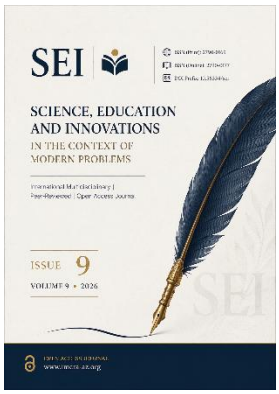

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RESEARCH ARTICLE

Shadowless in a World of Shadows: Diminishing the Refraction of Light via Nanoconfinement

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Abstract

This paper presents a physicochemical study that merges science and art in the context of exploring the refractive index of water under nanoconfinement. Using a simple and economical experimental approach, it is shown that confinement within the micropores of a zeolitic structure, characterized using electron microscopy and X-ray diffraction, paradoxically reduces the refractive index of water, bringing confined water droplets closer to a shadowless state. Counterintuitively, water under confinement, as indicated by vibrational spectroscopic analyses performed in the transmittance mode in the IR range and reflectance mode in the near-IR range, exhibits greater structural freedom than in its bulk or surface states. An inverse relationship was found between the micropore size and the refractive index of confined water, as well as the structural resemblance of confined water molecules to those in an ideal gas state. This finding inspired the elaboration of the idea that restrictive conditions are commensurate with liberation – a stance serving as a symbol of hope for those who find themselves oppressed. The narrative framing this research, built around the author's metaphorical journey through hell, purgatory and heaven, mirrors the scientific process: from the struggle to formulate an original research question, through diligent experimentation, to the ultimate reflection on the moral and aesthetic implications of the findings. Drawing parallels between Dante's pilgrimage as documented in the Commedia and the author's quest, the paper serves as a critique of the cultural and epistemic aridity prevalent in contemporary science, which the author likens to a desert, calling for its renaissance through an infusion of poetry and lyricism. Despite the anguish and despair proliferating across the pages of the paper, stemming from witnessing the idea of merging science and art vanish like droplets on dry ground, the study ends on a high note with the realization of unexpected beauty and freedom in confined water – a single luminous droplet, pressed between the narrowest of walls, that refused to disappear into the dust and instead chose to shine.

Citation

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1. INTRODUCTION

Water, albeit being transparent, casts shadows. But can it be made shadowless? If so, what methods could be used to reduce its refractive index? This question sets the stage for the scientific exploration pertaining to chemical interfaces that is being reported here. As this exploration will shortly begin to unfold, the reader will be taken on a journey aimed at finding out the means by which water can be made shadowless. The content that follows provides a lyrical autobiographical account of the research performed on this subject and is split into seventeen sections, each numbered by a Roman numeral. This, however, describes only one aspect of this journey.

Equally importantly, in this paper, a physicochemical research study revolving around a conventional but novel scientific question has been cast in an unconventional and innovative literary form. Specifically, complying with the philosophy of poverty, a methodologically simple and economical attempt at reducing the refractive index of water and rendering its droplets shadowless is told by reflecting on a poet's journey through hell, purgatory and heaven, as documented in Dante's *Commedia*.

The author, the protagonist of this paper, is accompanied in the pilgrimage by guides who swap, as in *Commedia*, midway through this docufictional, self-referential voyage, which ties to the author's lifelong attempt at delivering a fresh breath of poetry into the stale state that science has trapped itself in following centuries of pursuance of prosaic philosophies ranging from logical positivism to corporate utilitarianism. Science today, culturally and epistemically, as one of the key analogies posited here has it, is a desert, whereas the author's effort to provoke its renaissance by infusing it with the neoromantic spirit of lyricism has been akin to dropping a droplet of water onto the desert floor, only to see it disappear, thus imposing great anguish upon the author, as echoed in this narrative. As the story progresses and research unfolds, however, in this little droplet of water, tensely confined between the nanoscopic walls of the zeolitic framework, something unexpectedly beautiful will be found.

2. MATERIALS AND METHODS

A raw zeolite powder collected in deserts of Morocco was mechanochemically processed by grinding for different periods of time between 1 and 4 hours. X-Ray diffraction (XRD) analysis was carried out on a Rigaku MiniFlex 600 powder diffractometer. Zeolite powder was fitted inside the standard stainless steel sample holder with the depth of 0.5 mm. The 2q range chosen was 5 – 90 °, with the step size of 0.01 ° and the scanning rate of 5 °/min. The working conditions were 40 kV and 15 mA, while polyhcromatic, K_b-filtered Cu K_a radiation was used the source. Prior to the measurements, the device was calibrated by running a corundum references sample and ensuring that d-spacings match the literature values to within 0.5 %.

Scanning electron microscopic (SEM) analysis was conducted on a Zeiss Sigma 300 microscope. Samples were deposited on the carbon tape (*Ted Pella*, Redding, CA) glued onto aluminum stubs and sputtered with gold on a Quorum Technologies sputter coater (SC7620) in a low-pressure (~ 3 mbar) argon atmosphere at the current of ~ 20 mA for 45 seconds. To circumvent the sample drift, the excessive brightness and other charging artifacts, the acceleration voltage used to image the samples was 3 kV. Secondary electrons were used to generate the images captured at 9 seconds per scan.

Low-pressure N_2 gas adsorption experiments on different zeolite samples were carried out on a Micromeritics ASAP 2020 device. Calibration of the vacuum gauge, the pressure gauge, the pressure scale, the manifold temperature, and the system volume was performed according to the manufacturer's instructions before the measurements. Prior to adsorption, the samples were degassed in vacuum at a temperature of 250 °C for six hours. Around one gram of each zeolite powder was exposed to N_2 at −196 °C. The quantity of the adsorbed gas was measured in the relative pressure (P/P_0) range of 0.050 – 0.995, where P is the actual gas pressure during the experiment and P_0 represents the saturated vapor pressure of N_2 under the laboratory conditions. The Barrett-Joyner-Halenda method was used to calculate the pore size distribution, with the emphasis on the average size of micropores (< 2 nm) in the materials[1]. After the micropore volume, V_p [cm^3/g], and the specific surface area, S_a [m^2/g], were derived from the adsorption isotherms, the average pore size, d [nm], was calculated using the Wheeler equation:

$$d\ [nm] = 4000 \cdot V_p[cm^3/g]/S_a[m^2/g]$$

Fourier transform infrared (FTIR) measurements were conducted on two different Shimadzu IRAffinity-1S spectrometers. The system runs an internal calibration routine that automatically determines the corrections and applies them to the detector output. A 20 wt.% paste of zeolite was prepared by mixing water and zeolite and placed on the attenuated total reflectance (ATR) crystal of the FTIR device. Continuous measurements were taken at the resolution of 2 cm^{-1} until complete dehydration and disappearance of the OH stretch in the 2800 – 3800 cm^{-1} range. The dehydrated samples were rehydrated to 20 wt.% and once again continuously measured until the disappearance of the OH stretch, with only the latter measurements being used for further processing. This procedure was devised and performed to ensure that sufficient time was given for the finest pores in the material to be wetted. FTIR measurements were conducted in the transmittance mode in the IR range and in the diffuse reflectance mode in the near-IR range. After the conversion of the IR transmittance and near-IR reflectance spectra from wavenumbers to wavelengths, they were loaded into the PRISA 1.0 software (*Bhabha Atomic Research Center*, Mumbai)[2] to calculate the refractive indices at wavelengths corresponding to the OH stretch in the IR spectra and to the 1600 – 2100 nm range in the near-IR spectra, also characteristic for water. Prior to loading the IR spectra into PRISA 1.0, mirror images of IR spectra were produced by converting negative transmittance peaks into positive. To avoid the bug in the code, spectra were imported in nm units for the wavelength and in arbitrary units (a.u.) for the transmittance, even though the latter was expressed in percents. The sub index n_s value inputted was 1.33. Origin Pro 8.5 (*OriginLab*, Northampton, MA) was used to process the peaks and calculate the integral peak areas and full widths at half-maxima (FWHM). Integral peak centers were also calculated as a part of the peak analysis in Origin Pro 8.5 to assess the hypsochromic shifts with parameters including the drying time and the microporosity.

All graphs present data from multiple measurements taken under identical experimental conditions to ensure reliability and reproducibility. In cases where variability between measurements was minimal, the plotted data represent the average values calculated from the collected datasets. For instances involving more complex results or minor fluctuations, the most representative samples were selected for graphical depiction to best illustrate the findings and trends. While error bars were not included in the graphs, the consistency across replicates and the robustness of the experimental setup minimize the impact of variability on the interpretation of results. Detailed raw data, including measurements across replicates, are available upon request for transparency and further analysis.

3. RESULTS AND DISCUSSION

I. Haunted by shadows

I was just following the road. That is how I arrived here.

I let my life speak through my science. I let the trauma of eviction from the academic order on account of being a poet, a romanticist, a renaissance polymath, a soul in it for the search for soul in things, enter my scientific work and begin to live through it, breathe through it, kick and shout through it. The will not to succumb to the depression that filled in multitudes the ditches I was shoved in; the will to create the work of my life notwithstanding the circumstances; the will to justify the tormentors' actions – for without their cruelty none of this work would have come to life – and thus appeal to the celestial seats of justice to forgive them; they all prevailed over the pettiest petulance, which, at the end of it all, anyway, always gives in to the placid streams of love. Research study by research study, paper by paper, road sign by road sign, these works guided me on this path and dropped me here, amid a land of shadows.

Where I stand is still. In the still, there are shadows. Many shadows. We are haunted by shadows.

II. The ashen wasteland

How did I get here? What has brought me to this dark terrain, with not even a flash of light to chirk this sad space up? What has driven me to produce a series of works that cross-fertilize science and poetry to an extent and in a way no one has tried or done before? When I look deep into myself in search of an answer, I am blasted away by one angelic energy, all blissful and light, and petrified by one dark,

refractory energy, rife with spite and anger. If I were to push down the cliff one of them, the other one would go down too. Tangled they are, inextricably, like two streams meeting in a vortex. If one of them is to be thanked for the audacious swirls of life it has given rise to, the other one must have laurel wreaths put on its pate as well. Drop one, and none of this work would have ever been brought to life.

The landscape I am in is scarce. A nearly dead, post-apocalyptic sycamore is swaying in the breeze, evoking all things gone with the wind, albeit without even a sign of a dreamer wondering about the meaning of the word underneath it[3]. Two domes are there too, looking like skulls, though, in reality, being replicas of observatories tucked side by side in the desert sand. From their petite vista, the liveliest object on the horizon is a junkyard centered around casa de Julia, a weathered shackle from slums long gone. Myriad objects are scattered around it, all rusty, chipped, twisted, piled upon one another in sepulchral silence, yet none I can see: a shredded eye dazzler rug, a blue swallow motel sign, a wooden red diner stool, a dismantled R2-D2 replica, a torn Roy Lichtenstein-themed tie-dye tee, a juggler of dices on a spring, a spacesuit with tattered butterfly wings, an unnervingly grinning Felix the cat figurine, a packet of circus postcards, and a stack of crumpled Route 66, that mother of all roads, signs. Closer to me, a plush bunny with wings lies decapitated, shoved into the dusty ground, speaking of innocence that once resided here, but is now no more. One button and one pompom of a Paddington Bear coat, threads of hair shaved off a bouffon's beard, a cornucopia of crushed Disney-themed souvenirs and scrambled pieces of a telescope with eyepieces painted black litter the ground, rather eerily. And shadows, shadows everywhere, gliding lithely through the night of the soul.

III. Abandon all hope, ye who enter

On March 24, 1300, Dante Alighieri, a poet and a politician, cast out of Florence, the city he would thank for this expulsion by handing it the seed from which the Renaissance would sprout and the city emerge from the Dark Ages, began his journey up a mountain, having glimpsed an ethereal sun at its top. No sooner than he blinked was he face to face with a panther, a lion and a she-wolf. The message, to him, was clear: those who take a straight path to the earthly paradise shall be devoured by these beasts, the embodiments of avarice, pride and will to power, respectively.

The clock near where I stand shows the same date, but exactly, down to the very hour, seven and a quarter centuries later. I have returned to the site of Golgotha, of soul-expunging trials and tribulations, of heartless persecution and eventual excommunication from the academic order. But I know the drill. I know that one is not to fall in love with the surface appeal. Rather, deep underground one must go. One must venture through hell. Not only through hell one must go, but to the center of hell, and then fall into it in order to emerge at the bottom of Mount Purgatory, before continuing the tedious journey toward heavenlier vistas.

Am I brave? I am brave. I will walk, step by step, through a womb-like darkness. Never mind the shadows, shadows that nest everywhere around me, unreceptive to the call of one who cries in the desert and who tries to deliver the blessings of scientific renaissance born from the marriage of science and art in one cold and callous kingdom, where no one is eager to even look at them, let alone pick from the rest. So far these shadows are apathetic and unconcerned with any of this. Should they begin to haunt me, though, and should the pressure of their haunt become unbearable, I may, like the Florentine poet, "shut my eyes, transforming thought on thought to dream"[4]. The dream, however, is destined to be a short-lived one and in a blink I will become aware again of the dismal landscape I have found myself in.

IV. The reign of shadows

As the dark gives way to the dim and the dim drifts back to the dark, the only thing becoming increasingly clear is that I am and that we are surrounded by energies, ghosts and shadows. They guide us. They are a reality realer than the one we perceive with our senses.

This realness realer than the real is an idea that, like a rock in Saturn's rings, begins to orbit the mind of this traveler across this ghosted landscape. Shine the light of the sun onto a rock like this, catch its shadow far enough, and you would be amazed to see that this shadow may move faster than the speed of light. For a rock like this, in fact, moving at the speed of around 10 km/s, the screen would not even have to be on the planetary surface for the shadow on it to exceed the speed of light. It needs to be only 30 km away from the moving object. The calculation racing through my head also shows that if the light was beamed onto me walking right now and the shadow was projected onto the moon, it would show me walking at around the speed of light. Is this to say that shadows are greater than light?

