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Regimes of near-wall vortex dynamics in potential flow through gaps

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A two-dimensional problem of the motion of a single vortex near an infinite straight wall with singular gaps is solved both analytically, using a point-vortex approach, and numerically based on the method of contour surgery for a vortex patch. The background irrotational flow was generated by a balanced point source-sink system located at the gaps. Three different regimes of vortex evolution were detected and studied in detail: (i) complete or partial transit, i.e., continuation of the motion along the wall; (ii) complete destruction, i.e., the ‘penetration’ through the sink gap; and (iii) capture in a certain area against the wall between the gaps. These regimes are controlled by three parameters: the ratio of the vortex size and the distance between the gaps, the remoteness of vortex trajectory from the wall, and the ratio of the intensities of the background flow and the vortex. A bifurcational character of the transition between the regimes was observed. Steady-state solutions were found numerically, including the orbital <I normal">O-state, where the vortex's centroid moves along a constant orbit, while the shape of the vortex changes periodically. Capturing the vortex was usually carried out in a form close to this state