

CHAPTER 9

GENERAL THEORY OF OPTICAL PROPERTIES

9.0 Introduction

This chapter opens Part III of the present work wherein we shall be concerned with the theoretical study of the main optical properties of natural optical media, with particular emphasis on the properties of natural hydrosols such as seas, harbors, and lakes principally under natural lighting conditions. Some of the optical properties to be considered have been introduced as a matter of course in the earlier developments of Part II. Other properties will be defined and studied here for the first time. For example, we have already encountered the volume attenuation function α (Sec. 3.11), the volume scattering function σ (Sec. 3.14), the volume absorption function a (Sec. 4.2). The functions α and σ constitute the inherent local optical properties of radiative transfer theory which are *fundamental* in the sense that they are sufficiently complete to allow the construction, in principle, of all other optical properties of radiative transfer theory. They, however, are not unique in this property: There are other collections of inherent optical properties which are *fundamental*, i.e., which allow a similar construction of the class of optical properties used in radiative transfer theory. It is the purpose of this chapter to define and classify the optical properties normally encountered in radiative transfer discussions, to derive and display some of the manifold interconnections existing among them, and to list some of the fundamental sets of optical properties (such as α , σ mentioned above).

We shall begin in the following section with some general definitions which will help to initially classify the collection of optical properties associated with a given medium into four main groups: the local, global, inherent, and apparent properties. Since the settings of hydrologic optics are most naturally plane-parallel media, we shall for the most part develop and illustrate the optical properties and their interconnections in such media. Thus in Sec. 9.2 the most important apparent optical properties of hydrologic optics will be introduced and some general patterns of geometric and radiometric behavior of these properties will be derived in Secs. 9.3 to 9.5. Section 9.6 collects together for reference the principal optical properties of radiative transfer theory in plane-parallel media.