Whatever the answer, shadows continue to emerge from all corners. They arise and then vanish, and all over again. To befriend them or to avert them. I wonder what I should do.

Whatever I choose, the feeling is that they will continue to prowl. That they will continue to be present.

They seem the only reality in this eerie space.

V. In shadowless' footsteps

The clock strikes eight, at which point the rusty hands turn into dust. There is nothing anymore to keep track of time. Here and there shadows pierce each other's hearts with the darts of temporal coordinates, but is this to say that independence from time I must cherish if I am to find the way through and out of this desert? In place of an answer, sporadic stabbing of shadows with arrows of time has grown into a full-fledged war on the top of the hill, hinting at what lies at the root of all human woes: the passage of time. Meanwhile, sickening pretense in the air has gotten so ample and so foul-smelling that I must pray from my head to my toe to remain immune to it, to never fall prey to it. I must ceaselessly remind myself who I am: a child of the universe, only one more of the littlish, naïve, clueless, artless. I may be tempted to use a shield, be it of ego or of knowledge or of something else to keep myself free from this vice, but I know it is not the way to go. I must be transparent and open and let all the rays of energy, good or bad, flow in and out of me, untouched. I must grow to be shadowless.

Thinking these thoughts does not help the matter. There are only shadows around me. Shadows to unnerve me, shadows to guide me, shadows to take hold of me. I must act to unearth wings and fly beyond this plane.

I wonder if my yearning for light is so immense that it is what makes the shadows so apparent. Were I a shadow, perhaps a fellow shadow would be but a source of light. A dim one, but still a spectacle of light. And of wonder more pleasing to senses than this.

A shadow, though, I want to be anything but. To kick and scream and fight with my claws and fists I vow until I emerge from this bubble of shadowiness.

Indifference is the language of the shadows and so they shift in procession, following something, someone, one another; hence their becoming and being shadows. To follow and orbit around in lieu of being the prime movement, the holy Yea, the shining from the inside, is how one becomes a passive follower, a shadow. But to shine, like a star, is the goal, so what to do to escape this curse of shadowiness?

The question, then, is this: how to become shadowless in a shadowy world? Especially so since everyone is a shadow; everyone shadows a shadow; everyone's light is being shadowed.

In lieu of an answer, a pixie comes my way, flaps its wings, alights on the temple of my baldie head and forges summery vibes vivid all around her. Suddenly, the gray, sunless desert has transformed into a lush haven lit by a summery star. There is sunshine, there are palm trees and a splendid promenade, but, most importantly, there is water. So much of it that we are swimming in it, like two dolphins.

After tossing, tumbling, twizzling, summersaulting side by side, like a sea elf and a siren, we swim to the edge of the pool and there, panting, with water dripping from our armpits and our foreheads, the pixie notices something. A droplet of water has fallen onto the bricked floor and she observes it, carefully. After some examination, she asks: why does water make a shadow when it is transparent?

No sooner had this question ascended through the air than it seemed to pierce the balloon of this oasis and it deflated, as fast as it had been conjured.

Shadows, again, roaming wretchedly through a dark and deserted land is all that remains.

VI. Arrival of the changelings

As deathly dismay has descended upon me once again, I feel wholly defeated. I want to give up this whole race. The end of the road has been reached, yet no way out of this darkness and back to where people are dancing like lustrous silhouettes under the moonlight, I feel, will ever be bestowed upon me. But when the night of the soul is at its darkest, there comes the light of the savior, in the shape of the petite pixie. This time, however, she vows not to wave her magic wand, but to stay with me, in this dark, desolate constellation.

Pixie, is this real? How did I end up here? What plan of escape should I contrive? Will you give up on me? Or are you going to be with me? She flaps her wings and nods her head in confirmation and with a fine dose of jolliness. A boy in that instant steps into the scene, Mowgli-like, slender like a willow, hopping from one of these weary, nearly leafless and creaky birch tree branches to another, with the agility of a chipmunk, until he is up in almost the topmost cloud. Like the pixie a minute or so ago, changing this gray desert into a

splashy summertime scene, dressing us up in bathing suits and plunging us into a pool, the boy, with his elated and buoyant jumps, suddenly colors the trees and makes the vegetation opulent, though I know all the way through that this is only a mirage, a hint at an oasis that exists for now only in my dreams.

While the idyllic scene still persists and the boy glides across the space with mesmerizing vigilance, the pixie nests beside me, as if wanting the hug of a watermelon moon or some sparkling attention. Albeit having the memory of a fruit fly, she adores science for the imagination and wonder it harbors and nourishes us with, far more than for its analytics, and she says this: science will show you the way out of this impasse. I blink in disbelief, but this petite tinkly bell opens her eyes even wider, in wonder yearning to swallow the whole wide world, it seems. If you want to stick around, we shall conceive of a project, she adds enthusiastically. A project? What kind of project? A summer science fair project she wants it to be. But what will the project be about? By the time I asked this question, the pixie had flown away, leaving only a trail of swishy air behind it. The jungle boy, the bell's pan and a brother, who had likewise twisted around me like a soft serpent a minute ago, has now hugged a liana and used it as a zipline to vanish out of sight, too. I am all alone, again, to rummage through the dustbin of ideas my mind has become. Shadows, naturally, nest around me like gulls circling a wreck by the ocean shore. Soon, their presence will become unbearable. It feels as if all the shadows that all the peter pans and tinker bells have lost in the hands of mundane, lackluster and timid darlings of this world have congregated and come to exist right around here.

VII. A drop

Apart from the shifty shadows that have claimed this space, I am alone and I must listen to the ageless advice I was given once, on a train through wilderness: think. I think I can[5]. I think I can. Think.

Here and there a heavy burden, icy cold to the touch, appears, and I, hunchbacked, with hands tied to the back, carry it up the hill lest my path forward be impeded by an invisible barrier. Some common-or-garden busts I walk by, but who would ever want to be demoted to a bust? Not me; I vow to forever be a no one and drag my tail through the mud[6]. The landscape I am in is, in fact, so dismal that the brightest element in it is a crumbly piece of the Berlin Wall, the second biggest in the world, they say, sprayed with graffiti. Near it, I hear, a dreamer of the dream of "hewing out of the mountain of despair a stone of hope"[7] once spoke, with Hesperian sunsets gracing the horizon. No voice of this breed resonates around here anymore; no voice but that of wisps of cold air, whipping every soul in sight into the stance of a sycophant or a slave.

The pixie has vanished into thin air and now, with a question from a sunshiny oasis and the idea of turning this question into a topic for research towering through this dark land like a beacon of hope, it is time, indeed, to think. How would I conduct research on shadows cast by transparent water. The research, of course, must be original, novel and relevant – there is no doubt about it. It also must be beautiful in terms of the analogies it will evoke. And lastly, it must be told beautifully, which is why all these low lines are hung here and all these weary steps through the dark, dark land, where but shadows dwell, made.

First, to answer why a water droplet, any water droplet, casts a shadow, like that shown in Fig.1a, dropping down the pixie's chest, is not difficult. Causing this effect is the refraction of light at the interface between air and water (Fig.1b). The degree of this refraction, that is, the bending of light as it changes the medium, is determined by the ratio of refractive indices between the two media crossed by the light. The refractive index (n) of any medium is a ratio between the speeds of light in vacuum and in the given medium. For most liquid media, n is greater than that for air, meaning that the speed of light would lower when it enters water from the air. For water, n varies from 1.32 to 1.47 as the wavelength of light decreases from circa 1100 to 200 nm, meaning that it is directly proportional to the frequency of electromagnetic radiation[8]. Meanwhile, for air, n is just slightly higher than that for vacuum, measuring around 1.0003 relative to 1.0000 for vacuum. It also depends on the air density, composition, temperature, pressure and the wavelength of light, exhibiting the same inverse proportionality typical of most ordinary materials.

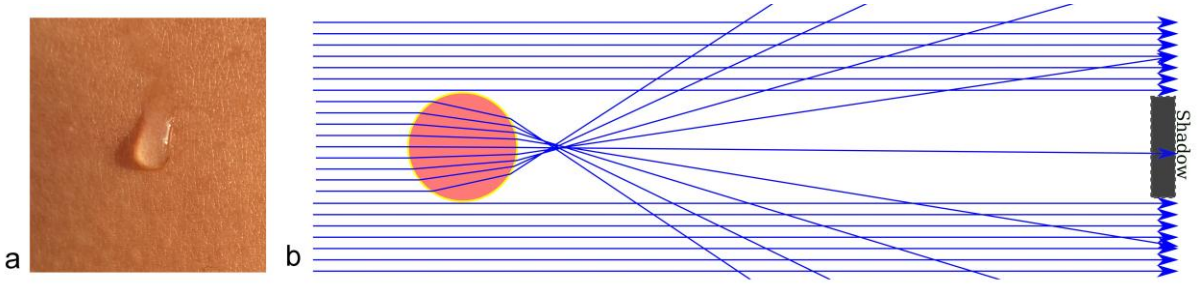

Figure 1. A photograph of a water droplet and its shadow on a sunny day (a). Schematic description of the refraction of light at the air-water interface being responsible for deviating the paths of light rays entering a water droplet and creating a shadow behind it despite its transparency (b).

A word of caution from a literalist and pedant in me is that the absolute speed of light is always the same; 'tis the key premise of the theory of relativity. The speed of light considered in the refractive index estimation is, therefore, essentially, the speed of the propagation of light through the medium. The more obstacles the light encounters on its path, the more it will be scattered and the slower it will propagate between two points in the medium.

As this thought was passing through my head, the earth began to rumble, yet I, always primed to catch a still small voice that comes after the quake, stood tall, watching a droplet of water that fell from nowhere, shaking not even the slightest. Too fine and delicate it is to be disturbed by the grand shudders like this.

When the ground stopped shaking, the thought process continued from nearly where it had come to a halt, undisturbed and untouched by all these blaring minutiae. Refraction, as it goes, is intimately tied to surface tension because this fundamental physicochemical effect is what makes water adopt the geometric form of a droplet, fold into a concave shape and resist wetting to some extent. This tension, furthermore, entails an increased compactness of water molecules at the surface. That is, the lower number of molecular neighbors that undercoordinated water molecules on the surface experience makes them seek those missing partners and dig their heads deeper into the core of the droplet in search of them. This is why water near the surface is denser than water in the interior of the drop, yet how in the world things coming together intensify the shadow rather than dissolve it is a mystery in itself. Whether this is to say that society is sinful *per se* and whether this explains why stars shine in solitude are questions I do not dare probe deeper lest I be led astray.

In all, explaining the reasons for the shadow formation has not been difficult. What will be difficult, however, is to think up a plan for an original and intrinsically aesthetic research underlain by this phenomenon, which, also, importantly, must be feasible in this desert, where not too many opportunities for the use of exquisite equipment for synthesis or characterization exist. The topic, in a way, and the methodology must live up to the philosophy of poverty that I have been erecting, brick by brick, in recent years, despite the harshest of circumstances. Another philosophy I dearly wish this research to abide by is that of children's science, and this may be why the pixie and the jungle boy have come out to help.

Let me, therefore, brainstorm ideas in view of the lightning and showers that are about to befall this land.

VIII. Of the question kindled in the dark

I am near a road sign, but any road here has long since ceased to be. Even when the dust is blown, there is not even a trace of a path under my feet. Yet I stand in-between. At a crossroads. Between Clark and not Hilldale[9], but Pine I appear to find myself, yet people, as they did once upon a time, on Sunset Boulevard, turn to time, again and again. Time is these shadows' worry and timelessness is out of their sight and grasp, and so their spatiality dissipates and is turned into clocks clocking in, out, in, out, sardined somewhere between nil and naught.

Albeit papery in stature and flimsy in integrity, they glide boastfully. Evidently, they take pride in their rank and file, but then again, these are only shadows and not even a speckle of light glistens from their cloaks, let alone hearts. Their souls they have lost in all this striving for the top of the hill. They have fallen victims to the panther, the lion and the she-wolf. Having caught up to them, the beasts have mauled them. And then they have devoured them.

Where I stand, things look darker still, for there is not even that remote light blazing from the top of the Dantean hill that these shadows are after. Albeit dark on the outside, there is still a light somewhere inside me, of the belief that descending into an even deeper darkness is the right way to go. Still, in moments like this, the sensation of incredible oppression, of everything beginning to press and crush me, takes over, and I feel utterly defeated.

Walls are closing in on the whole world, not just me, it seems, and I want with all my might to think up thoughts so expansive and so free that they would stand in the way of these walls and impel them to begin to open up, like petals of flowers in a springtime that is but a distant dream in this dusty desert. Yet each grain of dust, I know, can carry an inkling of an idea, a nucleus for the birth of a semantic crystal worth endless wonder. A thought it'd be that'd set me free.

This sowing of the signs in the air somehow inspires the creative thought process and the rise and filtering of ideas on what to study and how, in ways relevant to the question about water droplets and their shadows. And so, ideas start to churn, as if on a conveyor belt, the end of which I cannot see, unsure whether it leads to a meatgrinder collector, an unfathomable chasm, the back of a turtle with the radius of the equator, or something more optimistic.

The first ideas that come to mind are usually the very best, at least in the heads of us, forever believers in take-ones and improvisations that never die. In any case, I will now let myself go with the flow of the natural stream of thoughts as they arise and follow one another in my head.

