Large-scale Cavitation Structures

When the density of cavitation events becomes large enough, they begin to interact and to alter the flow in a significant way. This increase in density may come about as a result of a decrease in the cavitation number, which causes the activation of increasingly smaller nuclei, or it may result from an increase in the population of nuclei in the oncoming stream. As long as the interaction effects are small, they seem to cause a decrease in the rate of growth of the bubbles (see, for example, Arakeri and Shanmuganathan 1985) and a shift in the spectrum of the cavitation noise (see, for example, Marboe, Billet, and Thompson 1986). Significant progress has been made in developing analytical models that incorporate such weak interaction effects on traveling bubble cavitation; these models are described in sections (Nm).

An example of dense traveling bubble cavitation is included in Figure 1. Note that the bubbles seem to merge to form a single vapor-filled wake near the trailing edge of the foil. Notice also the wispy trails of very small air bubbles that remain after the vapor-filled cavity collapses. In a water tunnel special efforts are required to allow these fine bubbles sufficient time to dissolve before they recirculate back to the working section. Without such efforts the population of small bubbles in the tunnel would quickly reach unacceptable levels. Even with special efforts it is clear that cavitation itself contributes to the population of nuclei in a closed loop water tunnel.

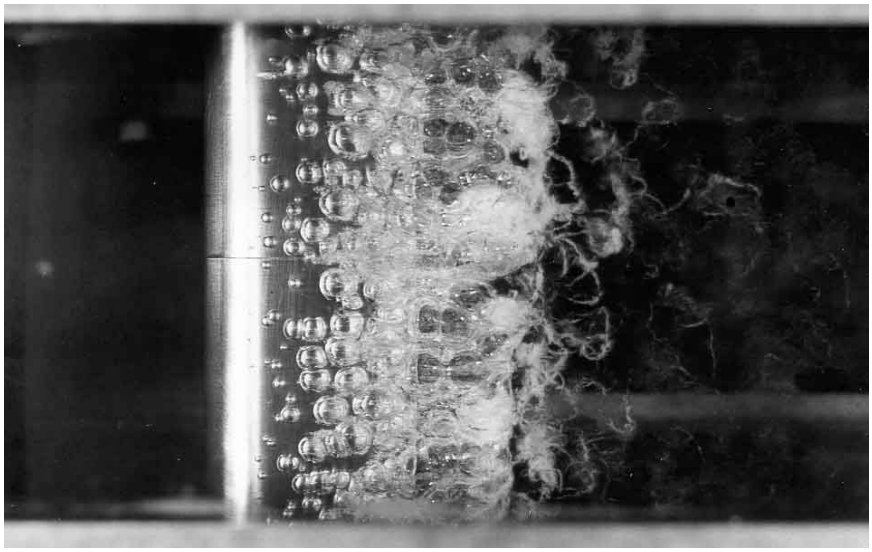

Figure 1: Dense traveling bubble cavitation on the surface of a NACA 4412 hydrofoil at zero incidence angle, a speed of 13.7 m/s and a cavitation number of 0.3. The flow is from left to right and the leading edge of the foil is just to the left of the white glare patch on the surface (Kermeen 1956).

The large-scale cavitation structures that are formed when the cavitation number is reduced can take a variety of forms, and we review these in the next few sections. In many practical devices such as pumps or propellers, the first large-scale structure to be observed as the cavitation number is decreased takes the form of a cavitating vortex, so we begin with a discussion of vortex cavitation.