Microscope Images Indicate That Water Clusters Are the Cause of Phyllotaxis

Harry K. Hahn

Abstract

With my study I want to advance a hypothesis that Phyllotaxis is caused by a lattice of Ice-Crystals or large Water Clusters which are stablized (coated) by certain proteins, e.g. special Ice-binding- or Water-Cluster-binding-proteins.

The microscopic Image of the remains of an evaporated water droplet shows a phyllotactic pattern that formed during the evaporation of the water droplet on a silicon wafer. This image is a proof that Water itself must be the main contributor which causes Phyllotaxis ! The pysical process Evaporation, and electric charge and coloumb forces caused by evaporation also seem to play a role in the pattern formation and in the precise orientation and positioning of the water clusters in the pattern.

Important for the formation of a phyllotactic Fibonacci pattern seems to be a large central Water Cluster, that may have icosahedral MacKay-geometry, consisting of large icosahedral Sub-Clusters formed by the stable icosahedral water clusters (H2O)100 or (H2O)280. Typical cluster numbers of Mackay-Clusters are 13 and 55 which are Fibonacci Numbers ! Additional proof comes from SEM-Images of the Sunflower Capitulum. These images indicate that new primordia are caused by rhombic crystals, which seem to be either ice-crystals or large water cluster crystals that formed with the help of ice-binding proteins or similar. Proof for a physical cause of Phyllotaxis is also provided by a study about variations in the Fibonacci-spiral patterns of twigs of the three “Pinus Mugo“ which shows that the Fibonacci-pattern variation depends on altitude and temperature- /radiation- conditions. With the results of this study I developed an infinite Fibonacci-Number-Sequences-Table that contains all existing Fibonacci-Sequences and all natural numbers. Finally I present a mathematical discovery regarding constant Phi. All natural numbers and their square roots, as well as constant Pi (π), can be expressed by only using constant Phi (1.618…) and the base unit 1.

<u>Summary</u> : Microscope Images indicate that Water Clusters are the cause of Phyllotaxis

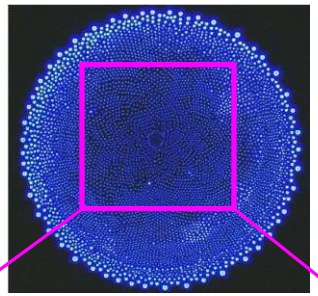
by Harry K. Hahn

→ Please see my more detailed study : **Microscope Images indicate that Water Clusters are the cause of Phyllotaxis** (or at vixra.org)

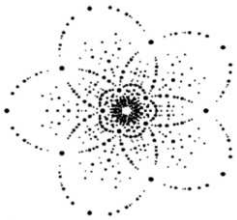
The microscopic Image of the residue of an evaporated water drop shows a phyllotactic pattern that formed during the evaporation of the water droplet on a silicon wafer. This image is a proof that Water itself must be the main contributor which causes Phyllotaxis ! The pysical process Evaporation, coloumb forces and electric charge caused either by radiation (electron beam / or light) or evaporation also seem to play a role in the pattern formation, and in the precise orientation and positioning of the water clusters in the phyllotactic pattern, as my own experiments indicated.

Important for the formation of a phyllotactic Fibonacci Pattern seems to be a large Central Water Cluster, that may have icosahedral MacKay-geometry, consisting of large icosahedral Sub-Clusters formed by the stable icosahedral water clusters $(H_2O)_{100}$ or $(H_2O)_{280}$. Typical cluster numbers of **Mackay-Clusters** are **13** and **55** which are **Fibonacci Numbers** ! Additional proof comes from SEM-Images of the Sunflower Capitulum. These images indicate that new primordia are caused by rhombic crystals, which seem to be either ice-crystals or large water cluster crystals that formed with the help of special proteins

