Free-Jet Code Benchmark

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Level-Set Analytical Solution

$$\varphi_t + \vec{u} \cdot \nabla \varphi = 0$$

The analytical solution to this wave equation is

$$\varphi(x, y, z, t) = \varphi_0(x - ut, y - vt, z - wt, t)$$

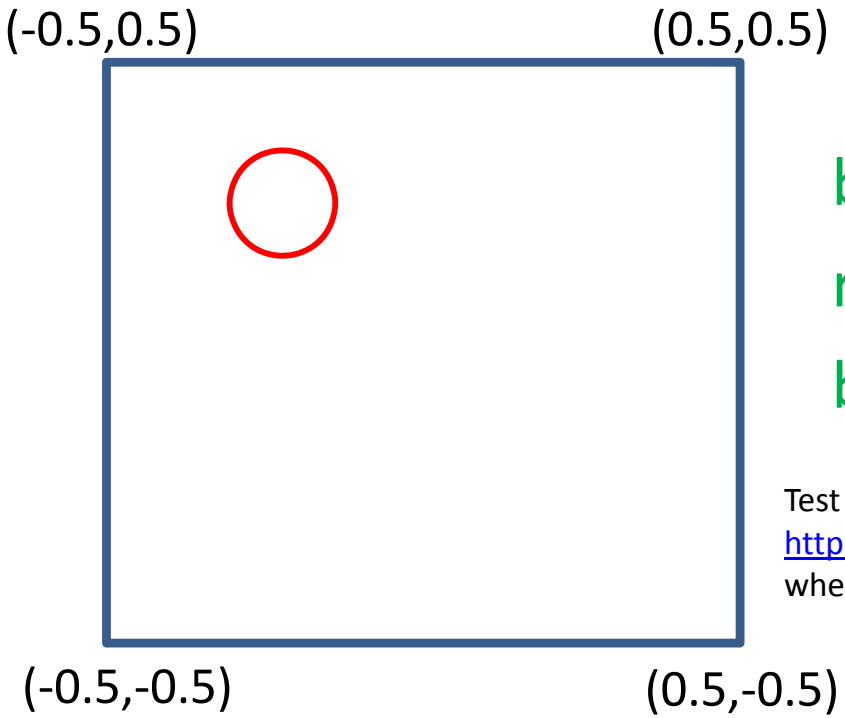
where

$$\varphi_0 = \varphi(x, y, z, 0)$$

Analytical Solution

Analytical solution of level-set function for the following 2D problem, movement of a bubble with velocity u = v = 1, is

$$\varphi(x, y, t) = \sqrt{(x - t + 0.25)^2 + (y - t - 0.25)^2} - 0.15$$



bubble initially centered at (-0.25, 0.25),

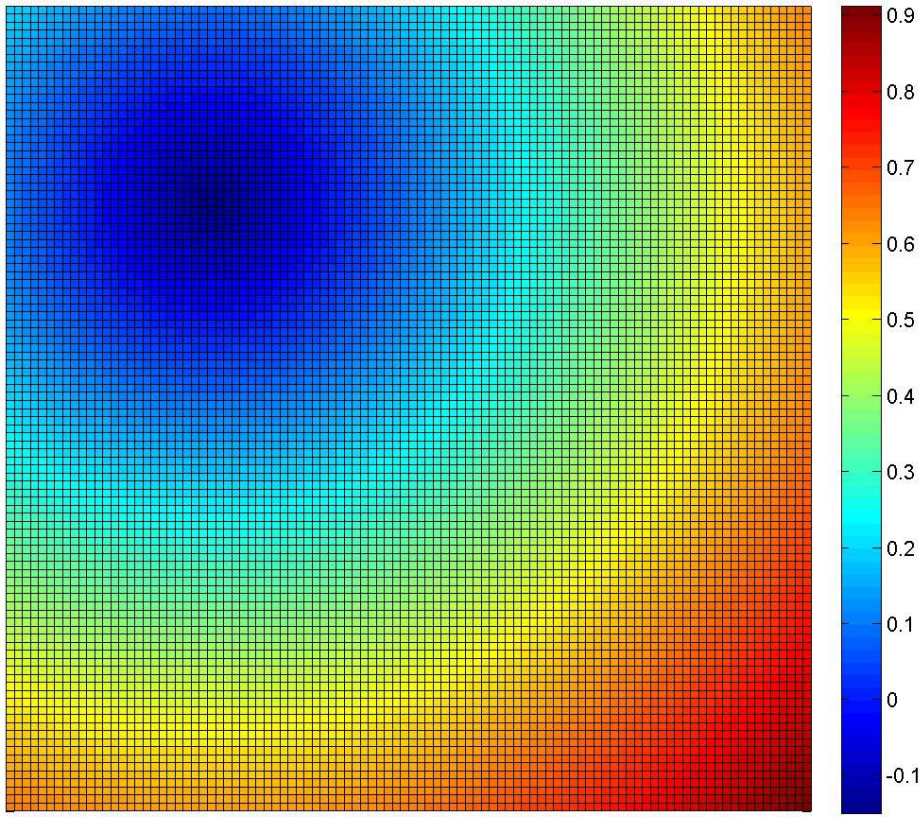
radius of the circle is 0.15,

box is just a window in a larger domain.

