Evolution of vorticity regions of Ka´rma´n-vortex-street type

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The evolution of uniform or non-uniform circular vorticity regions \( \text{of radius } R \) of Ka´rma´n-vortex-street type \( \text{with a distance } h \text{ between the two rows, and a spacing } d \text{ of the regions of the same sign} \) is examined numerically and analytically. The domain in the \( h' = h/R \text{ and } d' = d/R \) plane for which the vorticity regions merge to nearly parallel vorticity layers and the domain for which they continue to be localized are obtained using the discrete vortex method. Most of this localized behavior is qualitatively explained by the theory in which each neighboring vorticity region is replaced by a point vortex. Moreover, the increase in \( h'/d' \) from a small value due to an external transverse flow causes the transition to the nearly parallel vorticity layers if initial \( d' \) value is small. It is suggested that \( h/d \) just before the breakdown of the Ka´rma´n vortex street in experiments is larger than 0.365.