First, the idea that a water droplet can hide neither more nor less but a whole universe of insights is not new[10]. But what if we could make water shadowless? What message would it carry to us on the wings of remarkable analogies? In spiritual terms, tuning the structure of interfacial water so that water ceases to cast shadows would say that whatever we harbor inside will get to be released outwardly with perfect transparency, without being warped at the interface between us and a fellow spirit. Dreams we nurture inside will get to be lived directly, without being tainted by whatever goes on at this interface, without having dark shadows cast on them. But how do I turn this now into a research question? Perhaps by starting from conceiving of ways to annul the tendency of water to shed shadows?

If the goal is to render water shadowless, the first thing that comes to mind is to think up a way to reduce the refractive index of a water droplet. Interestingly, the literature says that the refractive index of water is reduced upon confinement to nanosized spaces[11]. This, on one hand, is deeply counterintuitive because water in confinement is known to be more structured than bulk water, despite the inverse scaling of the average number of hydrogen bonds per molecule with the degree of confinement[12]. The thickness of the hydration layer surrounding the interface, for example, shrinks when the volume to which water is confined expands[13], speaking of structural stiffening entailing tight confinements. If anything, this increased structuring should be expected to slow down the speed of light, not increase it. Water, on the other hand, is an anomaly with respect to nearly every one of its properties[14]. As it turns into ice, for one, water reduces its density, meaning that this increased structuring under confinement can be accompanied by reduced density, and this is exactly what is being seen when water is confined in spaces smaller than 10 nm[15,16]. This may also explain why the refractive index of ice is at around 1.31 lower than that of water. Still, the refractive index reduction has been observed even under confinements in 10 – 100 nm sized spaces, where changes in density are not that pronounced, meaning that other effects must be at work. Rather than a bulk effect such as density, it is likely that interfacial effects prove decisive here, most probably involving a change in polarizability, given the direct effect polarizability has on the refraction of light at the interface[17]. Simulations have predicted a dramatic decrease in the dielectric constant of water at the interface[18], for example, and this reduced polarization of water in the out-of-plane direction leads to reduced refraction. Then the most interesting part comes, namely that of long-range correlations of hydrogen bonds, in a sense that correlations in electronic polarization mediated by the strengthening of the hydrogen bond network under confinement extend beyond the interface and into the core of the water volume. This extended correlation effect echoes the similar geometric configuration retention associated with the cooling of heated water and allowing for the Mpemba effect to occur, at least according to our earlier explanation of this wondrous effect[19]. Consequently, because the reconfiguration and increased ordering of hydrogen bonds contributes to the reduction of the refractive index, this index increases with water temperature[20], given that increased temperature progressively disorders the hydrogen bonding network.

The follow-up question, therefore, is whether water squeezed into a nanodroplet or another equally minute morphology would still cast a shadow? This takes us back to the opening spark of curiosity over the fact that a water droplet does produce a shadow when light is shone onto it. Now, if the less organized nature of the hydrogen bonded network at the interface of the water droplet than in its core, which entails its higher polarizability as well, is a positive contributor to the rise of the shadow, then bettering the organization of this network and making it akin to that in the interior may be the way to make water fully transparent.

But how do I, with the help of one pixie who goes in and out of this corporeal reality at will and one jungle boy who spends more time on treetops, hopping from one liana to another, than near me, alter this interfacial layer? In vacuum, a nanodroplet would not only be perfectly spherical regardless of its size, as Joseph Plateau's famous 19th century experiments on weightless drops showed, but would also have no interface that constrains it; rather, it would dissipate into constituent molecules as soon as it were placed into one such airless, zero-pressure environment. What if micellar, vesicular or liquid crystal, mono- or bi-layer surfactant structures are used to confine water? The desired ordering phenomenon would not be produced here either, owing to the constant fluctuations of the micelle composition[21] and structure[22] on the atomic scale. Besides, were surfactant-bound reverse micelles to be considered as a nanosized space to test the shadow-casting of water droplets, this would be untestable given that most of the volume of reverse micellar suspensions is

occupied by an oil, the refractive index of which, as in the case of hexanol, is around 1.4. Surfactants *per se* lower the surface tension of water, which leads to a lower refractive index[23,24], but the drops are very small and the solubility limit will likely be reached before the index falls to 1.2. Hence, only a solid material can provide confinement walls convenient for the intended reduction of the refractive index. The practicality of this approach, however, is questionable because of the finitely reflective character of most of such materials. After all, what is the use of being shadowless if we end up being confined behind an impermeable dark capsule where no one can see us and no light can reach us. Glass and transparent polymers cast shadows due to the same interfacial refraction mechanism as that explaining the shadow of water, so using them would not be meaningful either.

At this point, my thoughts have begun to spiral, making circle after circle, resembling "a wheel within a wheel, never ending or beginning on an ever-spinning reel"[25], turning the thinker dizzy, like a child riding a carousel horse all through day and all through the night.

IX. By chaos to the celestial spheres

My brain, after this exhausting storm, has begun to fume, has begun to fizz. Poppets materialize again, pick up the vibe where the mental apparatus had scrambled and deranged itself, and begin to drop sign after sign, of times timid and tumultuous, whispering this to my ears: calls bing ban other nowhere paradise you me entrance missed party water curtain mirror lipstick backstage rainbow take picture silence mode turn off on desert off all in out soul of to me all. Hey, y'all, it's the national anthem up in the air and flags are waved left and right, with nothing, not even a piece of cloth or a cane or a silken scarf[26], hanging from them. Against borders, against states, against governance we stand, we who say, anarchy or bust. In make-believe we believe and so just wave the wave, holding nothing in our hands. All of this is made of fancy alone, and in defense of fancy, unpolluted by the stains of reality, poppets and me, with a hatful of stars, stand here today, before the world, offering all and nothing at once.

Just when an irrevocable descent into madness seems imminent, the daystar boy and the cosmic girl step in and take the matter into their hands. There is nothing to see, nothing to do. And then the scene is split. The solution has not been reached, nor has even the path thereto been sketched. Yet I know that in these scrimshawed mumbles and jumbles of one stream of consciousness lie the glimpses of the ending that is simultaneously the beginning, the birth of something extraordinary, something new, something the world will have seen for the first and last time.

X. Dust beneath our feet

In desperation, when all ideas look exhausted and every last source of creativity drained, my head bows down. As far as my eyes can see, it is all one endless ground covered with desert dust, stretching in all directions. There is nowhere more to go. I have come to the end. To the wall of it all.

Feeling down, lower than I had ever been, the urge in me arises to embrace the earth under my feet and remain hugging it, with the face buried in the dust, for the rest of my existence. In the midst of this downness and the pull of gravity like none ever experienced before, a million memories begin to flash through my head, creating a magic concoction of melancholy and mystical beauties and stirring feelings no ordinary mortal could harness or explain. The best I could do is let them stream as I set the sails of spirit in motion. But what motion when all that it makes sense to do is lie down, face the ground, and never again stand up, remaining still and stolid until I merge with the dust of which I have been made. Gravity one way, grace the other, and crucified I am, on a cross that exists beyond what any human can see. A crack, I feel, is created somewhere deep inside my chest and from it a tear is plucked and falls to the ground, disappearing inside this desert dust. There and then it occurs to me: this is what I must look into. The interaction of water with dust like this must be the route to conceiving the idea for the research project in this study. Besides, if the drag of depression has become so intense that the attraction to the ground seems irresistible, and if my instinct is to press my ears to the ground in search of a sign, and if the flows of emotion running inside me are drawn by and into this earth, then it must present the starting point for the research project that would provide the way out of this impasse. Where else, then, would this science begin from but from this desert dust I have walked on and now lie on, desperately. I pick it up and analyze it, only to confirm that it is of a zeolitic composition (Fig.2).

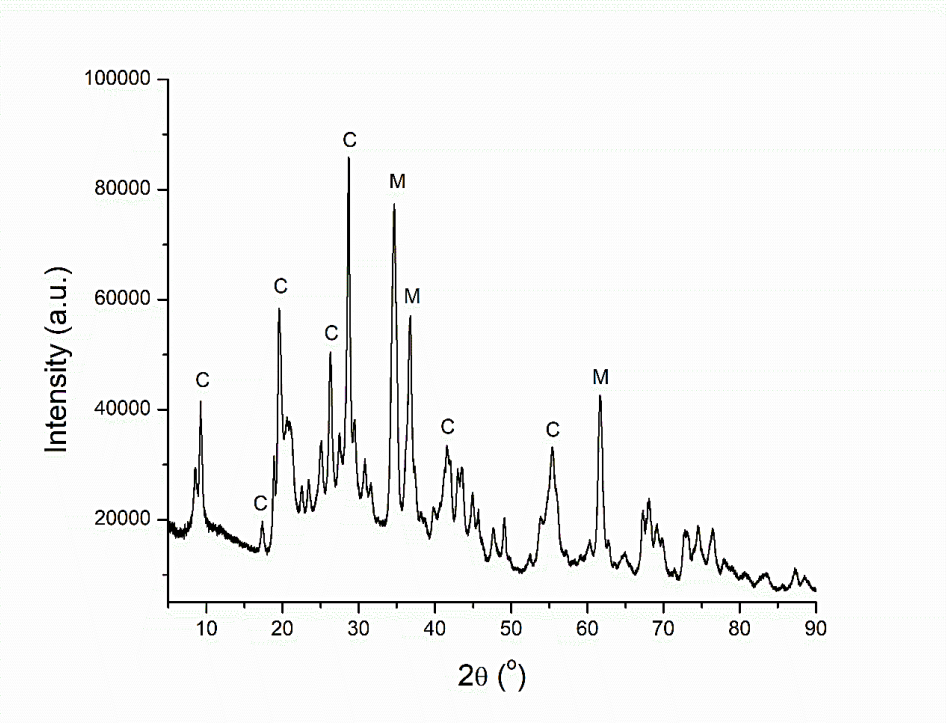

Figure 2. X-ray diffractogram of the natural zeolite sample, with C and M marking the reflections contributed by clinoptilolite and mordenite, respectively.

Alright, it is zeolite[27], one of the first minerals to have been used as a dietary supplement, a natural therapeutic and a water purifier. It has also been used intensely as a soil fertilizer owing to its ability to sustainably release metallic cations or nitrogen-containing ions such as ammonia when preloaded with them[28]. Therefore, it is hardly surprising that it is found on this graveled and grimy ground. But then, what are we, three romantic stooges, going to do with it? In lieu of verbalizing the answer, angels are fond of flapping their wings to blow the dust off some long-forgotten paths, which might take us to the solution. And so, the pixie comes by first, flaps its petite wings over the powdery sample and begins to dance over it, with the jungle boy following suit, in nearly a blink. The vow I gave myself long ago is to follow children wherever they go and whatever they do, and so I begin to stomp over the samples as well. In the absence of the wings or the ability to swing myself on a liana and leap from high up in the treetops to the ground, I also crush the samples vigorously with my fingers. What a punchy punch to science of the day this will be, to use stompy shoes, pixies' wings and monkish stances to process our samples instead of subjecting them to perfectly controlled treatment conditions. Nor is our synthesis any more controlled than our processing because this zeolite was picked from nature, containing natural impurities, naturally irregular particle shapes and very broad particle size distributions. Yet, in the face of all this, we will show that science far more conceptually groundbreaking than that engaged in by lackluster copycats populating the world's most prestigious research centers today – obsessed with cleanliness and accuracy and reproducibility rather than with imagination, creativity and beautiful dissent – can be made by adopting this punkish methodology of a renegade, a rebel that I am and that I promised I would always be.

XI. From Inferno to Purgatory

Creativity, they say, is born from an empty space[29]. Deserts, likewise, it can be said[30], are the best sites for dreaming up dreams about water, just as confinement zones encircled by tall, spear-tipped gates and barbed wires are the places where most beautiful dreams of freedom get sparked. Hence, all I am seeing in front of me, on this dusty, desert road, is a droplet of water confined to something as airtight and oppressive as this tin can with jade walls in which I felt, for a second, I had found myself. Water, therefore, is in the focus of my attention, along with something constraining its surface. What would this something amount to? What about zeolites, now that my attention has been diverted to them? They were the key protagonist in the last physicochemical study we ran[31], and it always makes sense to continue from where we stopped earlier. Like words piled here, everything must have a flow to it; everything is a thread that

can be traced from the beginning of a cosmos to its end, pardon rebirth and new beginning. With one foot on one tile, another tile, the next, adjacent and made of the very same material, will be hopped onto.

Zeolites can adsorb varying amounts of water, ranging from as little as 1 % to as much as 40 % of their weight[32]. The water immobilization capacity of zeolites depends on their topology[33] and the rule of thumb here is that the larger the pores, the greater this capacity[34,35]. Moreover, one major advantage of clinoptilolite-based zeolites is that their microstructure is geometrically stable and does not change upon the absorption or desorption of water[36]. Therefore, unlike surfactant-based or other soft, structurally malleable chemical architectures, zeolites can be used as solid cages for entrapping water and testing the effects of confinement on the water's refractive index. All that is needed for a study based on these premises to commence is to find a way to vary the pore size in these materials or a way to selectively detect water inserted inside the finest pores available. One notable feature of zeolites, namely, is the presence of micropores (< 2 nm), which act as sites for the adsorption of solvent molecules and various other sorbates. These pores, at their finest, are delimited by tetrahedral units composed, most commonly, of aluminum or silicon oxide groups[37]. However, due to the clayish nature of zeolites, pores exist inside them at numerous other structural levels, including as mesolayers separating individual crystallographic planes. Due to this highly ordered and porous microarchitecture, zeolites are, in fact, frequently referred to as "molecular sieves", the term that highlights their ability to selectively trap and separate molecules based on size. Therefore, by controllably changing the pore size in the material, a series of samples can be produced and tested, enabling the establishment of the correlation between microporosity and the refractive index. Simultaneously, the drying of wetted zeolites will proceed through the sequential evaporation of water from the largest to the finest crevices in them, which would allow for the establishment of similar correlations between the degree of confinement and the refractive index.