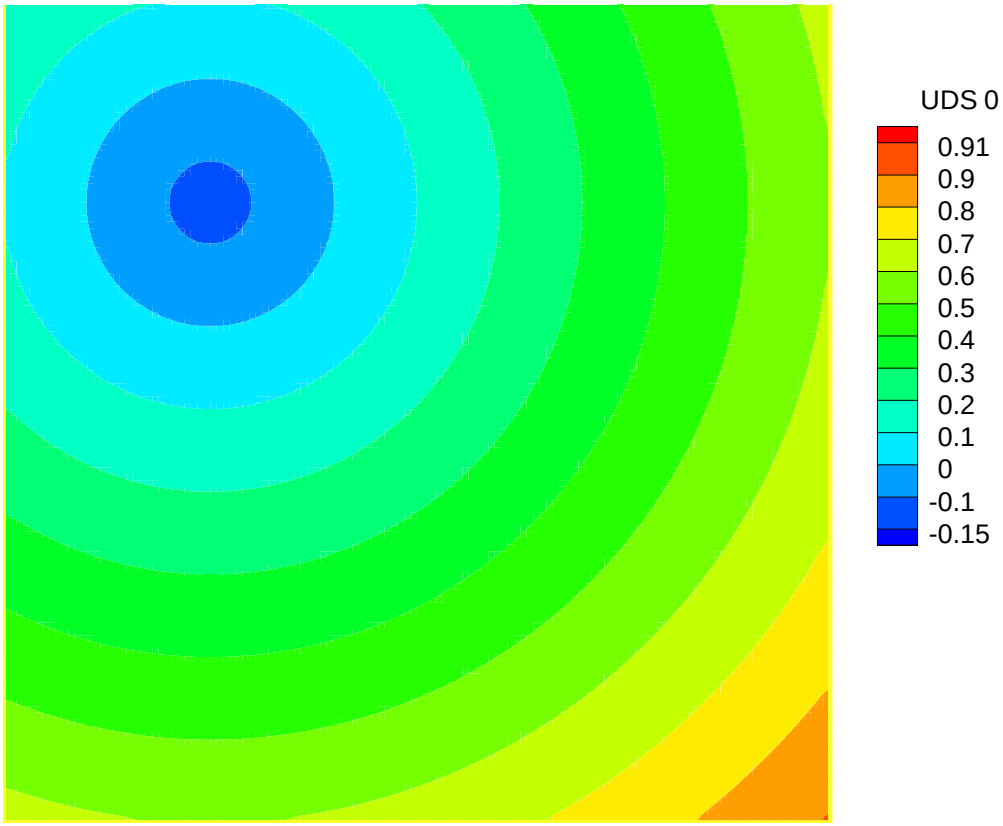
Test case inspired by sec. 5.1 of
http://puhep1.princeton.edu/~mcdonald/examples/fluids/rider_jcp_141_112_98.pdf
where periodic boundary conditions were u se

