# Introduction to Cavitating Flows

We begin this discussion of cavitation in flows by describing the effect of the flow on a single cavitation "event." This is the term used in referring to the processes that occur when a single cavitation nucleus is convected into a region of low pressure within the flow, grows explosively to macroscopic size, and collapses when it is convected back into a region of higher pressure. Pioneering observations of individual cavitation events were made by Knapp and his associates at the California Institute of Technology in the 1940s (see, for example, Knapp and Hollander 1948) using high-speed movie cameras capable of 20,000 frames per second. Shortly thereafter Plesset (1948), Parkin (1952), and others began to model these observations of the growth and collapse of traveling cavitation bubbles using modifications of Rayleigh's original equation of motion for a spherical bubble. Many analyses and experiments on traveling bubble cavitation followed, and a brief description these is included in the next section. All of the models are based on two assumptions: that the bubbles remain spherical and that events do not interact with one another.

However, observations of real flows demonstrate that even single cavitation bubbles are often far from spherical. Indeed, they may not even be single bubbles but rather a cloud of smaller bubbles. Departure from sphericity is often the result of the interaction of the bubble with the pressure gradients and shear forces in the flow or the interaction with a solid surface. In section (Ntc) we describe some of these effects while still assuming that the events are sufficiently far apart in space and time that they do not interact with one another or modify the global liquid flow in any significant way. Often the words "limited cavitation" are used to distinguish these circumstances from the more complex phenomena that occur at higher event densities.

When the frequency of cavitation events increases in space or time such that they begin to interact with one another, a whole new set of phenomena may be manifest. They may begin to interact hydrodynamically, and some of the resulting phenomena are described and analysed in sections (Nh). Often these interaction phenomena can have important practical consequences as is the case, for example, with cloud cavitation (see section (Ntg)).

But increase in the density of events also causes the formation of large-scale cavitation structures either because of the coalescence of individual bubbles (often because they accumulate in regions of recirculating flow) or because a large region of the flow vaporizes. Typical large-scale structures include cavitating vortices and attached cavities. As a result, cavitating flows can exhibit a number of different kinds of cavitation; later in this chapter we shall describe some of the forms that large-scale cavitation structures can take. Some of the analytical methods used to understand and predict these structures are discussed in the next sections.