The oscillating vortex

The flow we consider is the time-dependent two-dimensional defined by velocity field defined by

$$u(x, y, t), v(x, y, t) = y/R^2, -(x - \epsilon \cos(\omega t))/R^2, \ R^2 = (x - \epsilon \cos(\omega t))^2 + y^2,$$

where ϵ, ω are constants. The instantaneous streamlines of this flow are concentric circles with center at $(\epsilon \cos(\omega t), 0)$.

Path lines may be obtained by solving dx/dt = u, dy/dt - v, X(0) = a, y(0) = b, yielding the Lagrangian coordinates x(a, b, t), y(a, b, t).

Streak lines are computed by solving from $t_0 < t$ up to a fixed t for various t_0 , with $x(t_0 = a, y(t_0) = b$.