Comparison For Initial Level-Set Value

which is negative inside the circle

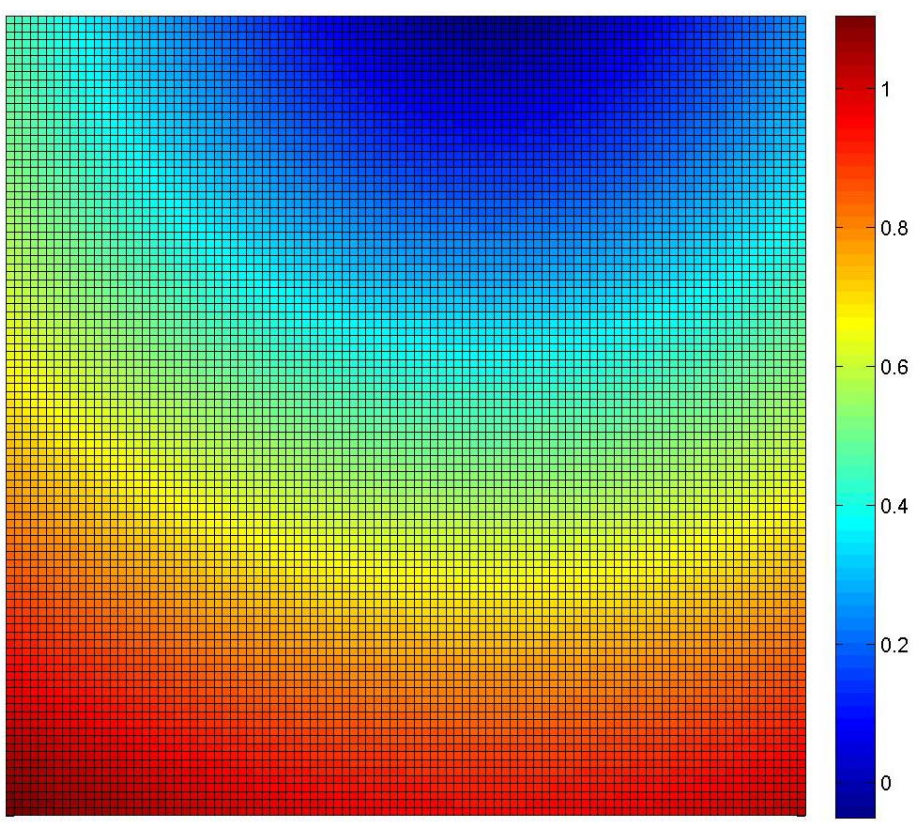


Analytical solution plotted by Matlab

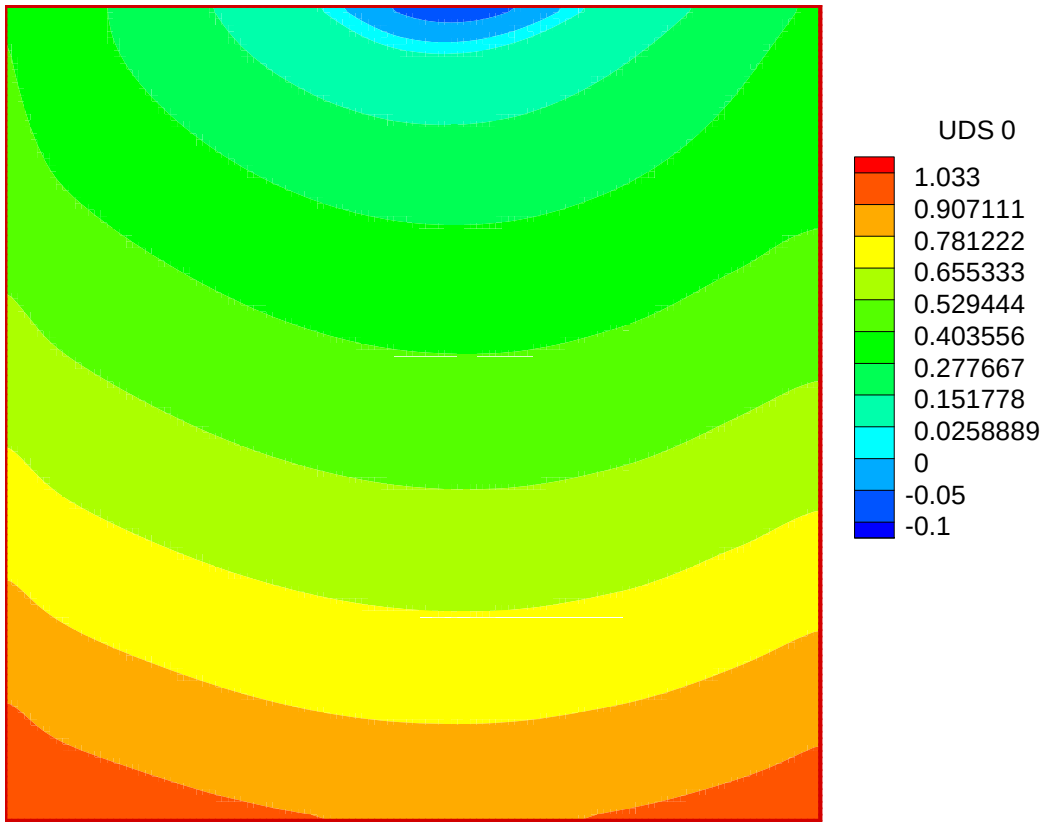


Numerical solution by level set code

