The polygonal destabilization of Leidenfrost levitated tori.

S. Perrard*, Y. Couder*, E. Fort** and L. Limat*

*Matières et Systèmes Complexes,
Université Paris 7 Denis Diderot, CNRS - UMR 7057,
Bâtiment Condorcet, 10 rue Alice Domon et Léonie Duquet
75205 Paris cedex 13, France
**Institut Langevin, ESPCI ParisTech and Université Paris Diderot, CNRS UMR 7587,
10 rue Vauquelin, 75 231 Paris Cedex 05, France

A drop of water deposited on a surface hotter than 150°C can levitate without contact with the substrate and survive for a few minutes. The evaporation of the fluid generates a thin vapour film[1], which supports the drop's weight by lubrication forces (Leidenfrost effect). This effect is usually limited to small droplets. We propose here an original substrate geometry that allows us to maintain in levitation a liquid torus of large volume. Furthermore we show that it is possible to obtain a permanently levitating torus by injecting fluid into the ring to compensate the evaporation.

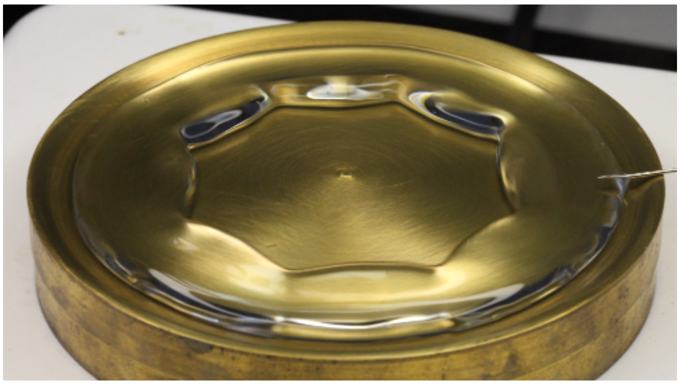

Figure : Photograph of the water torus levitated by Leidenfrost effect. The internal surface of the ring destabilizes spontaneously to form a rotating polygonal shape

Due to the temperature gradient between the top and the bottom of the liquid, a convective motion is generated in the torus. The structure of the velocity field corresponds to a vortex ring, where the water rise up at the centre. When the flow presents this vortex ring geometry we observe that the inner side of the torus becomes of a polygonal shape (see figure), this shape rotating at constant velocity in either direction. This effect appears very similar to the polygonal destabilization of the hydraulic jump[2,3]. It is remarkable that in this latter case the destabilization occurs when the flow beyond the jump[2] forms a vortex circulation having a geometry comparable to that of our convection flow.

We propose here an experimental characterization of these rotating polygons that can be from triangular shape to a dodecagonal one. We will discuss the origin of the destabilization and a model for the velocity and the shape of these non linear waves.

[1] A.L. Biance, C. Clanet, D. Quéré, Leidendrost drops. *Physics of fluids*. 15, 1632-1637 (2003)

[2] C. Ellegaard, , A.E. Hansen, A. Haaning, A. Marcussen, T. Bohr, J.L. Hansen & S. Watanabe, Polygonal hydraulic jumps. *Nonlinearity.* **12**, 1-7, (1999).

[3] J.W. M. Bush, J. M. Aristoff & A. E. Hosoi, An experimental investigation of the stability of the circular hydraulic jump. *J. Fluid Mech*. **558**, 33-52, (2006).