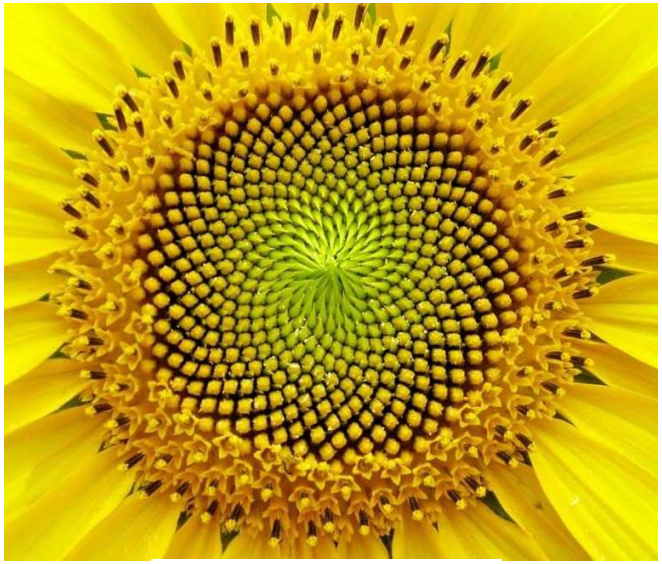
Evaporated Water Drop



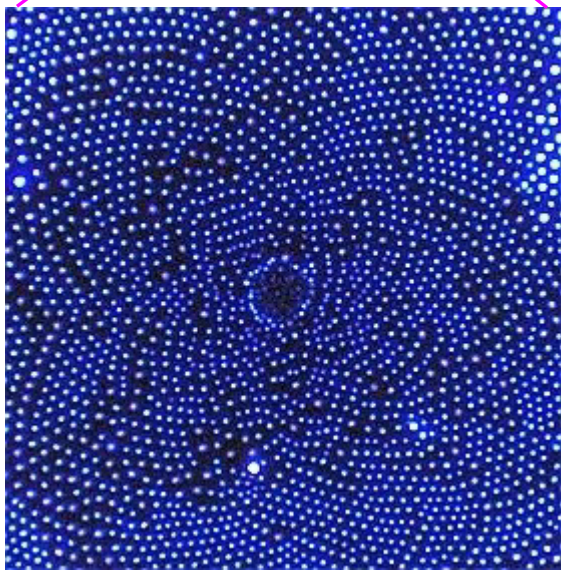
Myosotis
A flowering plant



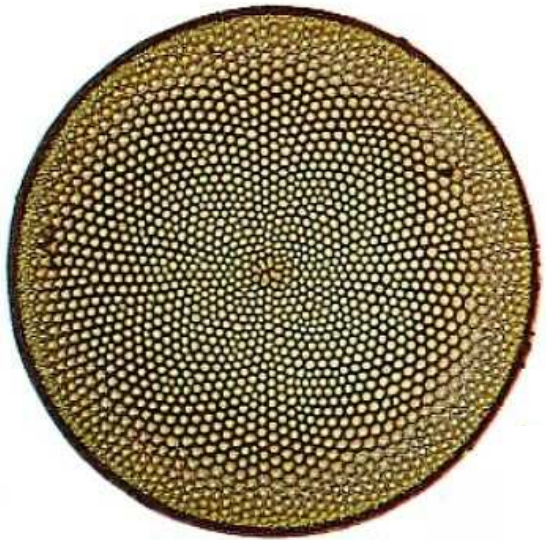
simulated Laue pattern
for X-ray diffraction from
an **Icosahedral quasicrystal**



The Sunflower (Helianthus)



Microscope Image of a water-cluster lattice visible in the residue of a small water droplet that evaporated on a silicon wafer in an Electron Beam Lithography System, the Image was made by Devin K. Brown from the IEN at Georgia Tech/USA - By courtesy of NSF



This image shows a Coscinodiscus Diatom, a class of unicellular microalgae, found in all oceans & rivers. They exist for ≥ 200 million years. Diatoms may be the plant ancestor that first developed phyllotactic patterns (Phyllotaxis) ! The cellwall of Diatoms is made of Hydrated Silica a form of silicon dioxide SiO_2