Comparison at t = 0.3 s

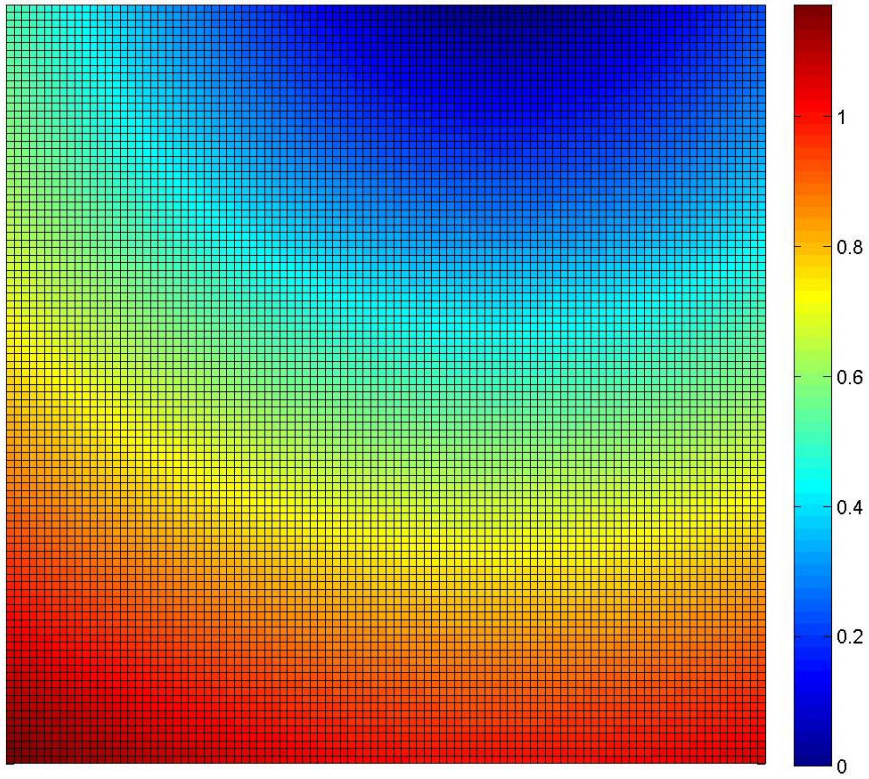


Analytical solution plotted by Matlab

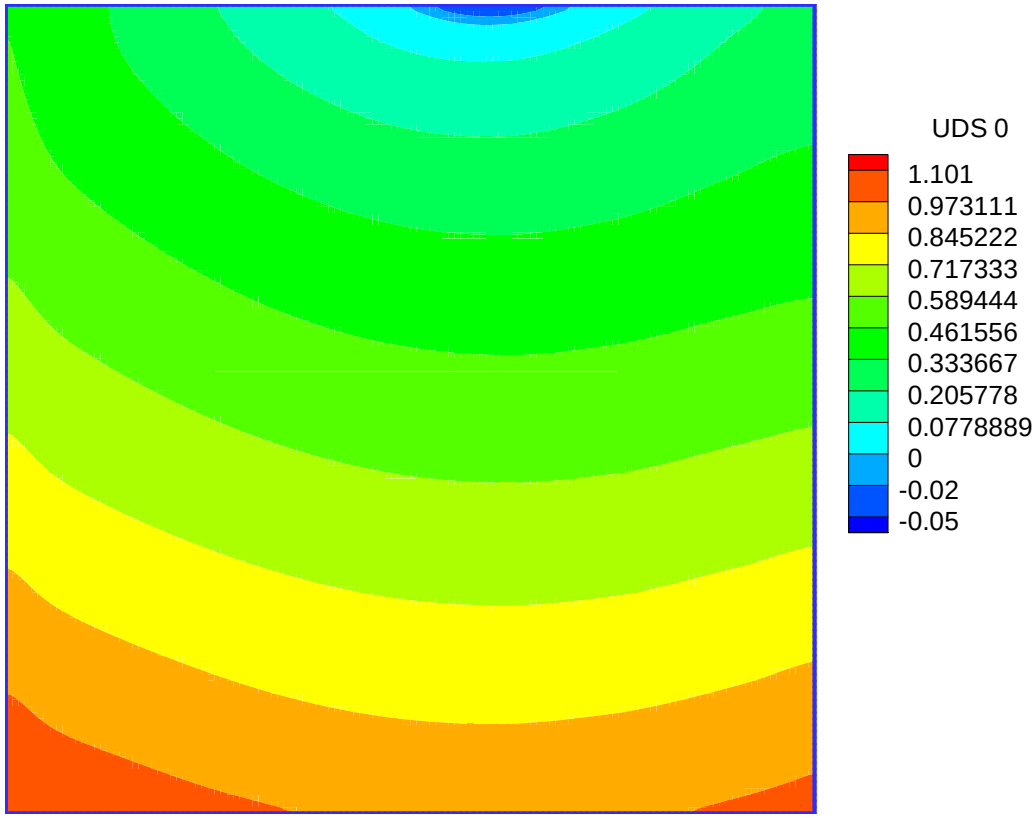


Numerical solution by level set code

Comparison at t = 0.4 s