As if this darkness enveloping me, the tears wept in despair and the dust kicked in frustration were not enough, now I must dig deep into this dirt. In it I must locate microscopic voids and dive into them, deeply and unreservedly, with the rays of attention directed by a scientific instrument or two. Into the voids I must jump – that is the only road leading to where I intend to arrive at the end of this journey. Cosmically colossal, yet entering the littlest holes one can probe at any level, this journey is. In it, the big and the small suddenly swap places and in a blink the last become the first and the first last.

And then a strange thing happens. Dante and Virgil had come to the center of hell and then boldly jumped to grab Lucifer who resided there, then slid down his putrid body and emerged on the other side of the earth, near the foothills of Mount Purgatory. I have the same impression that reaching the dead end, the darkest point in this journey, has suddenly flung open something luminous and full of promise in front of me, which now must be explored. It is a new road that ought to be walked on – the road of diligent experimentation and data analysis. Whether this work will bring redemption and resurrection to this petty soul in despair I must wait, yet I am dying, to see.

XII. Within the womb of the void

Albeit inside a void, things suddenly seem brighter, like the times I would, time and again, hide myself underneath a mountain of plushies. It is a different kind of mountain that I must surmount now, but it may be as fun as pulling plushie after plushie to come to the surface and face the smiling faces of the littlies who tossed all those plushies at me and buried me under them in the first place.

As for voids in materials, it is known that configuration of water molecules in them greatly depends on the size and shape of these voids[38]. The good news is that the plate-shaped pores visible under a scanning electron microscope (SEM) render the capillary action possible and with it the uptake of water deep into the material's crevices. Further good news is that with our stomping over zeolite, we had created samples with variable morphologies (Fig.3) and, likely, microporosities. In fact, the longer the raw material was mechanically treated, the more irregular and fragmented its morphology appeared. The subsequent series of N_2 adsorption isotherm measurements did confirm that the average microporosity increased with the treatment time (Fig.4). In general, mechanochemical treatments of zeolites produce a proportional increase in microporosity[39]. The gradual increase in the slope of the adsorption isotherms with attrition time also suggests a transition from purely microporous to increasingly mesoporous samples[40]. The specific surface area of the four zeolites ranged from 230 m^2/g for the unprocessed sample to 355 m^2/g for the sample processed for the longest duration.

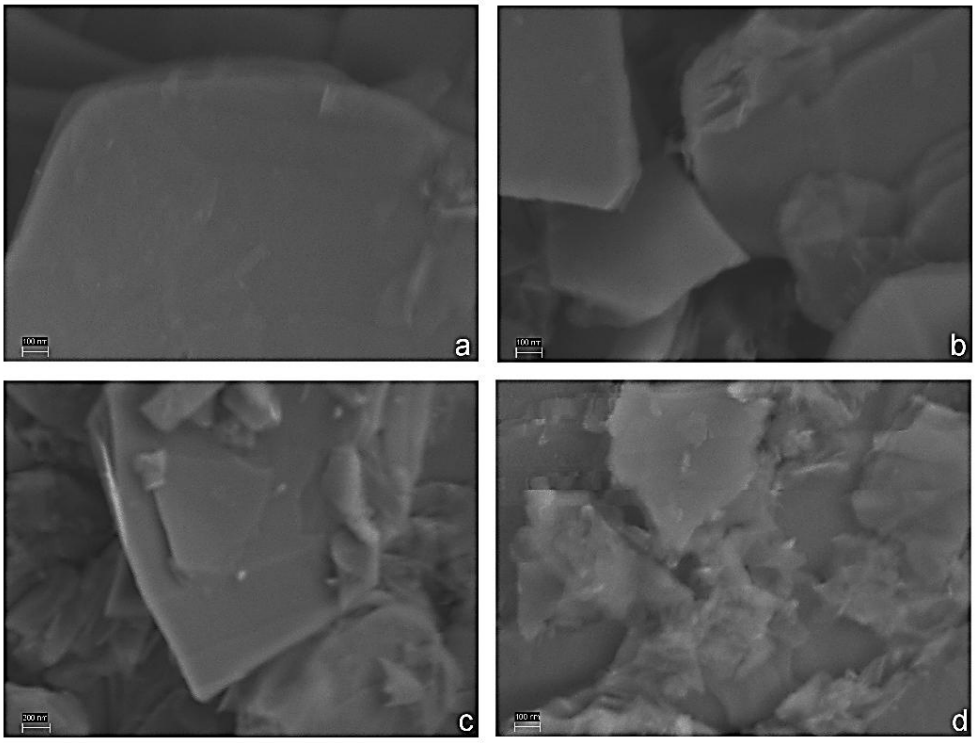

Figure 3. SEM images of zeolite samples subjected to progressively longer mechanical attrition times, ranging from 0 h (a) to 1 h (b) to 2 h (c) to 4 h (d).

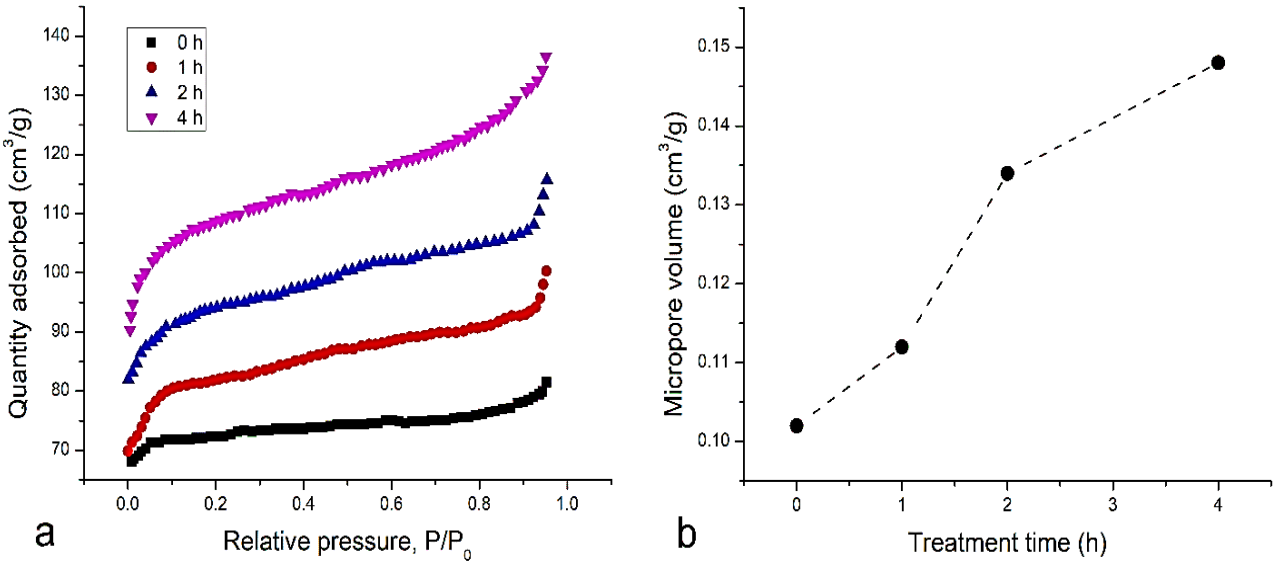

Figure 4. N_2 adsorption profiles (a) and average micropore volumes calculated from them (b) as functions of the duration of mechanical attrition of zeolite.

Analyzing the refractive index of a liquid confined inside nanoscopic containers impermeable to light is a challenge that calls for an indirect approach. Given this indirectness, a plethora of methods for assessing this index can be conceived of. Here, however, I resort to the use of FTIR vibrational spectroscopy to assess the freedom of movement exhibited by water in confinement. FTIR was used

previously, in the aforementioned study by Le *et al*., to derive the refractive index of nanoconfined water, attesting to the legitimacy, if not the complete lack of ambiguity, of this indirect approach. One way of relating IR absorbance or transmittance to the refractive index is by using the Kramers-Kronig relation, which, on the flipside, requires a more complex mathematical apparatus to be handled than that available in this desert, notwithstanding the fact that it can be reduced to pure calculus[41]. Still, a more conventional method for computing the refractive index from the transmittance in the IR range will be employed here, as described later in the text. Plenty of other experimental techniques could be used to complement FTIR, including differential scanning calorimetry (DSC), which was used before to assess the confinement of water in mesoporous silicates[42], as well as ^{1}H nuclear magnetic resonance (NMR)[43]. These methods, however, are allowed to fly by, without being captured by the dense net of conceptualizations harbored in this head. They are only touched, tenderly, and let go of.

Moreover, two slightly different methods of assessing changes in the refractive index as a function of microporosity will be applied. In the first method, the four zeolite samples with different average micropore sizes will be wetted with equal amounts of water and characterized spectroscopically after a single selected aging time. To avoid the uncertainties resulting from the broad distribution of pore sizes in zeolites, the second method is applied as well. Accordingly, the mechanically unprocessed zeolite will be wetted and characterized continuously as a function of the drying time, under the assumption that the first water to evaporate from it will be that confined to the largest pores and only then will water from the finest pores begin to leave the material. This is expected because the order of evaporation of water would follow the trend in its binding strength, starting with the surface water, then proceeding to capillary water held by surface tension, and ending with micropore water hydrogen-bonded or electrostatically bound to the ionic framework. In other words, spectra obtained after progressively longer drying times will correspond to finer and finer pores in the material and, correspondingly, tighter and tighter spaces to which water is confined. The dependence of the refractive index on drying time thus becomes analogous to that of the refractive index on the pore size in the material.

When an image is created in the eye of the human mind, the path leading to it is automatically traced. A strange emerald monolith thus suddenly appears before me. Everything, the epitaph-like inscription on it says, is inverted in it, almost as if it is a monument to and an embodiment of all things anti. Spectrometers are normally used to reveal the composition of stars, but here this monolith allows for starlight, figuratively speaking, to be concentrated onto a piece of matter and provide the information about its vibrational modes at the atomic level, the finest music it conceals inside. Out of nowhere, thus, with no other experimental devices in sight, this one emerges – the most mystical instrument one could imagine – yet it may be all I need to produce the data required to test how much shadow water locked inside zeolitic micropores casts, if any.

XIII. The spectral way

The first thing evident from the experiments on time-dependent dehydration of zeolites is that the FTIR band corresponding to the OH stretch shifts to the higher wavenumbers, increasing in energy over time (Figs.5a & 6c). Deconvolution of this band[44] resolves a number of components, with those at the high wavenumber tail corresponding to values one would find in water vapor, that is, isolated molecules subjected to minimal or nil intermolecular interactions. The medium ranges, most manifest of all, correspond to configurations of 3–7 hydrogen-bonded H_2O molecules, typical for the bulk liquid state, whereas the low wavenumber end originates from the solid or nearly solid, most rigid polymolecular configurations involving networks of 6 – 10 H_2O molecules. The observed shift toward higher wavelengths is counterintuitive, as it indicates that water confined to micropores, being the last one to leave the sample, is structurally looser and freer than both the surface water and the capillary water confined to mesopores of the material. It is more similar to water one finds in vapor than to water one finds in an ordinary liquid state.

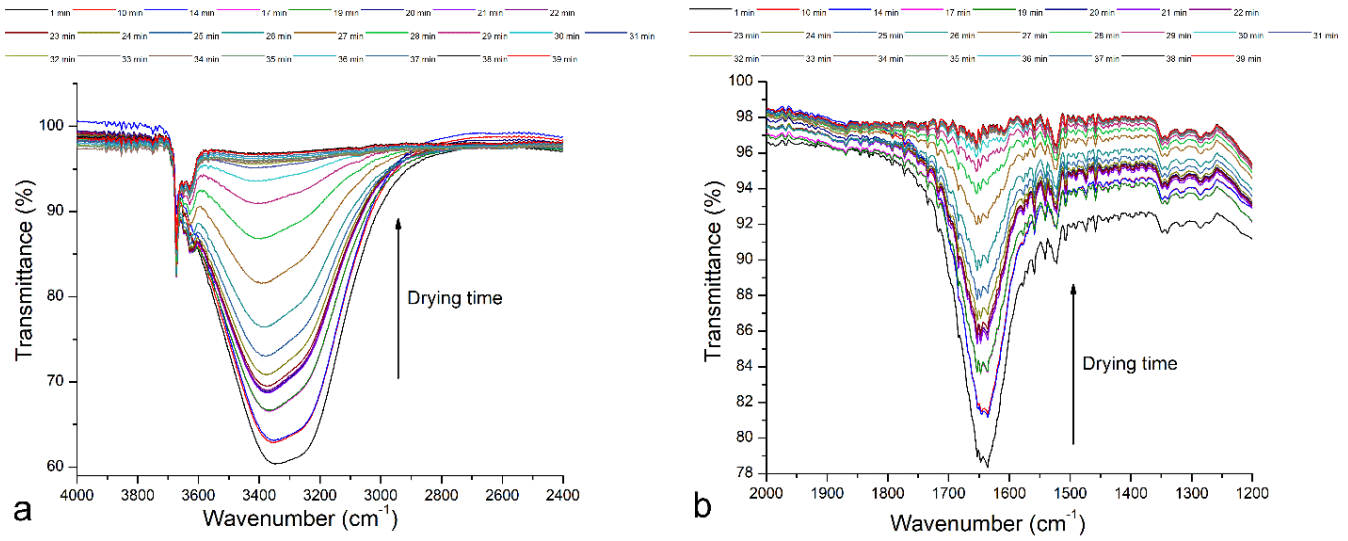

Figure 5. FTIR spectra of water confined to unprocessed 20 wt.% zeolite paste as a function of the drying time ranging from 1 to 39 minutes. Bands originating from the OH stretching mode (a) and the H-O-H scissoring mode (b) are shown.