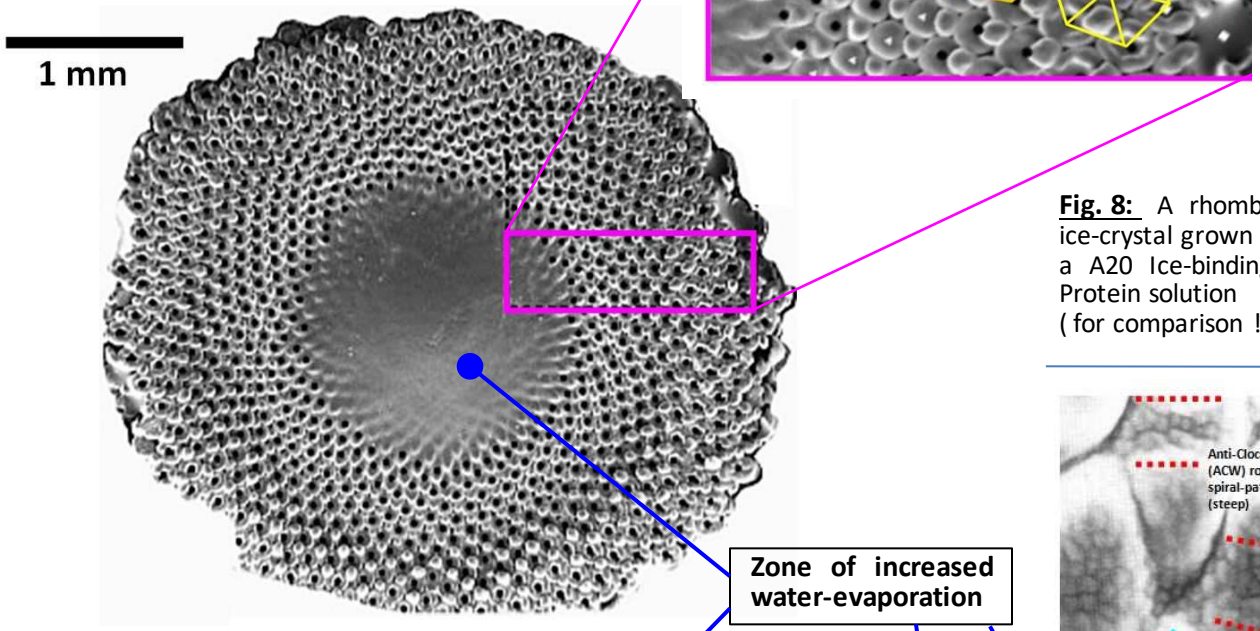
SEM-Images indicate that Water Clusters are the cause of Phyllotaxis in the Sunflower capitulum

Primordia in the generative zone of the Sunflower capitulum show crystalline structures

Crystals with rhombic (bi-pyramidal) shape seem to form the base of new generated primordia

SEM-Image of the young Sunflower capitulum

(SEM = scanning electron microscope)



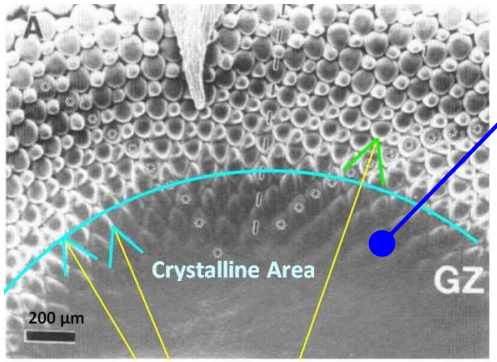


Fig. 1 : Fibonacci-array of floret primordia in the Sunflower-capitulum. The generative zone is marked as „**Crystalline area**"

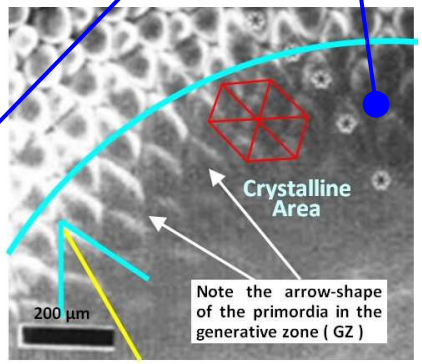


Fig. 2 : Inside of this „**Crytalline Area**" the new appearing primordia have a sharp arrow-shape !

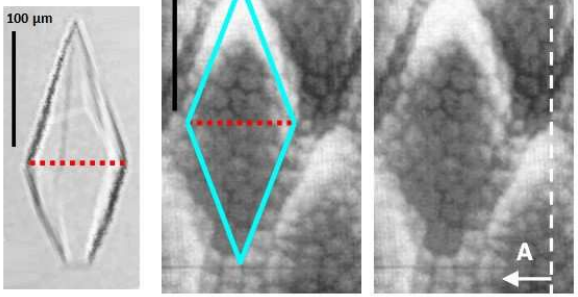


Fig. 8: A rhombic ice-crystal grown in a A20 Ice-binding-Protein solution (for comparison !)