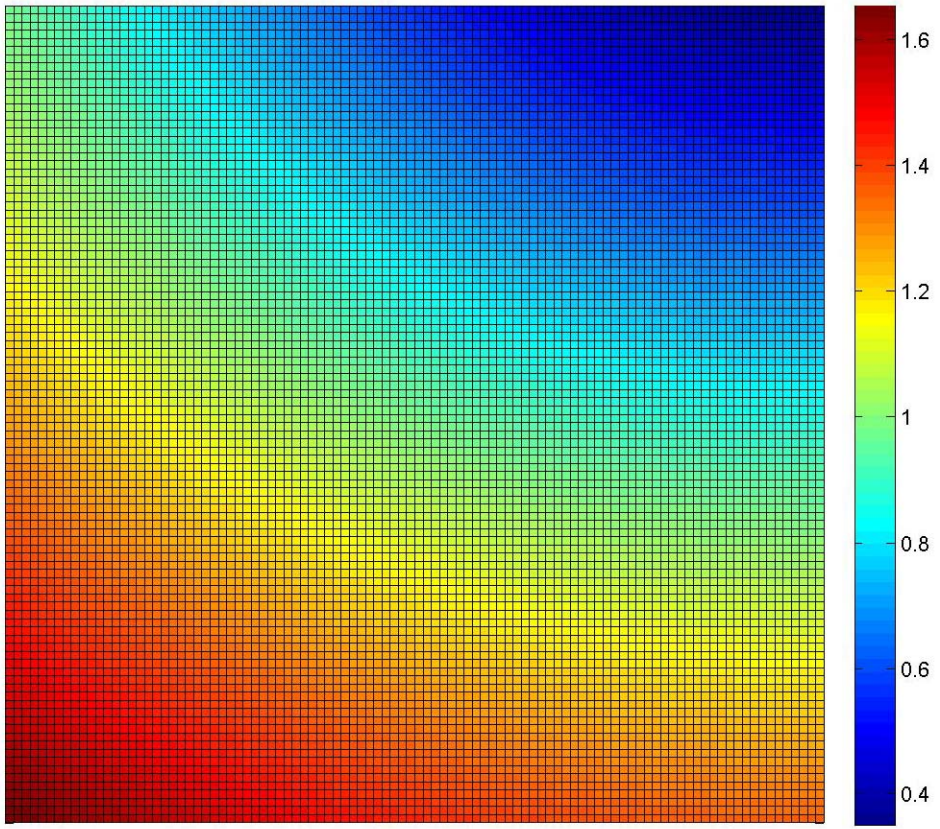


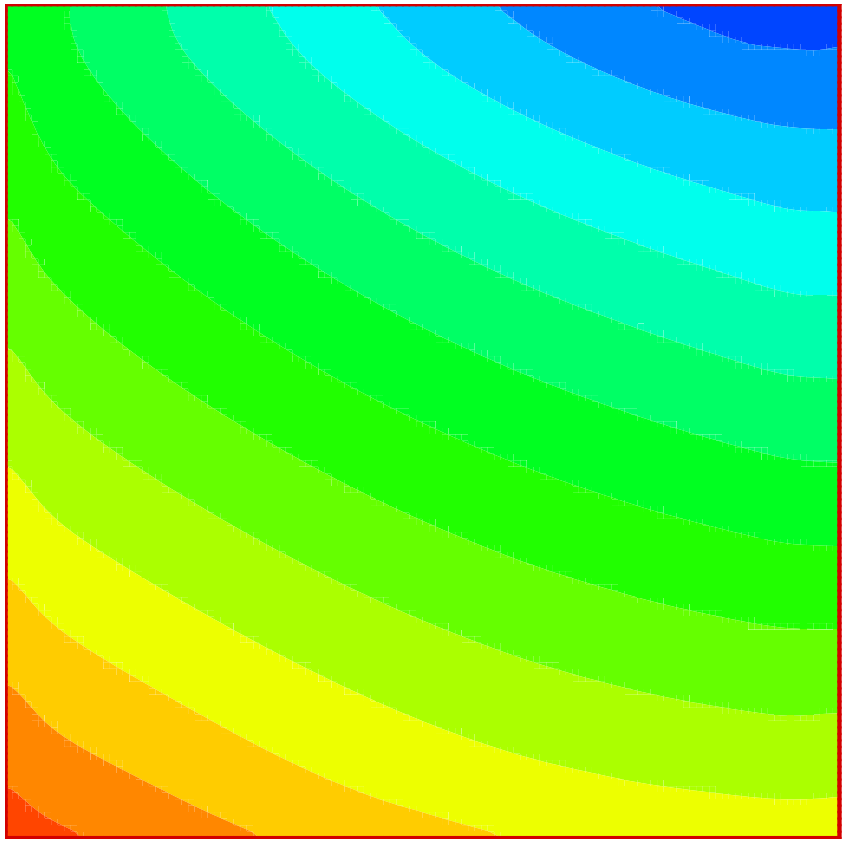
Analytical solution plotted by Matlab



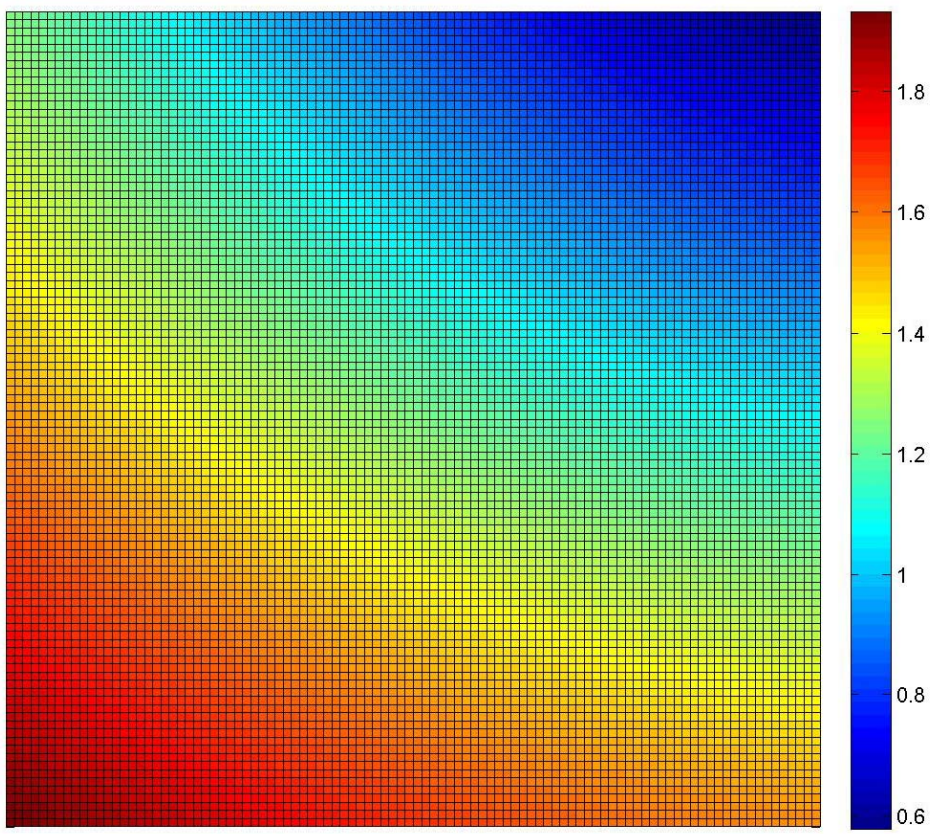
Numerical solution by level set code

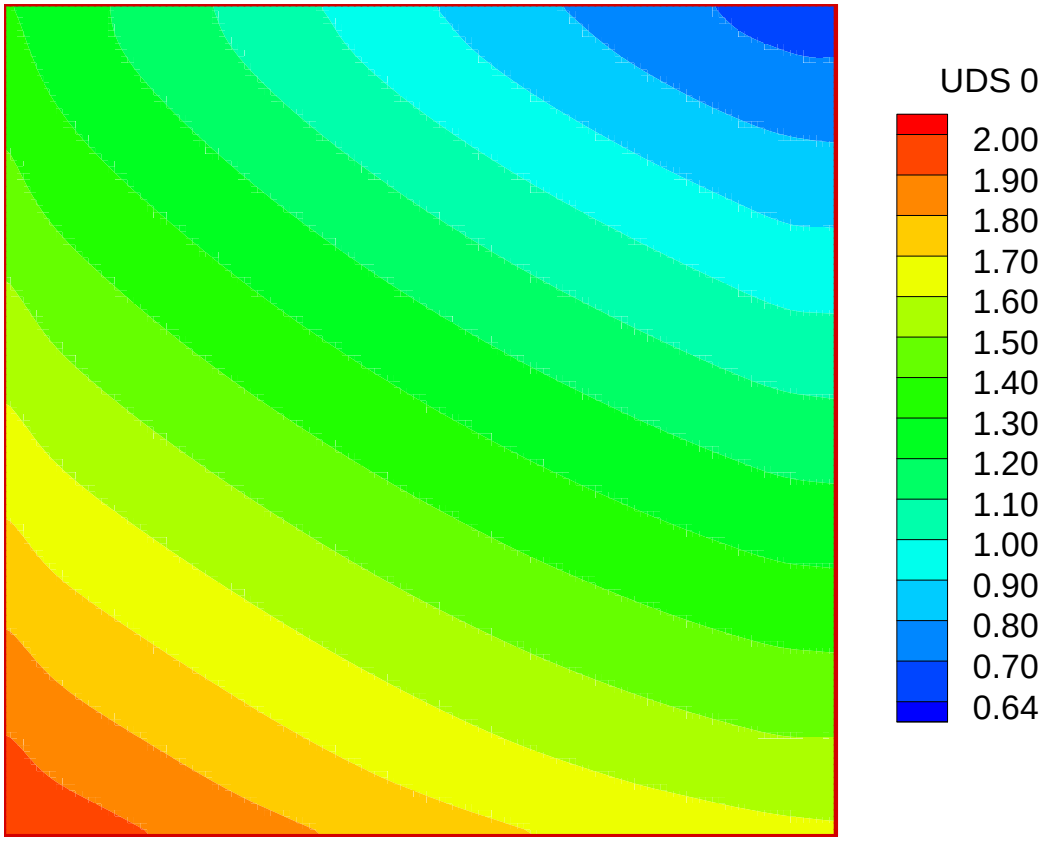
