Effervescence in champagne and sparkling wines: Recent advances and future prospects

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Bubbles in a glass of champagne may seem like the acme of frivolity to most of people, but in fact they may rather be considered as a fantastic playground for any fluid physicist. In a glass of champagne, about a million bubbles will nucleate and rise if you resist drinking from your flute. The so-called *effervescence* process, which enlivens champagne and sparkling wines tasting, is the result of the complex interplay between carbon dioxide (CO_2) dissolved in the liquid phase, tiny air pockets trapped within microscopic particles during the pouring process, and some both glass and liquid properties. The journey of yeast-fermented CO_2 is reviewed (from its progressive dissolution in the liquid phase during the fermentation process, to its progressive release in the headspace above glasses). The physicochemical processes behind the nucleation, and rise of gaseous CO_2 bubbles, under standard tasting conditions, have been gathered hereafter. Moreover, when a bubble reaches the air-champagne interface, it ruptures, projecting a multitude of tiny droplets in the air. Based on the model experiment of a single bubble bursting in simple liquids, we depict each step of this process, from bubble bursting to droplet evaporation. In particular, we demonstrate how damping action of viscosity produces faster and smaller droplets and more generally how liquid properties enable to control the bubble bursting aerosol characteristics. We demonstrate that compared to a still wine, champagne fizz drastically enhances the transfer of liquid into the atmosphere. Conditions on bubble radius and wine viscosity that optimize aerosol evaporation are provided. These results pave the way towards the fine tuning of aerosol characteristics and flavor release during sparkling wine tasting, a major issue of the sparkling wine industry.