# Preferential Scaling in Soft Matter Coalescence

When two different sized soft-matter spheres (parents) coalesce into a big sphere (daughter), the daughter is commonly expected to be "fairly" placed at the center of mass between the two parents. However, the daughter is "preferentially" placed much closer to the larger of its two parents. This phenomenon is called "coalescence preference." An experimental confirmation of coalescence preference as a function of parent size ratio has been made by Korean scientists of Pohang University of Science and Technology in South Korea [1]. They confirmed this preference by directly visualizing the coalescences of air bubbles on an oil-water interface using X-ray microscopy at Pohang Light Source and by observing water droplets immersed in oil using optical microscopy. Their results suggest that preferential coalescence would be common in coalescing soft matter, particularly when two spheres merge into a large one by size inequality.

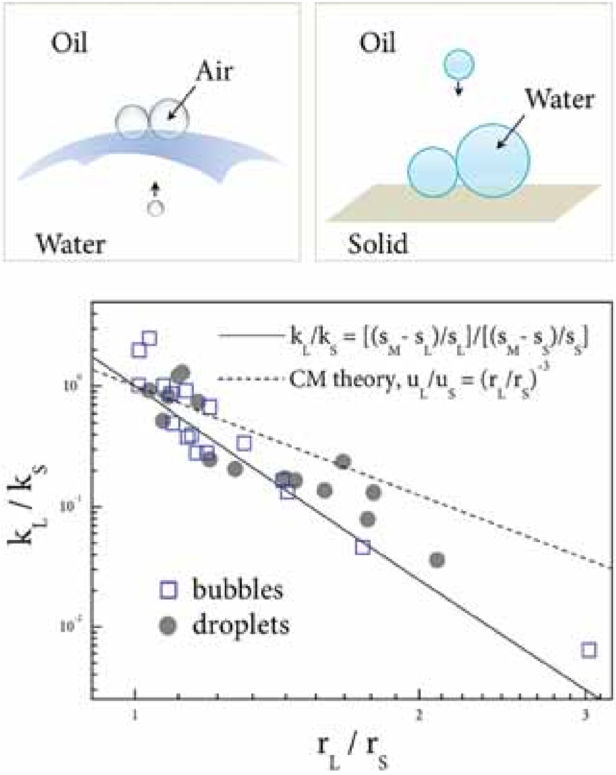


**Fig. 1:** The mass movement to the relative position ($a_L$ or $a_S$) is proportional to the kinetic energy ($k_L$ or $k_S$) gained from the fraction of the surface energy difference between the parent and the merged spheres. $k_L$ or $k_S$ depends only on the parent size ratio $r_L/r_S$ as $k_L/k_S = 0.99(r_L/r_S)^{-5.3}$ (solid line). Good agreement in $k_L/k_S \sim a_L/a_S$ for bubbles (squares) and droplets (circles) suggests that the coalescence preference is attributable to the topological change caused by the surface energy release. Center of mass theory (dashed line) predicts $u_L/u_S = (r_L/r_S)^{-3}$ and cannot explain the observations.

They also found that this preference is significantly enhanced by the size inequality of two parents, showing a similar economic inequality; "the rich get richer." As the parent size ratio $r_L/r_S$ ($r_S < r_L$) increases, the daughter position becomes closer to the larger parent position. This dependence on the parent size ratio was found to follow a power-law scaling as $a_L/a_S \sim (r_L/r_S)^{-5}$ with the relative lengths $a_S$ and $a_L$ from the smaller and the larger parent positions. Strikingly, this preference could not be explained by the center-of-mass theory. They suggested a new theory based on kinetic energy transferred from the surface energy released during the coalescence process. They assumed that the mass movement to the relative position ($a_L$ or $a_S$) is proportional to the kinetic energy ($k_L$ or $k_S$) gained from the fraction of the surface energy difference between the parent and the merged spheres. The kinetic energy ratio is then described as $k_L/k_S \sim (r_L/r_S)^{-5.3}$ and is in good agreement with the power-law scaling observed from bubbles and droplets (Fig. 1).

This preference of individual coalescence events is important in global assemblies of bubbles or droplets. The coalescence preference would be not only responsible for the continuous growth of a large bubble at the gradual expense of small bubbles, but also universally important in understanding the stability and the statistics of coalescing bubbles and droplets.

***References***

[1] B. M. Weon and J. H. Je, Phys. Rev. Lett. 108, 224501 (2012).