An introduction of the Shanlin's research

I want to introduce my research with a very common phenomenon in nature, i.e., the settling of the raindrop. A typical characteristic of the raindrop falling is that the raindrop has a uniform low settling velocity, so people will not be killed by the falling raindrop. The physics after the uniform settling velocity is the force equilibrium. When a raindrop falls in the air, it is mainly affected by two forces. The gravity and the drag force, which going opposite to the falling of the raindrop in the air. ~~The raindrop will increase~~ its falling velocity V under the effect of the gravity. Meanwhile, with the growth of V, the fluid drag force f_d exerted on a raindrop by air also increases. Once the increasing drag force f_d balances the gravity of the raindrop, it will fall at this velocity without any changing. The raindrop settling in the air is a very simple but ~~a~~ typical example of the particle settling in the fluid. The reason why I explain the settling of the raindrop is that the same phenomenon will occur during the settling process of a sand particle in water. However, the settling process of a group of particles in water is more complicated. Particles will hinder and impede each other so that the particles will decrease their effective falling velocity with the increase of the particle concentration of mixtures, and show different characteristics.

My research interest is simulating various sand/clay particle-fluid flow in the civil engineering, studying the motions and collisions among the micro-particles as well as their interactions with surrounding fluids. What I employ to accomplish the simulation is the coupled CFD—DEM (Computational Fluid Dynamics and Discrete Element Method) model, compared with other simulation methods, this method could capture the particles motion and resolve the fluid flow with agreeable efficiency. In this model, the fluid phase is solved in CFD program by the locally-averaged incompressible Navier–Stokes equations, and the Particles' motions are tracked in DEM program based on Newton's second law. Coupled program of the CFD and DEM is used to (1) obtain the kinetic information of the fluid from the CFD part and the information of particle from DEM part; (2) calculate the fluid-particle interaction forces, e.g., drag force; (3) transmit the interaction force and kinetic information back to the CFD and DEM part respectively to simulate the subsequent fluid flow and the particles motion. The simulation results can give us a direct understanding of the particle's motion in fluid and help study the influence of the physical properties of the fluid and particle on the practical sedimentation process.

Moreover, the simulation of the particle-settling process has many applications not in civil engineering, but also numerous field which involves the particle-liquid separation phenomena, such

as the tablet sorting in pharmaceutical engineering, the formation of the bitumen in the construction of road, the removal of the solids from sewage wastes, and even the erythrocyte settling and separation in blood. Although the force acting on the different objects is a little bit different, we could make the program to consider the different types of force in the simulation model to accomplish the accurate simulation. Therefore, I hope I could study this method and develop it so that study more and more miraculous particle-laden flows in our life.