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论文

鱼洗内颗粒流动的数值模拟

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摘要 实验表明，鱼洗内的流动存在高度非线性的相互作用，并最终导致表面连续性的破坏. 在数值模拟中，这类问题是非常难处理的. 该文从离散的观点出发，直接考虑容器内部粒子的运动. 即采用分子动力学方法，模拟鱼洗内的流动. 该方法所考虑的实质是颗粒流动，不要求介质是连续的，从统计物理的观点看，当所模拟的粒子数非常大时，在统计上和连续介质相当. 该文首先发展了基于消息传递(MPI) 的并行计算程序，可以用来做大规模的颗粒流动模拟. 对鱼洗内的颗粒流动模拟结果表明，在外界激励下，鱼洗内的颗粒流动表现出的现象和液体流动类似，边界的能量以波的形式向内部传播，并很快耗散掉，在边界激励点附近，颗粒因为受到边界和内部粒子的挤压作用而跳起，从直观现象上看， 和鱼洗的流动实验一致. 在能量的概率密度分布函数中，可以观察到两个明显的指数区.

关键词 颗粒流动 鱼洗 分子动力学模拟 并行计算

分类号 0347.7, 0353.4

Numerical simulation of granular flow in ``Chinese Fish Basin''

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Abstract

As demonstrated in experiments, highly nonlinear reactions exist in the ``Chinese Fish Basin'', which finally lead to the surface discontinuity. It is difficult to deal with such problems in numerical simulation. In this paper, Molecular Dynamics Method is employed to simulate three-dimensional granular flow in Chinese Fish Basin. we consider particles in the container from the viewpoint of discretization, without the requirement of continuous media. When the number of particles in the simulation is large enough, the behaviors of granular flow are statistically equivalent to those of the continuous media. We first develop a parallel program based on message passing interface(MPI), which can be used to simulate large scale granular flow. Interesting phenomena in the ``Chinese Fish Basin'' are demonstrated with our simulation results. As a result of the excitation from outside, energy from the boundary spreads to the interior of the basin in the form of wave, and dissipates quickly. And particles spout upward near the excited points, which is in consistent to the water spouting in the real Fish Basin.

Key words granular flow Chinese Fish Basin molecular dynamics simulation parallel computation

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