Comparison at t = 0.75 s





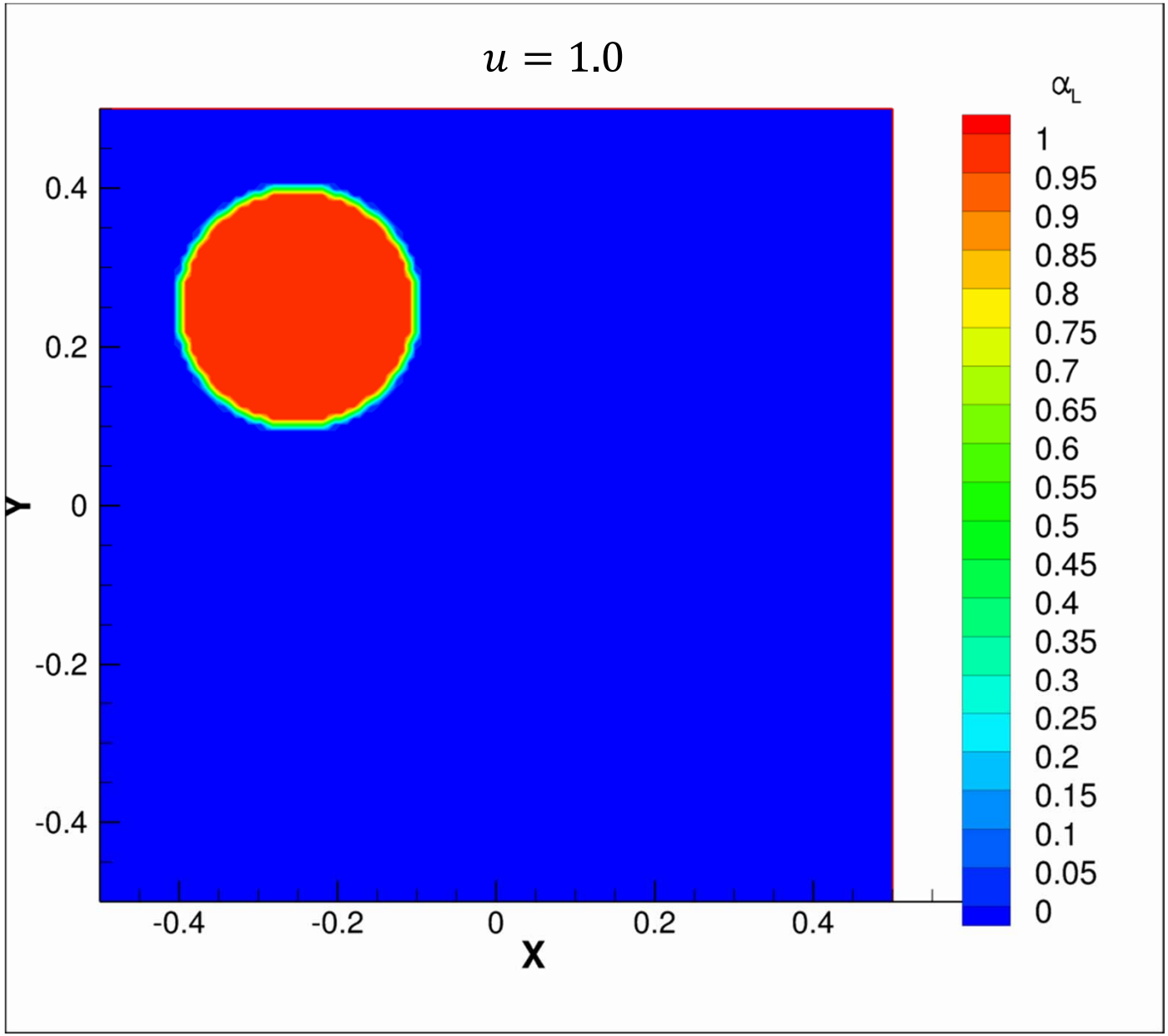
Comparison at t = 1.0 s



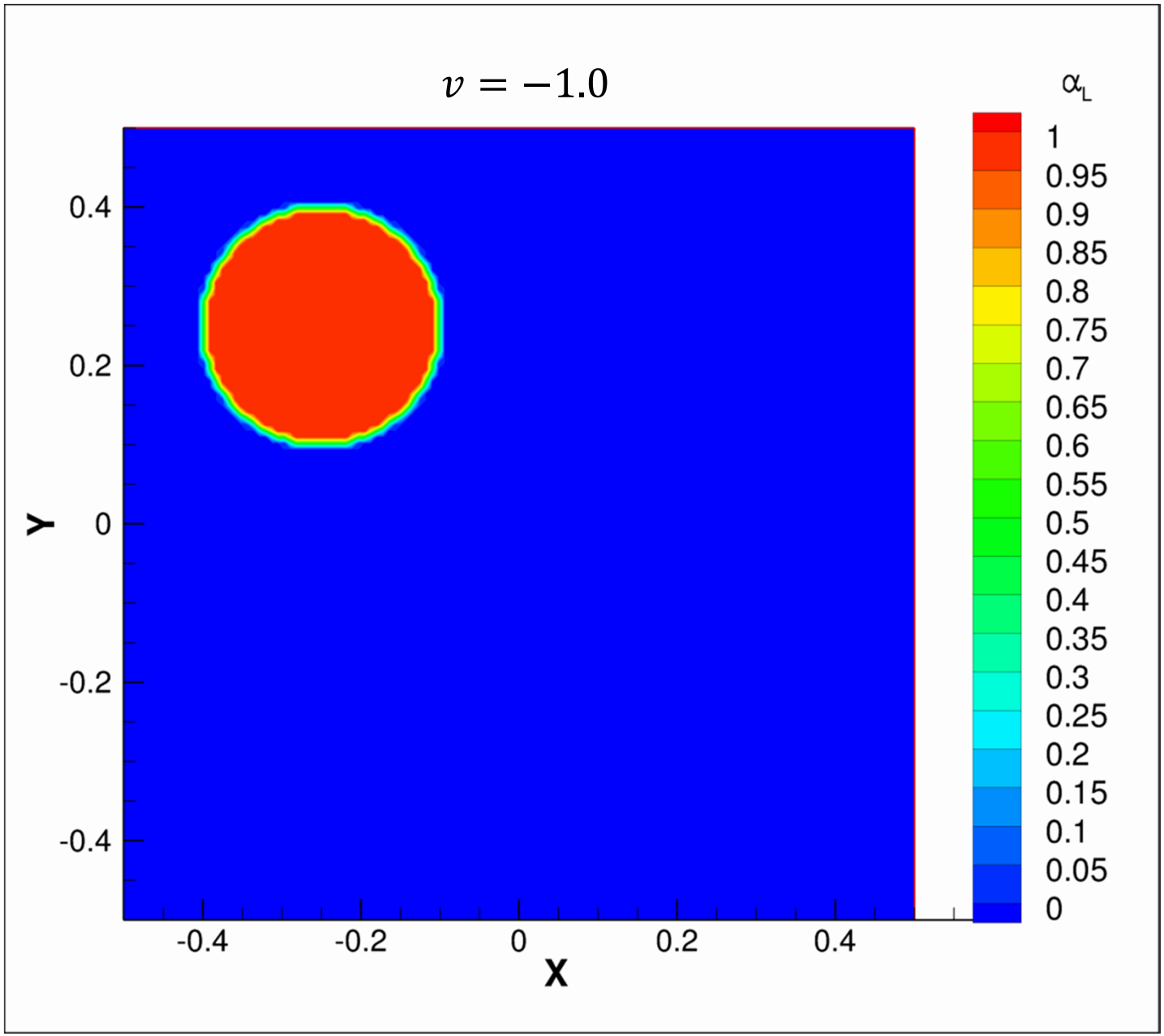


Movement of Two-Phase Circle Using Volume-of-Fluid Method (FLUENT)