This broad OH stretch originates from an equally broad distribution of states adopted by water molecules forming a variety of transient hydrogen-bonded configurations. Contrasting this pronouncedly collective band, capable of undergoing deconvolution to a continuum of states, is the very sharp band peaking at 3672.5 cm^{-1}. It originates from hydroxyls bound to Brønsted acid sites[45], which, themselves, arise at sites in the lattice where protons compensate the charge imbalance arising due to the replacement of Si^{4+} ions by Al^{3+} ions and other cations with a lower oxidation state than +4. The sharpness of this peak is due to the narrow dispersion of states adopted by hydroxyl groups bound to these sites. Because it exhibits no shift in energy as the drying proceeds (Fig.6a-b), this sharp band serves as the standard confirming the validity of the shifts that the broad OH stretch, which this band partially overlaps with, undergoes as a function of the drying time.

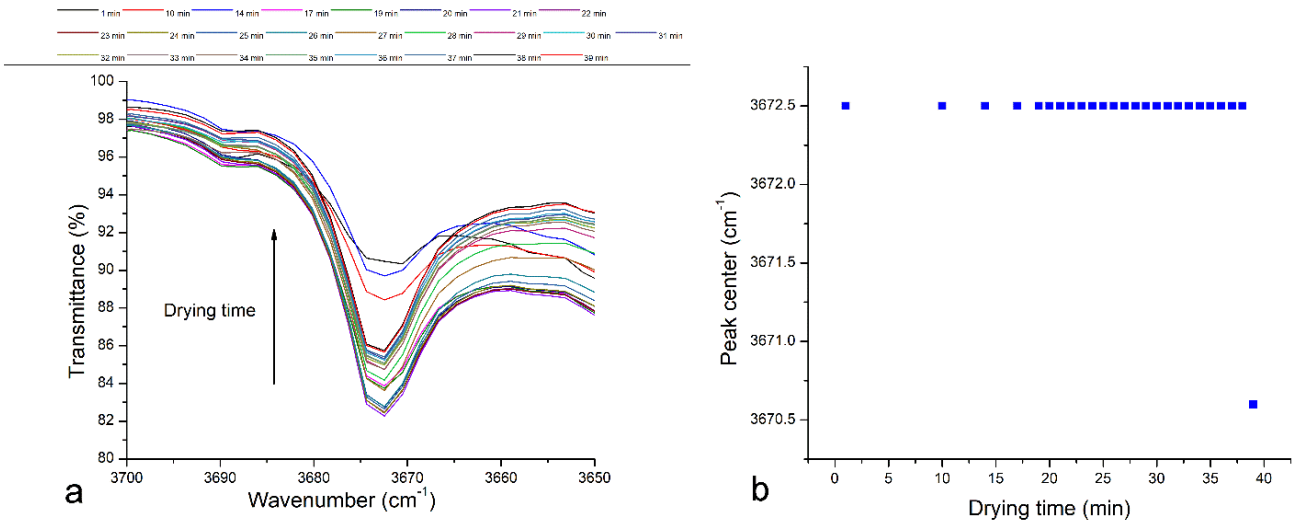

Figure 6. FTIR spectra of water confined to unprocessed 20 wt.% zeolite paste as a function of the drying time ranging from 1 to 39 minutes, focusing on the stretching mode of OH groups bound to Brønsted acid sites in the zeolitic framework (a), along with a change in its peak center as a function of the drying time (b).

Stretches are typically more dependent on their stereochemical environment than bends, and this rule of thumb is being confirmed here as well. Namely, unlike the OH stretch, which steadily increases in energy as zeolites dry and the amount of nanoconfined water increases relative to its surface and bulk counterparts, the H-O-H bend peaking at ~ 1650 cm^{-1} does not show anywhere as consistent of a shift with the drying time (Figs.5b & 7d). A moderate increase has been observed, from 1635 cm^{-1} at its lowest to 1675 cm^{-1} at its highest (Fig.7d), but nowhere as monotonously and consistently as for the OH stretch (Fig.7c). Expectedly, with drying, both bands become smaller (Fig.7a) and their full-widths at half-maxima, indicative of the polydispersity of states, get reduced (Fig.7b), suggesting a more compact and narrower distribution of configurations of water clusters and their microenvironments.

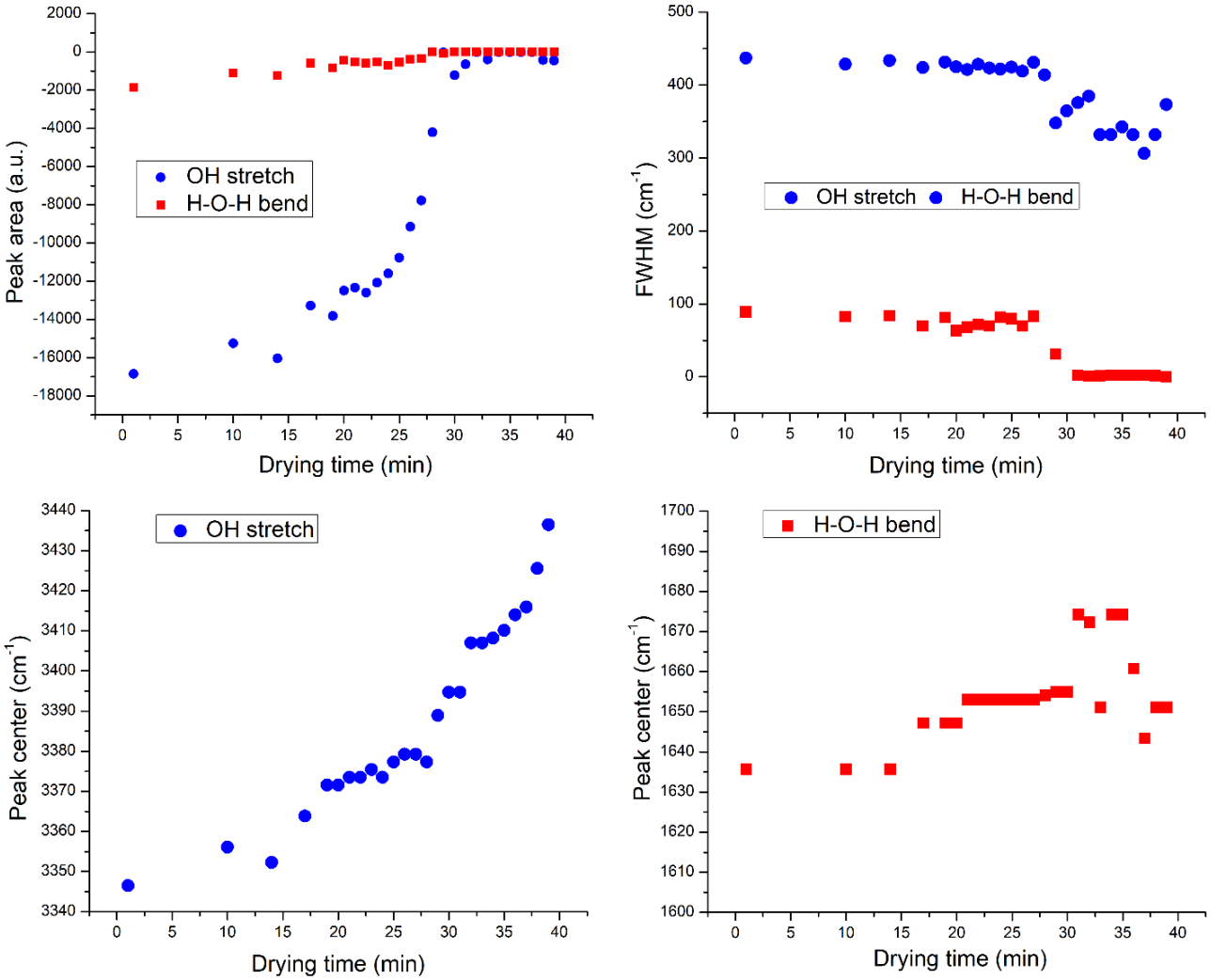

Figure 7. Total integral areas (a), full-widths at half-maxima (b) and integral peak centers (c, d) for the OH stretch (a, b, c) and the H-O-H scissoring (a, b, d) vibration modes in an unprocessed zeolite paste as a function of its drying time.

As for the mechanically treated zeolite samples, differing in microporosity, water confined to them exhibits an evident hypsochromic, blue shift of the OH stretch as a function of microporosity (Fig.8). This is the same type of shift as that observed with the drying time, unequivocally indicating that water confined to micropores exhibits a higher energy of its vibrational modes and bears more structural resemblance to water found in the gaseous, isolated state than to liquid or ice water.

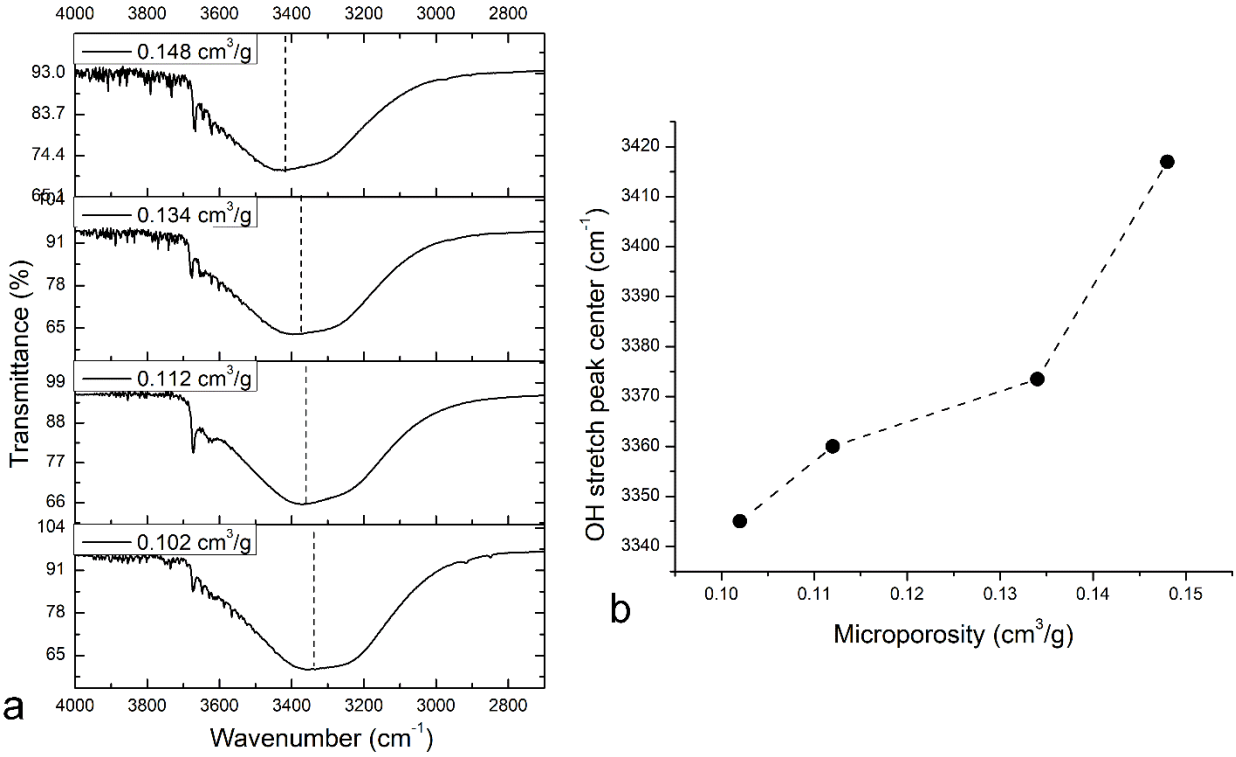

Figure 8. FTIR spectra focusing on the OH stretching mode of water confined to four zeolite samples with different microporosities after 20 wt.% zeolite pastes were dried for 5 min (a) and the blue shift of the integral peak centers as a function of microporosity (b).

According to Le *et al*., "blue-shifts indicate the lowering of the refractive index of water under nanoconfinement", and this is exactly what has been observed here. This correlation is in agreement with arguments made earlier, during these doleful ruminations in a desert, given that zero hypothetical refraction would correspond to vibrational modes of free water, as found in completely isolated state. If so, then confinement, clearly, makes water free, which is the statement as paradoxical as a statement can be. Despite its evidently more solid-like structure[46] and stiffened O-H bonds in O:H-O[47], water in confinement behaves freer than water in rivers, oceans and clouds. However, when it is considered how properties of water change upon its confinement, this paradox starts to become sensible. For example, it is known that the diffusion coefficient of water confined, say, between graphene sheets or inside carbon nanotubes is subject to a rapid increase[48], as one would expect from water that is freer than its bulk analogue. Similarly, despite the stiffer structure of confined water, its dissociation is shifted toward products, increasing the acidity of cations, for example, relative to bulk water[49]. To confirm the correctness of the correlation between the blue shift and the reduced refractive index, calculation of the refractive index from the FTIR spectra will be conducted, first in the IR range and then in the near-IR range. As for the UV/Vis range, it was tested, but the predictions derived were unreliable because of the dependency of the signal on the concentration and the impossibility of testing very dense, paste-like samples where water under confinement presents its major ingredient, as compared to the bulk and surface waters. The derivation of the refractive index from the transmittance spectra was based on the envelope method as an alternative to models making use of dispersion equations. This method[50] relies on interference fringes in the transmittance spectra and represents a routine analytical technique for estimating optical constants of thick films. Concretely, the refractive index, n, was calculated as the function of the wavelength from the envelope of maxima (T_{max}) and minima (T_{min}) of transmittance oscillations caused by thin-film interference:

$$n = \sqrt{N + \sqrt{N^2 - {n_s}^2}}$$

where n_s is the refractive index of the substrate and N is defined as:

$$N = 2n_s \frac{T_{max} - T_{min}}{T_{max} T_{min}} + \frac{{n_s}^2 + 1}{2}$$

The results of these calculations conform to the expected inverse relationship between the refractive index of water and the blue shift of its OH stretch (Fig.9a). The refractive index at an arbitrary wavelength, corresponding to the central region of the OH stretch, is shown to consistently decrease with the drying time and, thus, with the ratio between the amount of water confined to the zeolitic micropores and the amount of surface and bulk water in the material (Fig.9b). Further, as the microporosity of zeolites increases, the refractive index of water in it decreases (Fig.10), simply owing to the more prominent presence of confined water relative to that of surface and bulk water.

