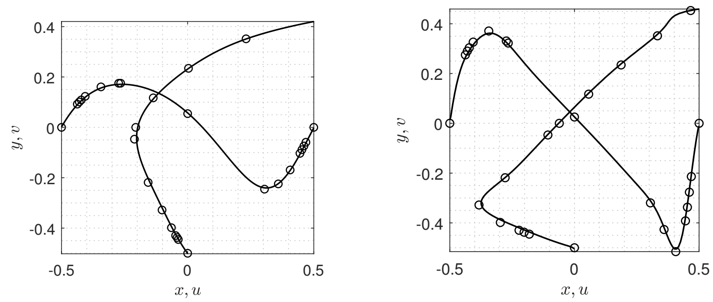

(a) $Re_{\mathrm{w}} = 100$ (b) $Re_{\mathrm{w}} = 1\,000$

Figure 1: Benchmark: two-dimensional lid driven cavity flow. Horizontal and vertical velocity components along the vertical and horizontal centrelines, respectively. Lines: our lattice Boltzmann code with periodic boundaries in the z-direction. Markers: data from Ghia *et al.* (1982). Reynolds number Re_{w} defined from lid velocity and cavity height.

Benchmark for the lattice Boltzmann code

The lid-driven cavity flow has been adopted as a benchmark case for the lattice Boltzmann code used for the simulations in this paper. This problem consists of a quadratic or cubic flow domain with walls on all sides, where the upper wall (orthogonal to the y-direction) moves in the positive x-direction, driving the flow within the cavity. Figure 1 shows the horizontal and vertical velocity components along the vertical and horizontal centrelines, respectively. Markers indicate the reference solution, computed by Ghia *et al.* (1982). This is a two-dimensional problem solved with our three-dimensional lattice Boltzmann code by adopting periodic boundaries to the third dimension. Simulations have for verification been repeated permuted axis orientations. The result of a three-dimensional cavity simulation is presented in table 1, listing the location of the main vortex centre (stagnation point) in various xy-planes. Reference values for a finite volume and a finite difference scheme is taken from Kristoffersen & Andersson (1989). Reference simulations contain a restricted number of grid points, but our intention here is to demonstrate consistency.

References

Ghia, U., Ghia, K. N. & Shin, C. T. 1982 High-re solutions for incompressible flow using the Navier-Stokes equations and a multigrid method. *Journal of Computational Physics* **48**, 387–411.

Kristoffersen, R. & Andersson, H. I. 1989 The three-dimensional lid-driven cavity as test case for numerical simulation algorithms. *Tech. Rep.* STF67 A 89004. SINTEF.

	finite volume		finite difference		lattice Boltzmann	
z	x	y	x	y	x	y
0.05	0.621	0.803	0.623	0.813	0.626	0.800
0.10	0.622	0.792	0.624	0.793	0.627	0.790
0.20	0.620	0.778	0.623	0.779	0.625	0.775
0.30	0.618	0.768	0.620	0.769	0.622	0.765
0.40	0.616	0.762	0.618	0.763	0.620	0.759
0.50	0.615	0.760	0.618	0.760	0.619	0.757

Table 1: Benchmark: three-dimensional lid driven cavity flow—vortex centres in the xy-plane slices for prescribed levels in z. $Re_{\mathrm{w}} = 100$. Data from finite volume and finite difference methods are taken form Kristoffersen & Andersson (1989).