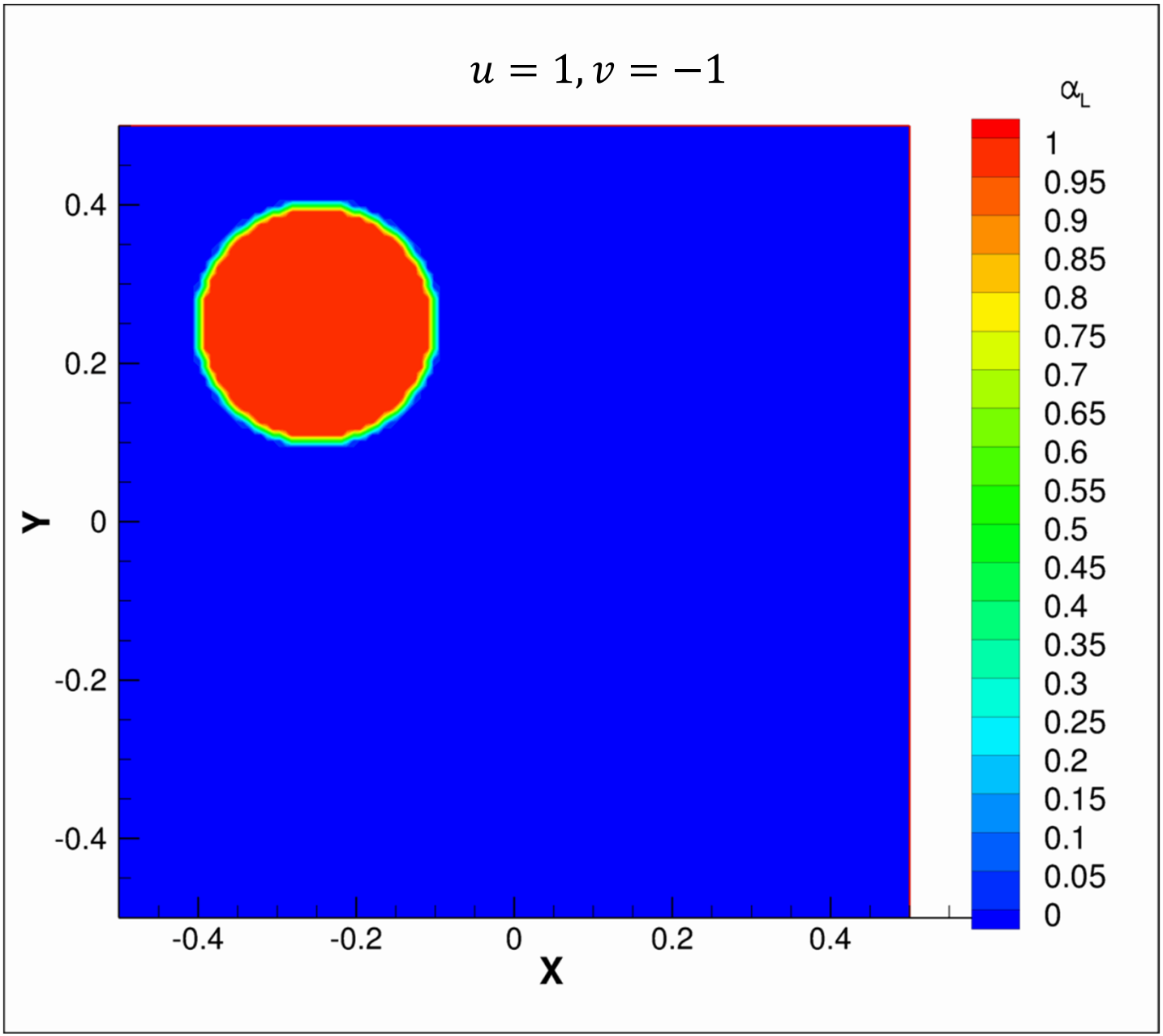
[Click on image to watch video]



Movement of Two-Phase Circle Using VOF Method



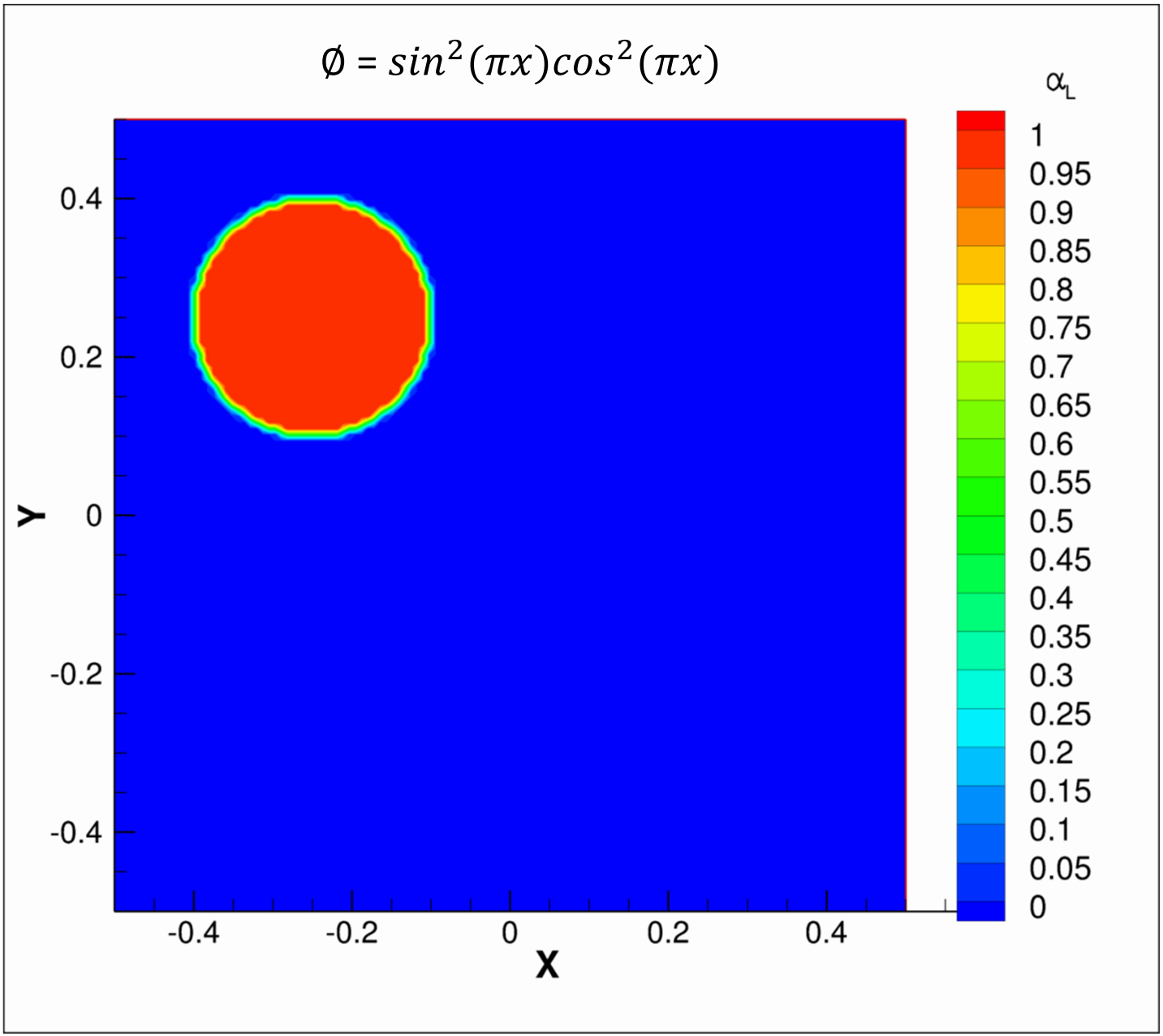
Movement of Two-Phase Circle Using VOF Method