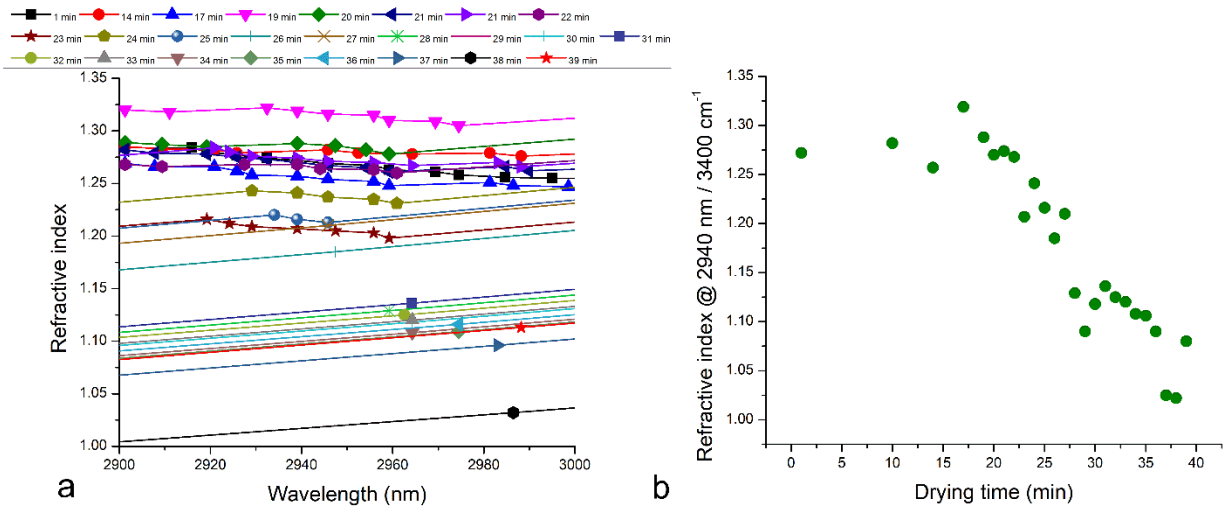

Figure 9. Refractive indices of water confined to an unprocessed zeolite paste as a function of the drying time in the 2900 – 3000 nm range (a) and at 2940 nm / 3400 cm^{-1} (b), as calculated from the stretching OH vibration mode in FTIR spectra.

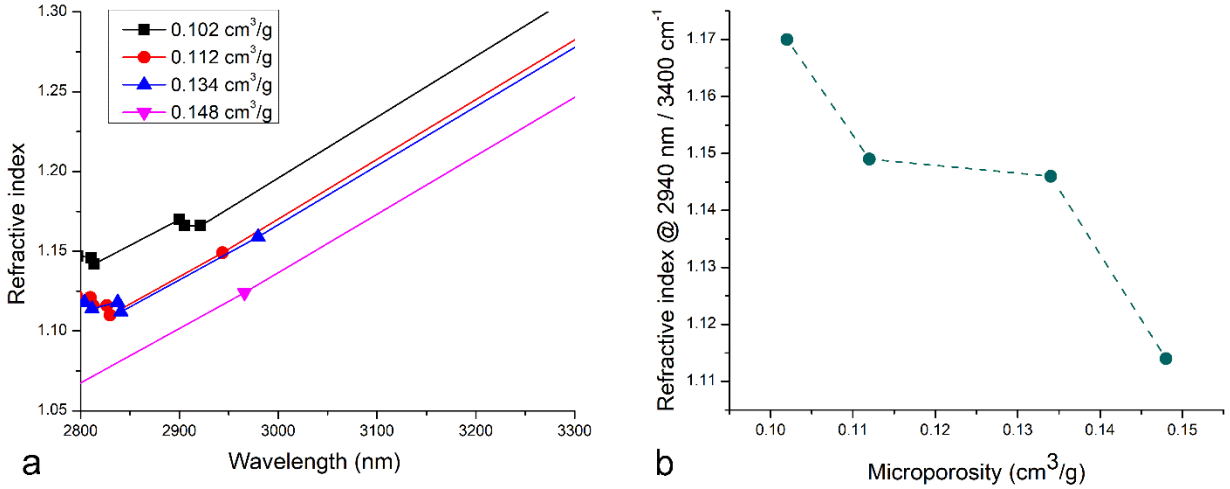

Figure 10. Refractive indices of water confined to zeolite pastes with different microporosities as a function of the drying time in the 2800 – 3300 nm range (a) and at 2940 nm / 3400 cm^{-1} (b), as calculated from the stretching OH vibration mode in FTIR spectra.

The very same analyses as those performed on the water vibration modes detectable in the IR range were next performed on the reflectance exhibited by water in the near-IR range. The reflectance peak evidently shifted to lower wavelengths, that is, higher energies, with the drying time (Fig.11) and with an increase in microporosity (Fig.12), exhibiting the same trend as that observed for the IR bands.

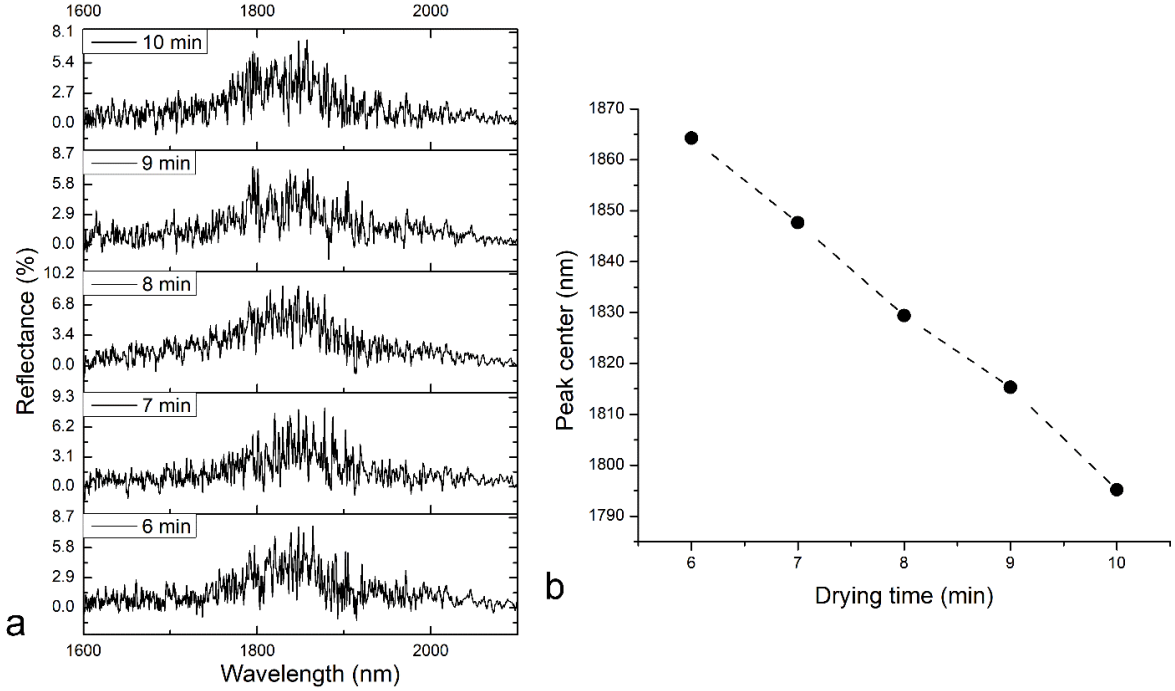

Figure 11. Near-IR diffuse reflectance spectra of water confined to unprocessed 20 wt.% zeolite paste in the 1600 – 2100 nm wavelength range (a) and the blue shift of the integral peak centers (b) as a function of the drying time.

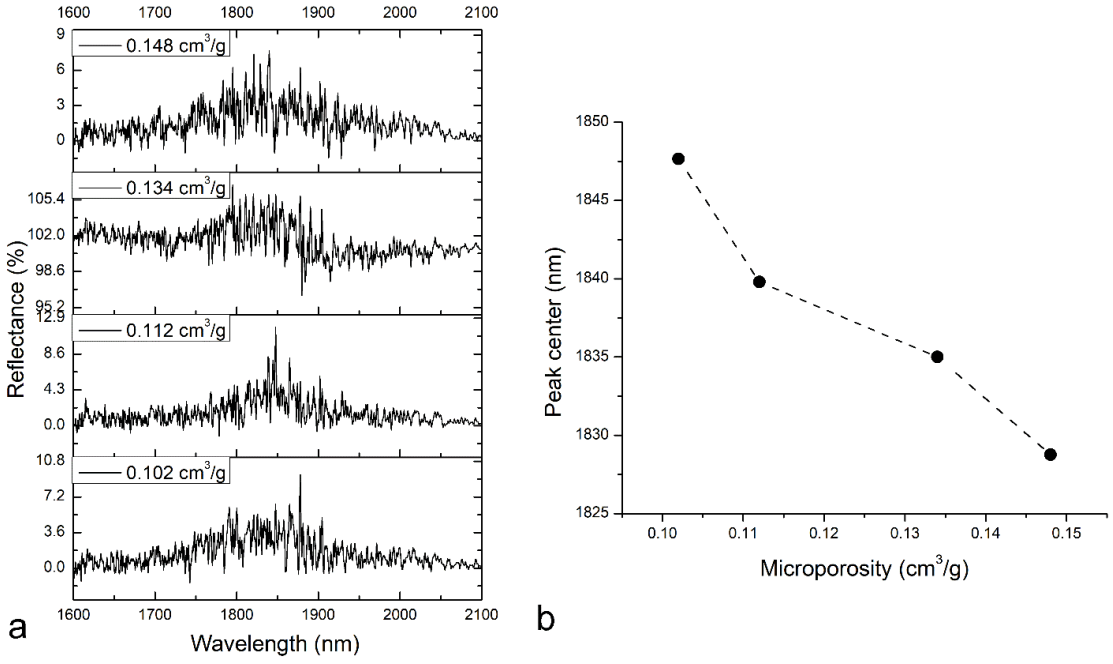

Figure 12. Near-IR diffuse reflectance spectra in the 1600 – 2100 nm range for water confined to four zeolite samples with different microporosities after 20 wt.% zeolite pastes were dried for 7 min (a) and the blue shift of the integral peak centers (b) as the function of microporosity.

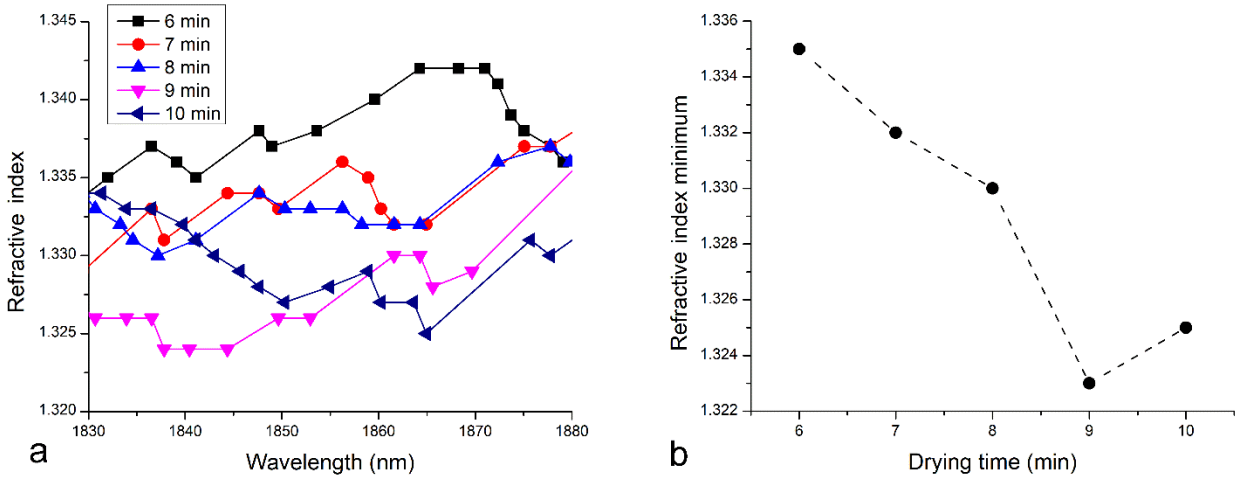

Figure 13. Refractive indices (a) and their minima (b) for water confined to unprocessed 20 wt.% zeolite paste dried for different times, as a function of either the wavelength in the 1830 – 1880 nm range (a) or drying time (b), as calculated from the near-IR reflectance spectra.