Fig. 5 B : This detail view of Fig 5-A shows one new generated primordia
The rhombic shape is indicated by the blue outline.

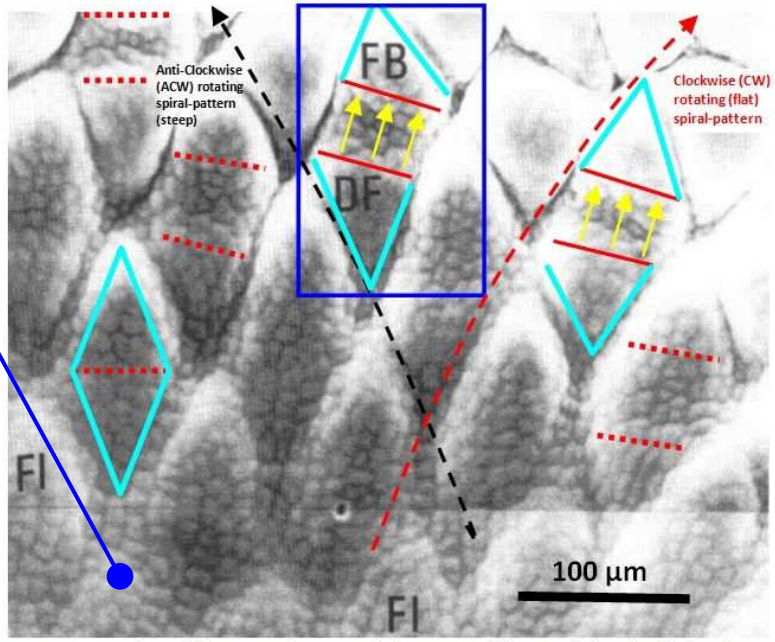


Fig. 5-A : Section of the generative zone (GZ) or „crystalline area" showing in detail new generated primordia. Blue lines indicate rhombical-shaped „crystals" which form the base-structure of the new primordia. Some of them are „broken" in two pieces (red lines)

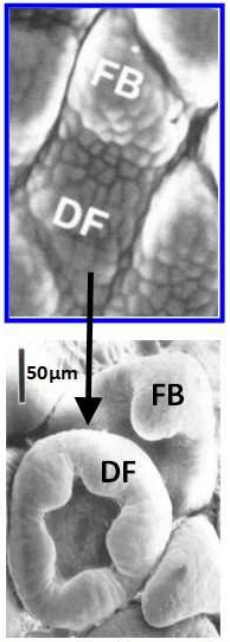
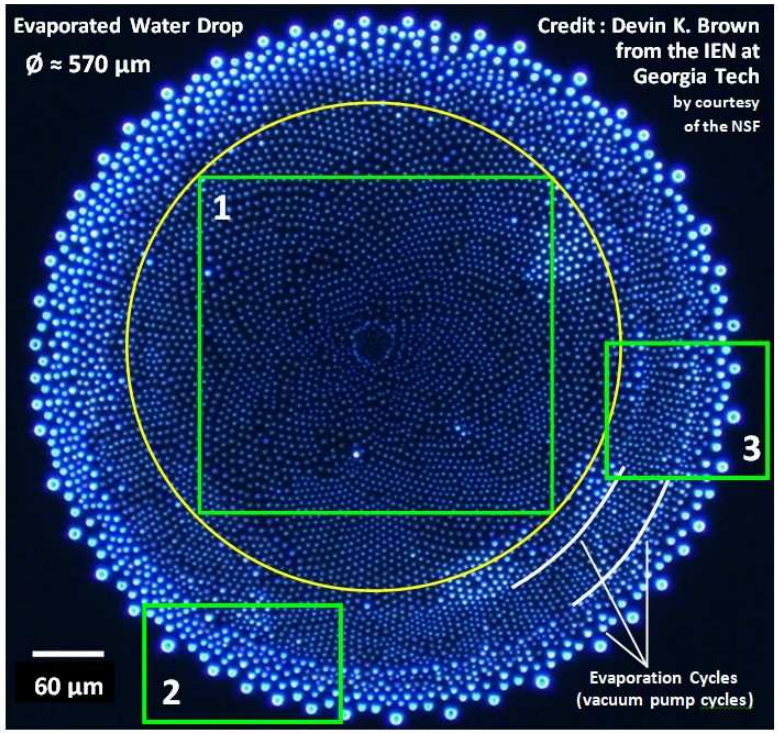


