Two-phase solid spheres settling in a line,

Two-phase flows with bubbles, drops, and particles in a non-Newtonian suspending fluid are common in engineering applications. Examples of this kind of flow include hydraulic fracturing slurries for oil and gas exploration1, processing of polymer blends2 and airlift bioreactors3. Non-Newtonian fluids do not follow Newton’s Law of Viscosity, i.

e. the viscosity is not constant and/or the fluid exhibits time-dependent rheological behavior (thixotropy and rheopexy properties) due to structural changes4. Many fluids exhibit a shear-dependent viscosity. For these fluids, the value of viscosity may decrease with shear (shear thinning or pseudoplastic fluids) or increase with shear (shear thickening or dilatant fluids).

Other fluids exhibit viscous and elastic properties. These viscoelastic fluids flow under stress and show partial recovery toward its undeformed state once the stress is removed. They also exhibit memory effects. 5For a sedimenting solid sphere in a stagnant viscoelastic fluid with shear-thinning viscosity, an interesting phenomenon may happen: the appearing of a negative wake downstream the particle, i. e. the flow moves in a direction opposite to that of the sphere (see Fig.

1). This phenomenon is explained by the memory effect of the fluid, which tends to recoil to its initial undisturbed state after being stretched or sheared. The negative wake leads to different hydrodynamic interaction forces. However, surprisingly, the negative wake is not related to the separation of two solid spheres settling in a line since it does not modify the interactions significantly. 6The appearing of negative wake may also happen for rising bubbles or drops. In this scenario, the deformable interface of bubbles and drops adds to the complexity of the problem.

For instance, the bubble experiences shape transitions when its volume is above a certain critical value, which triggers the negative wake as well. Unlike the settling solid particles, the possible influence of negative wake of a leading bubble over a trailing bubble has not been studied yet. 5Figure 1 – Axial fluid velocity around a sphere for the case of negative wake. 5Considering the fundamental problem of drops and bubbles under gravity or buoyancy force in a quiescent (stagnant) non-Newtonian fluid, this work aims to investigate the influence of induced flow pattern around bubbles. More specifically, how the negative wake dynamics change the hydrodynamic interaction forces between a pair of rising bubbles. For two solid spheres settling in a line, the negative wake does not modify the interactions significantly.

6 For two rising bubbles, the hypothesis is that the negative wake will modify the interactions significantly due to the small inertia of the bubbles. To test this hypothesis, an experimental study is proposed hereafter.