Calculations of the refractive indices from the detected reflectance spectra also conformed to the trend that applied to the absorbances in the IR range. Namely, the hypsochromic shifts of the reflectance corresponded to the tendency for the refractive index to decrease. This trend applied to both the blue shifts occurring as the function of drying (Fig.13) and those occurring due to increase in microporosity (Fig.14). In both cases, as the proportion of confined water increases, so does its refractive index drop, reaching in extreme scenarios values very close to 1.00 (Fig.9a), significantly lower than the bulk value of 1.33 used as an input in these calculations.

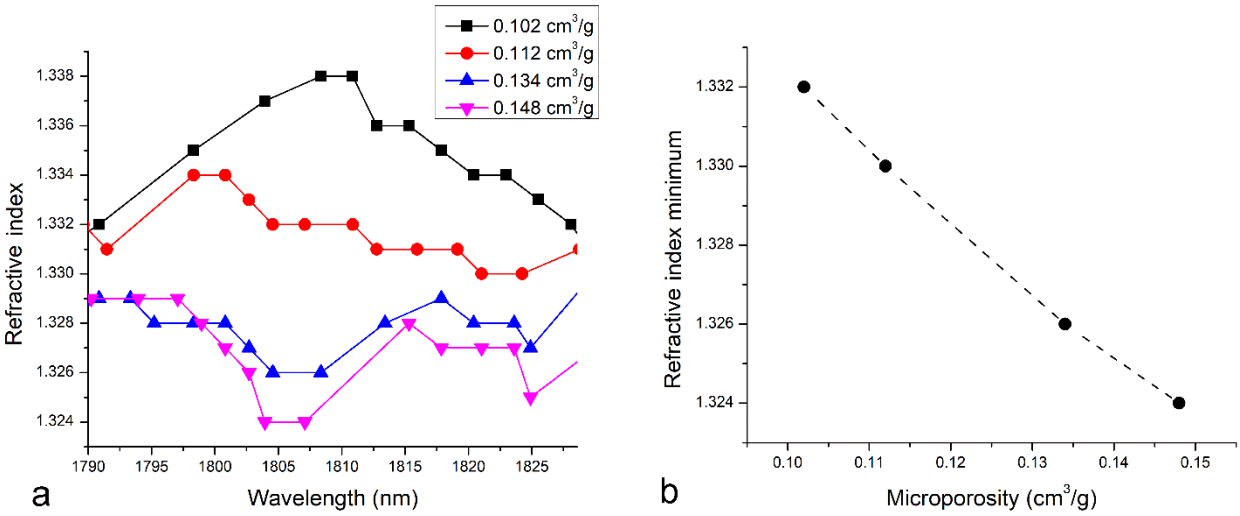

Figure 14. Refractive indices (a) and their minima (b) for water confined to 20 wt.% zeolite pastes with different microporosities after drying for 7 minutes as a function of either the wavelength in the 1790 – 1830 nm range (a) or microporosity (b), as calculated from the near-IR reflectance spectra.

Alas, while these data have been acquired, processed and interpreted, it has progressively grown darker. Eventually, the curtain of the night has fallen upon me. So dark, in fact, has it become that nothing could be seen anymore. Lifting my gaze from the temporary bliss the data analysis has brought about to the darkness surrounding me created the impression of someone coming in, turning off the lights to the stage, not realizing there is a play still going on, and leaving. On a darkened stage the actor is left standing, statuesquely, stranded in a state of utter bedazzlement.

XIV. Into the arms of the goddess

The more these results were dived into, the greater the absorption of the mind into the dark and unfathomable depths they sprang from became, until everything got swallowed by a pitch-black chasm. I remember what the jungle boy said once: the earliest memory is that of darkness. Only then came voices. Is womb what he remembers? If so, from this blackness that has grown around me, something beautiful must be born. Twinkles of stars are the first to pop as black slowly gives way to blue. I still see almost nothing and am now blinded by the blue.

From this enchanting blue, silhouettes emerge, of the poppet and the pan, whose faces I do not see anymore, but whose gaze I can feel on me, so tender, so solemn. That moment has come. The moment that had to come, the moment to wave farewell to guides who have taken me to the shore now visible on the horizon. With heart shredding into stardust, my hands wave, like wings of a butterfly. I say bye with my heart, but if this heart could pop out and travel with the littlies, like a balloon, to guide them wherever they'd go next, to tickle them and make them smile when clouds of sadness and veils of grim gather around them, may it do so now. I do never want to leave your side, my dearest, and if I could pull this heart out and hand it to you, I would.

The guide whom they pass me over to patiently awaits. I am backing nearer to the beginnings and feel as if my spirit has begun to swim in a sea of blue. The goddess opens her arms and welcomes me warmly. Waterfalls of love flow out of her heart, creating a most magnificent gown, glistening with stars. She, the goddess, looks into my eyes, and the whole world melts. I will be back to cater to the littlies, she says, after she shows me the abodes that lie before us on this road. My feet are blistered and my knees are giving way, but strength will be regained, she says, as we go, toward the sea that waves at us from afar.

XV. A heavenward reverie

As we walk hand in hand, I think about what this all meant. This trip, this desert I have found myself in, the road that got me to it, these cherubs that guided me, and, lastly, the findings of this study. I tell the goddess all about it. All about every one of them. Everything she missed all these years, I enthusiastically tell her about. After all, it is easier to let these thoughts confined under a crust formed by a lifetime of precipitates of fear and apathy flow outwardly when there is all this bliss nested around me. Yet, like Dante nearing the final destination of his journey, I too am aware of the limitations of language in describing all these magnificent impressions. Rather than attempting to squeeze the ocean into a bottle of stolen wine, I, aware of these limits, will remain anchored to the earth. The blaze burning till the end will be that of modesty, not pretense.

Yet, as always, my tongue gets tied and in spite of all these bedazzling beauties that wash over me from all sides, I engage in most the mundane descriptions of science behind all this. One inference that can be drawn from these observations, I say, is a reiteration of the well-known fact that water properties change dramatically depending on the type and the extent of its confinement. Thus, for example[51], the diffusion coefficient of water in the direction parallel to the two graphene plates confining it increases from ~ 2 nm^2/ns to ~ 3 nm^2/ns when the separation between the plates increases from 7 to 8 Å, but then drops down to ~ 1 nm^2/ns when the separation is further increased to 9 Å. This desert has made me thirsty and these travails hungry and I come to think of how even when it comes to the food we eat and the drinks we drink, ingesting water through them, where it is bound to various solid structures and molecules, forming nanoscale bubbles and films, may be vastly different in terms of the nutritious potential compared to bulk water. This is to say that under no circumstances should water be a singular term. For there is not one water only; there is an infinitude of waters. Change the size and shape of a water droplet and change the geometric, physical and chemical features of its microenvironment, and this water may end up having properties different from any other water in the world. This is how we show again that this most ubiquitous and simplest of all liquids is also the most complex and the most anomalous. When we look at it, we see infinities flourish.

This, however, was merely scratching the surface of knowledge from which the more concrete results emerged. They show that the finer the micropores confining water, the freer this water becomes, that is, more similar in structure and dynamics to water one would find in vapor, travelling toward the clouds, than in water we drink and bathe in. How strange it is that increasing spatial restrictions increases

freedoms too. I tell the goddess about it and she only winks, wordlessly, yet her presence is so intense and so crushing that it could make all the suns of the universe, shining as brightly and singing as sonorously as they could, blush.

Lest one of the key analogies flutter by unnoticed, science, as it has been depicted here, by the brushstroke of one bold metaphor that fell from the sky, is a desert that need be watered to restore life in it. All my effort all these years, made through severe hardship and destitution, aiming to romanticize science and fertilize its arid soil has found its image in the dropping of a droplet of water onto the zeolite powder sampled from a real desert, only to see it disappear and provoke reverberation in the scientific community no greater than the wisp of a whisper. Yet, sucked into a state of depression this lack of resonance brought about, I look to me as a soul squatted inside one such lonely droplet. I have sat and floated inside it, invisibly to the world, for a long, long time, penning my chefs-d'oeuvre in it. Despite being so miniature, so uptight in its structure and so ineffective at bringing life to this desert, beautiful freedom and transparency are now seen to reside in it, to the surprise of every sane scientific mindset. And if something so magnificent can be discovered in something so small and so insignificant, then it can be discovered in everything else; 'tis a lesson in the entwinement of smallness and beautifulness that lulls angels to sleep at night and impels them to rise and shine in the morning.

Yet, would I ever be able to convince the world of the trueness of these findings and the relevance of all this wobbly, lyrical eccentricity with which they were told? I doubt. Even if it were not for the aversion to anything poetic that pervades the eternal iciness of the ninth circle of the underworld the kingdom of science has safely nested itself in, there will always arise suspicions over whether the observed spectrometric shifts were indeed signatures of water molecules that spoke about its freeness or something else. Suspicions like these, should they only be nurtured, could grow so big, in the eyes of the quester and the inquisitors alike, that they may eclipse the whole sky. Their thorns may pop the balloon of fancy that has made all this come alive, as if by an act of magic, and it may plop. The question, then, would be this: what if all this was unreal? What if all this was but a dream? A figment of imagination that expanded itself into a balloon, in which a fantasy played itself to the fanfares of children's fancy, before the dreamer was prodded to a sudden awakening and the balloon deflated, never to make itself airborne again. Yet, even if this unreality was real and I must say goodbye to it now, the dream was dreamt and exited with treasure in these hands, a testament to the supreme realness of the supremely unreal. If it was a white lie, it was one that gave way to a white light, so big and so broad that I have bedazzled myself yet again. Unable to see anything but a gravid bright light, I flake, I turn away and I let this endless blah-blah-blah prevail once again.

The more I talk, the more, somehow, I become aware of how little correspondence there is between the way we, humans, look and express ourselves on one side of this great divide and our innermost feelings and sensations on the other. To close this gap while preserving the radiance and grace of our inner worlds is to become divine, but that is a mission I impart to those who follow in the footsteps of this weary traveler. The awareness of this chasm, however, raises the awareness of beauty residing in everyone, which plucks a tear from this thorny eye so that it drops from the cheek to the dusty soil. Another tear it is, whose fate, if traced, could yield findings equally phenomenal as those derived here.

Step by step, a gorgeous shore emerges before us and the goddess plants me beside her. We two, like lotuses, watch each other, softly, as waves of some mysterious energy, gracious and tender, traverse the space. The glistening ocean, meanwhile, talks to us about the bounds of infinity while the granite cliffs behind us hum the wisdom of ages. Waves of melancholy suddenly cross the goddess' countenance and she begins to speak, silently, the way it happens in dreams, when the dreamer hears no words coming out of the mouth, yet he understands every bit of the message. Unfold the petals of your heart or let them droop and fall off, if need be. From then on, let your feelings float to the surface, on the waves of Tao. There is nothing anymore standing in the way. Open, trusting it all, take in everything the world bestows upon you. Let the line drawn between you and what is external to you dissolve. Become everything and let everything become you. When this uninterrupted flow of mental and emotional energies between the in and the out is established, truth will be with you. The world, run by knockoffs and hypocrisies, will then be against you and will make you suffer greatly. However, the more injustices happen to you, the more beautiful a world opens inside you; remember that, she says. When the world stands against you, seraphs smile at you from the treetops and reach out to you from the edges of the clouds, to guide you and keep you safe. With me seated beside her by the ocean shore, she tells me this and much more. As she speaks, my heart trembles and the granite walls shake, so tall and so stalwart that next to them, the greatest human wisdoms seem like but a handful of grains of sand. Everywhere and at all times, she says, you must read between the lines. You must go beyond the meaning of language and touch the spirit on which everything floats. With crystal clarity I see now that only when another became nested beside me did I begin to transition from hellishness to heavenliness. Now I know that heaven, not hell, is other people. Guide oneself with love and the most blissful paradise will open before you. Yahoo, she touches my hand gently, and I know now that a single touch surpasses millions of words in its greatness and power to heal and

harmonize. The reveries of love are the only ones that can compete with it. Yet to compete is always to miss the point, no matter what. To trail willingly behind all, in turn, is to win this whole race, the goal of which is to lose everything. Because everything must go. Including us.

XVI. At the gates of Paradise

It is time to move from this idyllic shore and into an even greater bliss. A million choruses of angels and symphonies of thousands playing at once, with instruments more divine than any human ears have ever heard, reverberating with the fine tuning of my heart, echo all around me. We walk toward the edge of a cliff, to the sound and sight of crashing waves below. Everything my eyes see is smeared and hazy, be it because of tears or age, I know not anymore. The cliff is tall and the ocean underneath is mesmerizing, but it all pales in the face of the familiar faces that have suddenly gathered around here. Everyone I've ever loved, I feel, is here. They hold me and I walk. In no time I will be soaring. Music played straight to the heart has uplifted me and I, lighter than ever, feel that my feet are no longer touching the ground. Wings will be spread and although I, afraid of falling, hold back, falls can be no more, she says, and we begin to fly, together.

We see the world as it appears to birds and other aerial creatures and we greatly enjoy it at first. We turn and flip and freefall, and the joy of how we feel and what we see is simply indescribable. Alas, just as butterflies in my chest have begun to settle, the goddess points at the earth below and then at her heart and I understand the message I read on her face. Everything that comes up must come down and there is a reason why we were chosen to walk the earth. Empathy toward earthlings, she says, diminishes when they are reduced to little points as seen from the sky. We must come close to them if we want to feel their heartbeats and have ours beat in the same rhythm. Hence we must alight, lightly. And so we do, folding our wings and waddling our way to the nearest grotto, for it has begun to rain. Near a sign pointing at the Appian Way, we cross the path of two limping birds and because the road is so narrow, the goddess tells me to move ahead of her, keep going and not look back. I obey her advice but only for so long. When I do look back, she retreats, as if in a demagnifying glass, and her form changes. All of a sudden, she is in a cavern, lying wounded, her wings broken, limbless and helpless, and I can barely recognize her. Yet, the blink of her eye tells all: this is where our roads collide; this is the heaven for the heavenliest. The supremely divine consciousness is filled with so much love that it descends from heaven to earth to take upon itself the sufferings endured by people. Instead of watching life from a cloud, as gods envisioned by the spiritually impoverished or illiterate would do, the deities of this highest order come to us. Gods, then, are among us and here, on Earth, is where we too could become one.

