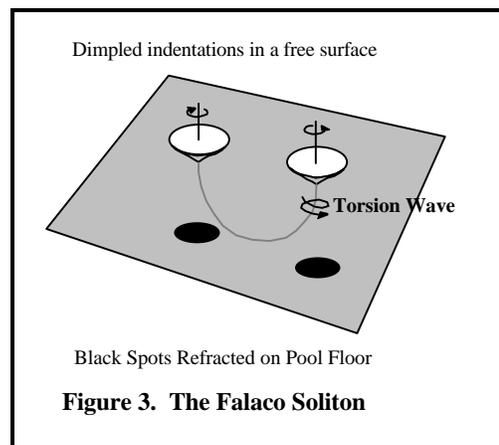
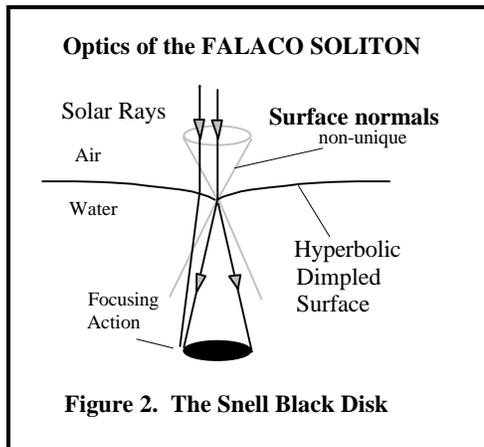


# FALACO SOLITONS

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Falaco Solitons may be replicated in a still pool of water by stroking a half submerged, flat, circular plate in a direction parallel to its oblate axis. Remove the plate at the end of the stroke to produce, initially, a pair of ordinary concave parabolic Rankine vortices in the surface of the density discontinuity. In a matter of a few seconds each concave shape will decay into the metastable soliton configuration of an inverted hyperbolic dimple of negative Gaussian curvature. The configuration, or coherent structure, has been defined as the Falaco Soliton. In the photo of Figure 1, the solar illumination is at the oblique angle of the late afternoon. The surface dimples have been captured by color contrast and are located about three spot diameters to the left and about one spot diameter above each black spot in the photo. These Falaco Solitons will persist for many minutes in a still pool of water.



The effect is easily observed, for in strong sunlight the hyperbolic indentation will cause an intensely black circular disk (or absence of light) to be imaged on the bottom of the pool. A bright ring of focused light will surround the black disk, emphasizing the contrast. The optics of the problem are completely described by Snell refraction from a surface of revolution that has negative Gauss curvature (Figure 2).