Movement of Two-Phase Circle Using VOF Method

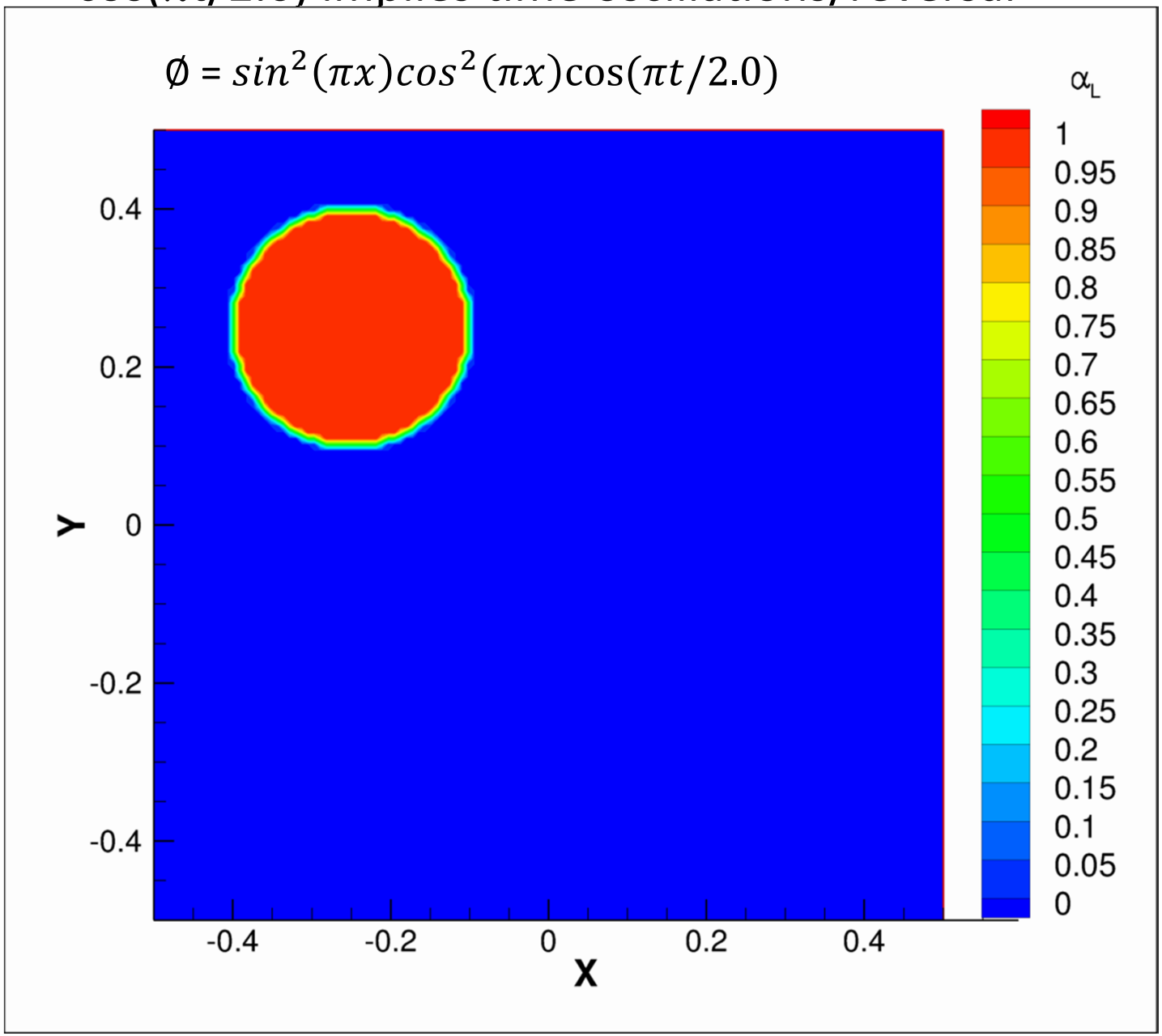
Φ = stream function (not level-set function), typo: $\cos^2(\pi x)$ should be $\cos^2(\pi y)$

velocity: $u = -\partial \Phi/\partial y$, $v = \partial \Phi/\partial x$



Movement of Two-Phase Circle Using VOF Method

cos(πt/2.0) implies time oscillations/reversal



Movement of Two-Phase Circle Using VOF Method