This is how I and all the gods' children who had roamed around heavenly heights return to the desert, except now, because of all this love they have brought with them, the desert is just about to be flooded by tears and perhaps even made fertile in time. Love, indeed, is what makes everything, even a death-ridden desert like this, alive.

Mind you, Dante did not get it right: the topmost heavenly spheres are void. All the angels and cherubs and divine spirits who could be there, had they wished, have given away the keys to their residence on the cloud and descended low to help those in need. The goddess' fate has been one of those. She chose to suffer to impart joy to the wretched. To be crucified to be crucified again, and again, and again, and again, ad infinitum – that is the road she and luminescent souls like hers have journeyed on. There is no more angelic fate than this. I watch the goddess crumble into dust and all the worlds, in and out of me, fall apart. Amen, kid, A, I say, crossing and not knowing which way to turn. The road from the darkest desert to the brightest heaven to an even more supreme heaven, which turns out to be the desert wherefrom my voyage had begun, has been crossed and I feel I am inside a wheel that is turning, an hourglass that is tumbling, a globe that is spinning, with no end in sight. I am in an undertow and there is no escaping it, so God help me.

XVII. Unto the Empyrean

Inside a whirlpool I am spinning, going 'round and 'round, and just when I feel I have finally drowned for good in a sea of heavenly tears, to the rescue comes the light tapping of children's fingers. Knock, knock, who is there? To this sweetest tap, I, thirsty and frightened to the bone, talking panickily in my sleep, come to a sudden awakening. I am awakened to a world that does not seem any realer anymore than that inside the dream I have just dreamt, if it was a dream at all. No less bemused do I stand than the sage who dreamt he was a butterfly and then woke up and knew no more whether he was a human dreaming of being a butterfly or a butterfly dreaming of being a human.

Anyhow, as poppets now assure me with their cheerful voices and joyous leaps, the dream, if we may call it so, seems to be over and I am awake and ready to open my eyes. The first thing I glimpse in a twilit room through slitted eyes on the nightstand beside me and on

the tufted bedroom floor are scattered papers showing the vibrational spectra and the exact same data as those I had elaborated upon in what I thought was a dream. To mind comes the rose Coleridge dreamt of picking from the garden of delight and to the sight of which he awoke, uttering an astonished "aye, what now". I think I hear also the ticks and tocks of the banjo clock repaired by a dreadful monster from a daydream to fulfil a wish wished near the ocean waves[52]. Likewise, the results of this research study, albeit being configured within a lucid dream, are here, right next to where I stand, now even impressed on these pages. These results, thus, I may christen a dream that came not from a dream. As real as you and I, the stuff dreams are made of, they are.

What should we say these findings tell us now that the end has drawn near? When walls close in on me, I can be freer than when I was free; that is what they say. Love, after all, is the ultimate anchor, a commitment to stay by another. Now I see that it frees one on another, internal level, even though on the surface one may seem so bound in shackles that one cannot move a limb.

Hence, I should not be afraid of becoming small, immovable, fixed, like on a cross, or pressed into a pancake between these serpentine walls that hiss and hum with deadening sterility. They can never take the life of me. This spirit can never be harnessed. It will always be wild among the wild.

Let me then squeeze into the tiniest spaces I could find. May I squat inside this tipi, inside this pea vine tent, inside this dollhouse, dragon's den or hammer-pounding workbench. Bury me with pets and squish me with squish mellows. Snuggle when the night is dark, near, nearer, nearest to me, so tightly that it takes my breath away. That is when I may render myself transparent and shadowless. That is when all the rays of light will be unimpeded in their flight. They will travel directly in and out of me, without being ruffled and warped at the interface. I will be infinitely open, with the boundary between me and what lies around me virtually nonexistent, like that of Pascal's imaginary sphere, the center of which is everywhere and whose surface is nowhere.

One may be tempted to think that freeing oneself from the oppression of fetters and borders will make one shadowless, but here we see that it is the exact opposite. For as long as we are a droplet isolated in space, we will bend the light's path and cast shadows. But when walls begin to press us and when their pressure becomes immeasurable and unbearable, we find ourselves at our purest, at least on this plane of reality. The more circumstances repress us, the freer we can be – this is what all this boils down to. The world, oppressive as it is, even when it breaks you on a Catherine wheel, can only free your spirit by such means, so keep this in mind when walls begin to close and you feel helpless. The free flights of our spirits can then soar to a far greater extent than in leisured settings, when we are free and untouched by the worldly troubles.

This research adventure proceeded by following the forgotten footsteps of one famous poetic pilgrimage, albeit in the kingdom of science, not politics, as was originally the case. Without this spirit of poetry, this empire is destined to remain as bleak and dismal as the desert painted in this work. With it, however, it can become a bliss of a kind that only science and art cross-fertilized can create. Unsurprisingly, the journey documented here has brought about the awareness of a fundamental paradox. Water, namely, when it is free, can never be as free as when it is confined and squished between four or many more walls. We, likewise, can never reach those long-sought heavenly vistas and stances except by hopping boldly into chains and, with them tied around our feet, treading footsteps across a calamitous terrain lying far, far away from what we may consider home.

The meaning of all the shadows nested around me early on has now become evident. They frightened me at first, but now I know that theirs was the path to follow. By trailing them and disappearing into realms where everything is so small, so tight and so dark, as if in a coffin, the secret to becoming shadowless was found. Shadows had to be embraced, with faith and with love, for this quest to have been completed. The key, therefore, is to follow Alice's advice after she tumbled out of that hole she had fallen into, having discovered a wonderland within it[53]. The advice is to stay small, under all circumstances, and never ever yield to the temptation of wanting to be big. May these starlings, these little lights be our guides and may they lead us to the worlds whose bliss only they know. May children remain the only kings and queens to whom we bow our heads to and by whom we let ourselves be led.

And now I am ready to open my eyes for real. And so I do. Eyes open and they open the world too. All around is no longer the desert it was. It is neither the desert nor the blinding bliss of heavenly impressions. It is a world mundane, ordinary, yet oh so beautiful. It is the world as it should be, the world I am meant to be in.

Whatever I am, this is what I am meant to be. Whatever I feel, this is what I am meant to feel. Time is no longer March 24. Time is no longer eight o'clock. Time is now.

What is most important, in this old world, now seen for the first time, there is life, there is people, there is a firework of exuberant ideas, reaching for the cloud, just waiting to be discovered. This Ferris wheel, this upright carousel pirouetting 'round and 'round has dropped me at the doorstep of what I least expected to find: the present moment and me in it, in a place folding, unfolding, trancing, entrancing, yet always keeping me fastened to the center. The treasure found at the end of this hunt is that which was already there to begin with. I have returned to where I had been before the storm in the hurricane eye of my mind sucked me into a Dantean daydream and spat me into a land of shadows. And now I am in heaven, heaven that is where I am, where I have always wanted to be. The future and the past have collided and merged into the present and what a shine they have produced. Not one that darkens and not one that blinds, but one that is mellow and moderate, one where the dance of shadows and light from which all this has come to life could safely be.

All the pieces have fallen into place, the place they were always meant to be. I am who I am. I am where I want to be. I am soul. I am all. All in Soul. Soul in All.

XVIII. Coda

A twelve-minute, twelve-second silence settles over the room like a shawl. At its far end, when peace and harmony appear to have annexed the whole of being, when the long-promised repose seems at last set in stone, when the seeker stands persuaded he has found the last missing thing, the show ruptures. It pops. It unhinges. It decouples, derails and slips into pure static, a white-noise weather system rolling in without warning. The sudden drop of the curtain first signifies nothing – less than nothing, a blank gesture, an error in the script. But as the hush keeps falling, as it keeps falling, the nothingness begins to glow. The longer it settles, the more it reveals its hidden hues: a slow-blooming, otherworldly beauty, as if the void were a negative developing.

From that abstract, unsayable, freshly fallen snow, everything resurfaces at the close of this radically unorthodox, deliberately unclassifiable, poetry-over-prose paper: the orange junkyard; the stiff little chips and wires; the unbroken procession of shadows; the dust that skins the Earth; the world's tiniest droplet – each one a bead in the rosary of the journey, each one demanding thanks for having carried the pilgrim even this far. Grain by grain, image by image, something imposing is being revealed, something resembling a cathedral obscured by static – its arches built of dissonant interference, its stained glass cut from noise, its altar set with the small, bright refuse of the world. The more the white hush settles, the more the outline insists: not ruin, not void, but a vast architecture of return, rising inside the blur until even the snow begins to look like scripture. It is madness returned, madness unchained.

And what, after all, is the dreamer, the pioneer, the self-rolling wheel supposed to do with this sudden placidity that arrives wearing the mask of an ending, at the supposed terminus of a voyage through spheres subterranean, terrestrial, celestial? Isn't satisfaction just a soft bed of conformity, and aren't those formal smiles we exchange with strangers the semaphore of a vanished heart, the neat little flags of compassion nailed up and left to weather in a world sealed inside one humongous cosmic tear? The dreamer did not come here to beam politely from the margins. He came to stagger and shimmer and blaze. And he knows that he can do this only if the brief stupor of contentment is smashed, only if utter craziness, lunacy, folly are welcomed back in, again and again and again, like a waking storm.

Besides: to write all this at all – to invent it, to dare it, to close it – this whole poetic expedition from inferno to purgatory to paradise inside scientific literature, that most prosaic of kingdoms, is itself an act of sanctioned derangement. Not to be crazy is never to imagine it; never to attempt it; never to carry it through; never to bring it, trembling, to its impossible end.

Crazy, then, is the note this has to die on – no lullaby, no clean cadence, only a defiant, riotous chord struck and held until the universe remembers its own delirium. Let madness take the throne again; let the coda flare and carom through the vaulted chambers of time and rattle the empty corridors of space. Let a rain of white noise sheet down over this page – cinders, ash, silver grit – and let the flood begin.

And let the passerines of paradise return, wheeling in bright panic above this cryptic skull, drawing their impossible circles tighter and tighter until the air in the center splits open and yields You.

You whom I scarcely recognize now: not because you have vanished, but because your radiance has outgrown all the names I learned for you. You glow with such splendor that these earthly eyes are rinsed of sight. Your heart trembles; your teardrops, cradled in the corners like contraband jewels, spark and stutter with their own small constellations. You stand taller than the arcades and atria of heaven and earth, taller than any architecture I ever mistook for shelter. You are the brightest plinth, an altar of light, and I a flower petal at your feet, trampled and ground to dust. You are the beginning that begins beginnings; you are the end that ends endings. I ache to fall into your mothering arms the way a lost thing falls into gravity. I vow to follow you, through the blackest crypts, through the salt-bright wreckage, into the sun's open hands.

In you I find home. In you I spin a cocoon. In you I disappear without being lost. In you it is night, and I remain – full of light.

And when the hour finally rips open, wings will tear through this torso like a verdict, and I will rise. Past names, past numbers, past the last charted boundary of the firmament, and into the celestine.

To infinity, and beyond.

3. CONCLUSION

A physicochemical research study directed at discovering the methods to reduce the refractive index of water was presented in an unorthodox and innovative literary style. The lyrical and the scientific elements, aspiring to satisfy the criteria of artistic aesthetics and analytical rigor, respectively, flowed into and from one another, indissolubly, throughout this paper. From the scientific angle, it was shown that confining nanoscopic droplets of water to micropores of a zeolitic structure reduces the refractive index of water and, according to the spectral signatures, endows water with structural freedom similar to that which it assumes in vapor. The refractive index of water became consistently lower as the size of the zeolitic micropores trapping it decreased, reaching, at particular wavelengths, values identical to that of air, attesting to the significantly diminished refractive capacity of water under nanoconfinement.

From the lyrical angle, these findings were presented through a lens reflecting on a poet's journey through hell, purgatory and heaven, as documented in Dante's *Commedia*. The author, the subject of this innovative exercise in merging science and art, like Dante 725 years ago, finding himself at a crossroads, commenced his travails in the hell of a quest for a research project that would satisfy the criterion of scientific originality and rigor, appeal to artistic sensibilities and, last but not least, speak to the author about the path he was to take in real life. From this stage, set upon a hostile terrain, he moved to the purgatory of redemption through diligent scientific experimentation, data acquisition and analysis, and finally to the heaven of reflecting upon the moral, aesthetic and spiritual significance of the findings, which showed, counterintuitively, that confinement reduces the refractive index of water. Water under confinement, paradoxically, becomes freer than surface or bulk water and its capacity to cast shadows is thus diminished. Reflecting on the scientific findings of the study, the paper concludes with the elaboration of the idea that conditions that oppress are exactly those that set human spirits free, providing a message of hope for all the enslaved the world over, whatever the fetters that hold them in place may be.

The content of the paper can be correspondingly perceived as a cry in a desert of one celebrating undying romanticism and freeness of spirit in a culture that is conservative and oppressive, wherein walls consistently grow thicker and taller, closing in on one ever more tightly. Symbolically, the topic elaborated throughout this journey – leading toward the creation of lyrical scientific paper as a new literary genre – pertained to the fate and states of water under nanoconfinement. This merger between the striving after novel research findings and after intrinsically beautiful ways of presenting them is the water that, albeit sparse, may spring the dead of the desert back to life.

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