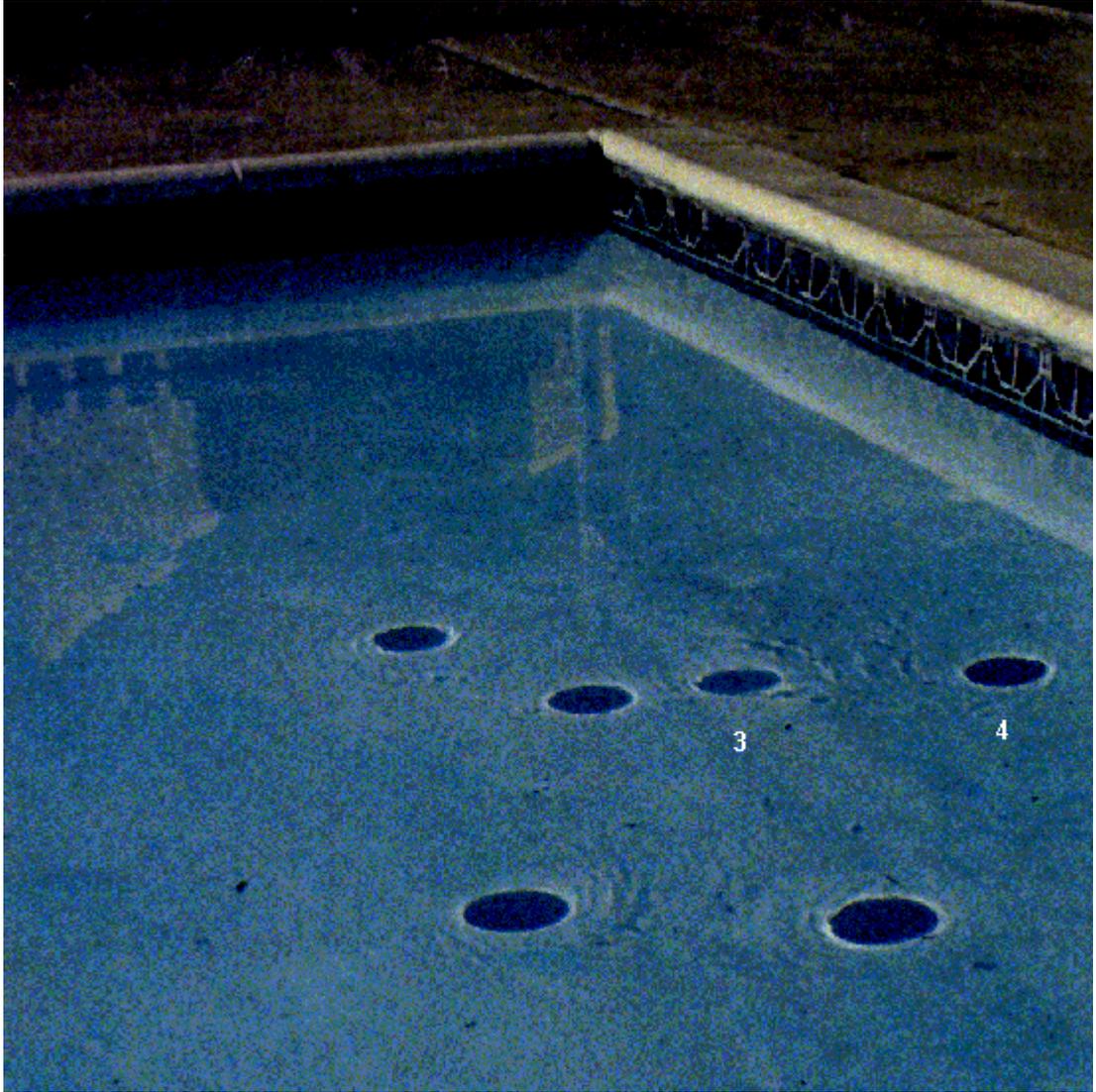
Dye injection near an axis of rotation during the formative stages indicates that there is a unseen thread, or 1-dimensional string singularity, in the form of a circular arc that connects the two 2-dimensional surface singularities or dimples (Figure 3). Transverse waves can be observed to propagate from one dimple vertex to the other dimple vertex, guided by the "string" singularity. If the string is "severed", the confined, two dimensional endcap singularities do not diffuse away, but instead disappear almost explosively.

It is as if the Falaco soliton is the hydrodynamic equivalent of the illusive hadron in elementary particle theory, where two 2-dimensional topological surface defects (the quarks) are bound together by a string of confinement.

The long life of the soliton state in the presence of a viscous media indicates that the flow vector field is harmonic, and generates a conformal minimal surface in space time. Guided by the fact that all holomorphic functions in four dimensions generate minimal surfaces, an approximate solution is given by the harmonic 4-vector field

$$W(x,y,z,t) = \{\exp(-br) \cos(\omega t), \exp(-br) \sin(\omega t), -br, \omega t\}.$$

The associated minimal surface has circular symmetry, and a hyperbolic profile similar to the observed dimple shape. Though created from a time dependent field, the minimal surface profile is constant in time.



**Photo by David Radabaugh (Schlumberger, Houston)**