SELF-PROPULSION OF LEIDENFROST SILICON BALL LIGHTNING

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According to reports collected from hundreds of witnesses in the past two centuries, ball lightning (BL) is a luminous globe observed in nature, most often after ordinary lightning, either near the impact or at some distance from it [1]. Previously [2], were performed electric arc discharges in pure silicon to generate luminous balls with a lifetime in the order of seconds and several properties usually reported for natural ball lightning. The balls leave smoke trails above it. The balls seem to be floating and spinning because the smoke trails tend to form aspiral, as shown in Fig. 1. Several natural ball lightnings are seen float and spin on the ground. In this work we believe that this property is due to Leidenfrost effect. A Leidenfrost drop forms when a liquid is deposited on a surface the temperature of which is large enough to create a film of vapor between the drop and the surface. For silicon, this happens for temperatures larger than its boiling point, $T_L > B_P$ = 3538 K. Linke et al [3] have reported in 2006 that such Leidenfrost drops can spontaneously move when deposited on a sawtooth-shaped surfaces where the drop is observed to move in the direction were it climbs the steps at a velocity of the order of 5 $cm.s^{-1}$. In the case of silicon luminous balls, the mechanism of displacement and spining is due to surface roughness, as demonstrated experimentally by Linke to water [2].

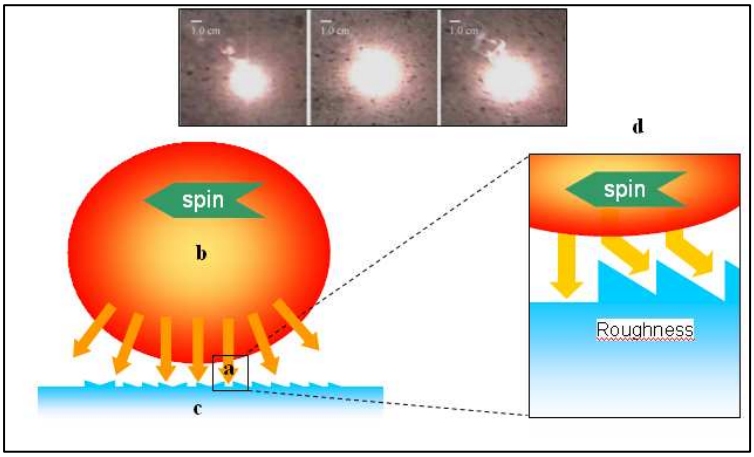

Figure 1 – In the Leidenfrost effect, or film boiling, a layer of vapor (a) from silicon luminous ball (b) forms beneath the droplet, keeping it elevated above the surface (c). As the vapor escapes, the asymmetrical surface (roughness) causes it to flow mostly in one direction. The silicon luminous ball spins around the vertical axis (d).

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[2] Paiva, G.S., Pavão, A. C., Vasconcelos, E. A., Mendes Jr., o. & Silva Jr., E. F. Production of Ball-Lightning-Like Luminous Balls by Electrical Discharges in Silicon. Phys. Rev. Lett. 98, 048501-1 (2007).
[3] Linke, H. et al., Self-Proppelled Leidenfrost Droplets, Phys. Rev. Lett. 96, 154502 (2006).