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Waves on vortex cores

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Abstract. Here we discuss the types of waves which can be supported on compact regions of vorticity. This is a subject first studied by Lord Kelvin for waves propagating along the vortex lines of the Rankine and hollow-core vorticity distributions. Kelvin's major interest was in the stability of vortex rings and the numerous resurgencies in interest have usually been driven by practically important phenomena, e.g., the observations of vortex breakdown and waves on tornado and aircraft vortices in the early 1960's and more recently in technologically and geophysically significant flows and on the quantised vortices of super fluid HeII.

The major wave-types of interest are of varicose, helicoidal and fluted form and represent a periodic swelling and contraction, a bending and a "krinkling" of the core, respectively. The first two propagate along and the third around the vortex lines. All have been studied theoretically, experimentally and numerically in the limit of small wave amplitude and their major characteristics are now clear. Of particular interest is the extension of these results to the non-linear regime in which case the two first types are known to exhibit solitary wave or soliton characteristics in certain parameter ranges. It is these non-linear waves which often dominate observations of vortex flows both in nature and in technological applications and which have caused much controversy in the interpretation of results found under complex circumstances of flow and apparatus geometry.