and only begin to explore the inverse problem in radiative transfer theory. The inverse problems (problems of the second class) of radiative transfer are classified in Ref.

[251], and are studied in the meteorologic context in Ref. [231] and Ref. [238], and in the hydrologic context in Ref. [247].

For further study of the questions raised in the closing discussion of Sec. 13.11, see [308]. This reference will serve only to familiarize the reader with the problem in the context of *single scattering* theory. Chandrasekhar's work [43] gives an example of the use of the *single scattering* phase function for Rayleigh scattering in computing a multiply-scattered polarized light field. The reference [53] can serve to generate some tentative numerical answers using its tabulated solutions of polarized light fields. The problem, however, of determining the *experimenter's operationally found* σ (in the form (4) or (24) of Sec. 13.6) in terms of the electromagnetic properties of an irradiated aggregate of disjoint and arbitrarily disposed microscopic scattering volumes, has yet to be solved in sufficient generality and detail. Such a result would contribute materially toward the efficient use of the equivalence criterion (16) of Sec. 13.11 for unpolarized and polarized radiative transfer theory, as applied to real optical media (see the closing remarks of Sec. 13.5).

Further questions on the nature of the equation of transfer, beyond these considered in Sec. 13.11, can now be raised, and offer interesting prospects for generalizing the attendant theory: what is the appropriate form of the equation of transfer for *partially coherent unpolarized* radiance fields? For *partially coherent polarized* radiance fields? Is the equation of transfer for incoherent polarized light fields mutually consistent with the equation for partially coherent polarized light fields--in the same general sense studied above for (7) and (17) of Sec. 13.11? All these questions and their close relatives can perhaps be studied with precision and depth within the context of problems I, II, III, and IV of Sec. 141 in [251].

<< Table of Contents << Title Page >> Next Page >>