Effervescence noise

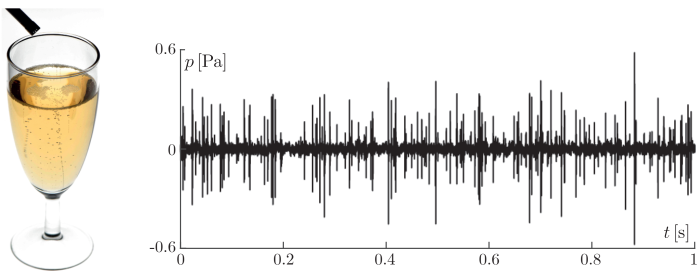
J. Pierre[1], M. Poujol [1], F. Ollivier [1], R. Wunenburger [1], A. Antkowiak [1]

[1] Institut ∂'Alembert, CNRS, Sorbonne University, Paris, France

E-mail: juliette.pierre@upmc.fr

ABSTRACT

Where does the sound of effervescence of Champagne or fizzy beverage come from ? To answer this seemingly simple question we have to address the intricate physics behind bubble formation and bursting. Sparkling beverages are saturated with CO_2 responsible for the formation of nucleation bubbles on the glass wall. Travelling between their nucleation sites to the liquid surface, bubbles grow by gas diffusion ; they accumulate and pack at the liquid surface and finally burst [1]. In contrast with the extensive knowledge about physics and chemistry of effervescence only few work explored the acoustic radiation [2]. In the present study we link air-borne acoustics with hydrodynamics. First, we focus on the acoustic emission produced by the effervescence of a glass of champagne. Fig.1. illustrates this experiment. A high frequency microphone ([0.1:100] kHz) is placed above the glass of champagne (fig.1 a) and a high speed camera, synchronized with the microphone, follows the events occurring at the liquid surface. The acoustic pressure field highlights a succession of tone bursts (fig.1 b). We conclude that this noise is mainly caused by the bubbles bursting at the liquid surface and not by oscillating bubbles in the liquid bulk. In order to understand the physical mechanisms behind the tone bursts, in a second part we explore the sound radiated by single millimeter bubbles bursting at the surface of a liquid bath without and with surfactants. The acoustic pressure is recorded using the high frequency microphone. The latter is synchronized with two high speed cameras, one to follow the collapse of the immersed cavity and the other one for the top view. We explore various bubble size and we precisely link the interfacial reconfiguration occurring during the collapse with the air-borne acoustic emission. Finally, we show that the audible sound of the fizz is due to the early time of the bursting bubble when the film starts to break.



(a) (b)

Figure 1: (a) photograph of the experiment : glass of champagne and microphone to record the air-borne acoustic emission. (b) Air-borne acoustic pressure over time.

[1] G. Liger-Belair, M. Vignes-Adler, C. Voisin, B. Robillard,and P. Jeandet, Langmuir18, 1294 (2002)

[2] K. S. Spratt, K. M. Lee, and P. S. Wilson, Physics Today71, 66 (2018)