Wave trajectories, quantum potential, superoscillations: Madelung, de Broglie, Newton

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The wave counterparts of classical particle paths and geometrical-optics rays are families of trajectories – patterns of streamlines – modified by a 'wave (e.g. quantum) potential'. Wave interference corresponds to undulations in these trajectories, as envisaged in optics by Isaac Newton. Streamline patterns are dominated by singularities at wave vortices and stagnation points. The local momentum (phase gradient of the wave), can exceed the values classically allowed. Regions of such 'superoscillations' are bounded by manifolds where the quantum potential is zero. Some classical 'curl forces' – not the gradient of a potential – are associated with Hamiltonians (dispersion relations) anisotropic in momentum components, with unusual group velocity field singularities, and eigenfunctions with unfamiliar classical counterparts. For simple dispersion relations, some singularities coincide; for general dispersion, they are separate.