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ABSTRACT

Leidenfrost drops often exhibit symmetric shape-oscillations when placed onto curved substrates. We give some brief remarks on vibrations found in liquids floating over highly heated surfaces for the overlooked period from the late 1700s up to the work of Holter and Glasscock in 1952 [J. Acoust. Soc. Am. **26**, 253 (1952)]; the latter pair were incorrectly credited as the first to observe such behavior in Leidenfrost drops.

When drops of liquid are placed onto a substrate at a temperature much higher than that of the boiling point of the liquid, they persist and float on a layer of their own vapor without visibly coming to boil. First described by Boerhaave in 1732[1] in an effect now known as the Leidenfrost effect,[2] on substrates that are slightly concaved, drops that were once sessile can suddenly and quite unexpectedly start to oscillate. Taking on star-shaped patterns of surprising pulchritude, depending on the type of liquid used, many different modes of vibration are possible.

Recently, these star-shaped oscillations in Leidenfrost drops have received renewed interest in the literature.[3–12] Drops found vibrating in a radial direction form either elliptical patterns with two lobes or more general hypotrochoid patterns with three or more lobes. In all cases, authors cite the 1952 work of Holter and Glasscock[13] as the first to report on the phenomenon of spontaneous oscillations seen in liquid drops levitating over highly heated surfaces. In an effect as old and well-studied as the Leidenfrost effect, it is only natural to suspect vibrations in these drops had been previously seen and described before this time. That this is indeed the case is hardly surprising, with the early literature in this area extensive, unexpectedly rich, and at times often contested.

Without going too deeply into the history of oscillating star-shaped Leidenfrost drops which I have given elsewhere,[14] it is enough to note the following. Beyond some cryptic and ambiguous remarks dating from the late 18th century about drops of water hovering over highly heated surfaces being jolted to and fro, the first clear reference to a star-shaped Leidenfrost drop comes to us in 1801 from the German chemist Martin Heinrich Klaproth.[15] When referring to his investigations into the Leidenfrost effect, he wrote "The edge of the ball [the water droplet] appeared to be engrailed." By the early 1850s, vibrations occurring in Leidenfrost drops were well known. Debate concerning their formation and the number of lobes found around the drop's periphery is what mainly occupied the attention of investigators at this time. A decade later a beautiful woodcut of an 18-lobe rosette can be found in John Tyndall's widely read text *Heat Considered as a Mode of Motion.*[16] Tyndall was also in the habit of projecting onto a large screen images of his rosettes he formed for the benefit of his audience at lecture demonstrations he regularly gave at the Royal Institution of Great Britain in London throughout 1862. By 1912, Batdorf was using high-speed photography to study these vibratory patterns with the photographs he took subsequently appearing in print.[17]

Of all the early studies on vibrating Leidenfrost drops prior to the work of Holter and Glasscock, it is the account given by the French chemist Auguste Laurent in 1836[18] to which we believe the discovery should be more properly accorded. Laurent was the first to correctly understand the star-shape patterns seen with the eye were a persistence of vision effect resulting from a rapid superposition between two extreme states in vibrating liquid drops. In fact, the account Holter and Glasscock give for the observed star-shaped patterns in Leidenfrost drops turned out to be no better than that given by Laurent 116 years earlier. Laurent managed to achieve this without access to modern (as in the mid-20th century sense) stroboscopic and photographic tools.

Star-shaped patterns found in Leidenfrost drops have a long, rich, and at times contested history. In drawing attention to the overlooked work of Laurent, we hope future investigators will find a way to rightly recognize the merit of his priority in the discovery of vibrating

Leidenfrost drops that today continues to be incorrectly assigned to Holter and Glasscock.

DATA AVAILABILITY

Data sharing is not applicable to this note as no new data were created or analyzed in this study.

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