Fig. 6 : A rhombic primordia broken-apart develops into a bract (FB) and a flower (DF)

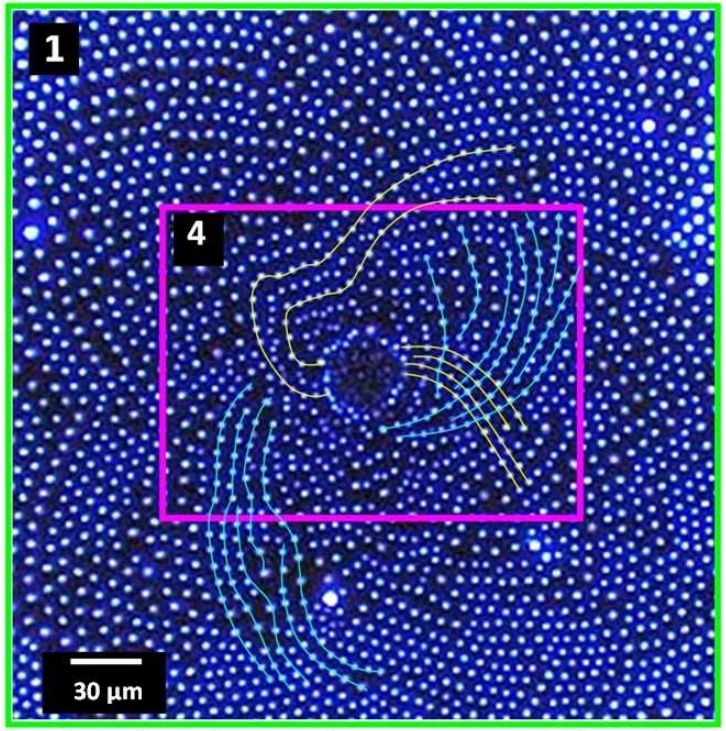
A microscopic image of an evaporated water drop indicates that water is causing Phyllotaxis

The drop evaporated on a silicon wafer that was treated with an electron beam and probably was electrically charged

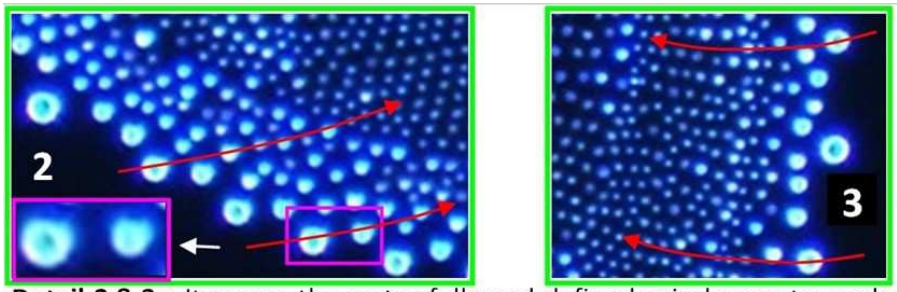
" The blue Sunflower"



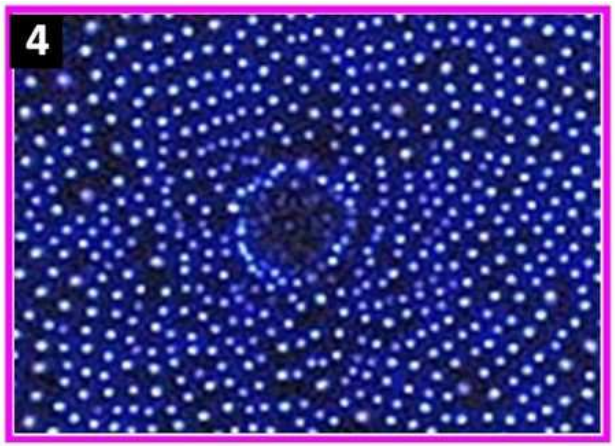
The Image shows the remains of an evaporated **Water Drop** Phyllotactic pattern with a ≈**90** clockwise & ≈**92** anti-clockwise parastichy-pair (spiral-pattern) visible.



