

HYDROGENY | by EVELINA DOMNITCH and DMITRY GELFAND

Nature's simplest atom and mother of all matter, hydrogen feeds the stars as well as interlaces the molecules of their biological descendants – to whom it ultimately whispers the secrets of quantum reality. Hydrogen's most prevalent earthly guise lies within the composition of water. Slight electrical perturbation splits water into hydrogen and oxygen gas, resulting in diaphanous bubble clouds slowly rising towards the liquid's surface. Though the founding fathers of electrochemistry posited that the mass of liberated bubbles is directly proportional to the input voltage, certain modes of electrolysis release more energy than is spent. One such mode involves water's Janus-faced capacity to react as either an acid or a base.

Emanating from an array of electrodes at the bottom of a water-filled chamber, strings and strata of hydrogen bubbles meticulously trace their emergent surroundings. In addition to eddy formations incited by a bubble's rapid growth and subsequent detachment from the electrode surface, acoustic vibrations permeate the two-phase fluid. As the sonic frequency and amplitude rises, the hydrogen bubbles start to coalesce with one another. When the sound field reaches maximum intensity, it can trap bubbles within its antinodes. The vibrations are generated both by transducers and by the bubbles themselves, which emit frequencies ranging from the audible spectrum to as high as 800 kHz.

A white laser sheet scans and illuminates the hydrogen bubble trajectories. Each quivering bubble-lens divides the white light into its constituent spectrum of colors. While scanning, the laser sheet swiftly pulsates and thereby extends the perceivable resolution of micro-momentary bubble dynamics. Before it even begins to map out its vibratory environment, a bubble goes through various stages of spatio-temporal evolution. "During the first phase of growth, a bubble nucleus inflates linearly with time. At the second stage, bubble growth is limited by the diffusion of gas within the liquid, causing its size to increase as the square root of time. The final phase before detachment is limited by the kinetics of dissolved gas production, causing the bubble to grow as the cube root of time". [Brandon and Kelsall, *Interfacial Electrical Properties of Electrogenerated Bubbles*, *Journal of Applied Electrochemistry*, 1985]

Beyond macroscopically observable bubbles, an expanse of nanobubbles hides within the water's internal architecture. Some researchers presume that these nanobubbles of dissolved gas are the carriers of water's magnetic 'memory', enabling electromagnetic fields to saturate its innards for hours and even days after their initial appearance. In the seas and oceans, the lingering presence of electromagnetic fields photonically imparted by sunlight, triggers the electrolysis responsible for most of the Earth's hydrogen. An essential form of photosynthesis, solar water splitting is the cleanest and most efficient means imaginable for generating and storing energy.