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The Acoustics of Two-Dimensional Leapfrogging Vortex Interactions

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We investigate the acoustics produced by coupled pairs of counter-rotating vortices. The DNS of the compressible near field is performed with the dilating vortex particle method, wherein mass-preserving computational elements convect with the velocity and carry vorticity, dilatation, enthalpy and entropy strengths, which vary in accordance with the Navier–Stokes equations. The acoustic far-field is extrapolated from the near-field results by a Kirchhoff method. We explore the effects of relative vortex strengths and spacing, core sizes, Mach number, and Reynolds number. The acoustics of the leapfrogging process are dominated by the event of one pair passing through the other, which produces a four-lobed pressure wave, followed by a second of opposite sign. In the intervening periods are small, higher-frequency oscillations due to vortex nutation. The eventual merger generates a large acoustic pulse, followed by smaller oscillations from the resulting pair of counter-rotating elliptical vortices.

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