Detail 1: Central area of the evaporated Water Drop. The large Central Cluster seems to be responsible for the structure of the central area of the phyllotactic pattern



Detail 2 & 3 : It seems the water followed defined spiral-arms towards the center, during evaporation, as the deformed small "drops" indicate



Detail 4 : Central Area & Central Cluster

Note : It seems the **electron beam of the lithography device** used by Devin Brown was partly responsible for the formation of the phyllotactic pattern, e.g by **electron diffraction aberration** (electron flow) to the etch-field limits (see: → page 101 here)

The Water-Cluster-Lattice seems to be strongly influenced by a large central Water Cluster

The rim-area of the water-drop evaporated first. Then the water in the center evaporated, leaving behind a outline (2D-projection) of the original central „Super Water Cluster Crystal“ in the form of a residue pattern. Each of the original „Super Water Clusters“ (Ø ≈3-10 µm) is represented by a white dot (→cluster residue) on the image. The cluster residues indicate that the original water clusters were connected, as **Fig. 4** indicates , e.g. for electric charge exchange.

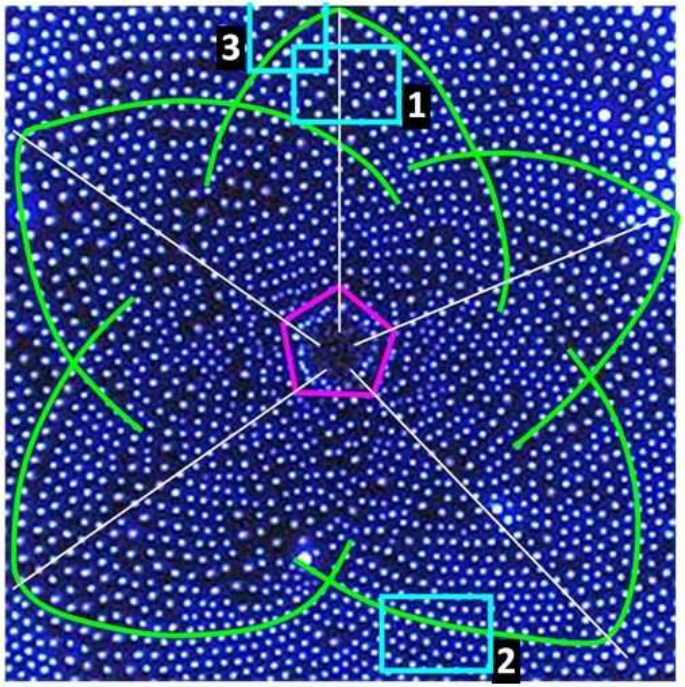


Fig 1 : Image of central area of an evaporated Water Drop. There is a clear connection visible between the pattern and the central cluster. The pattern is influenced by a pulsating Central Cluster.

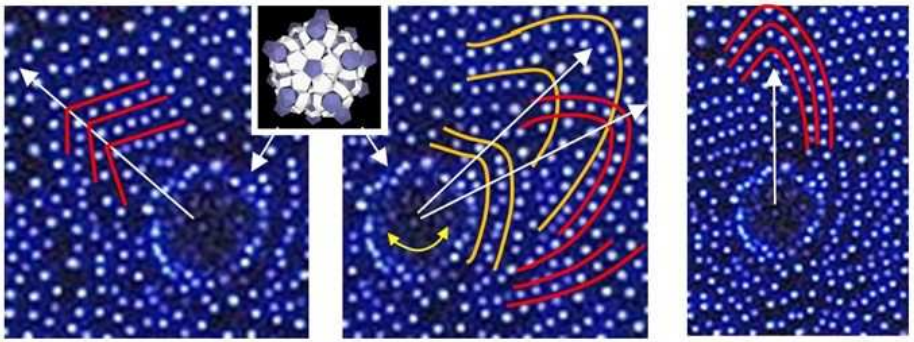


Fig 2 : Each corner of the pentagonal central cluster seems to be the starting point of one (or more) v-shaped wave-group (or shock-front)

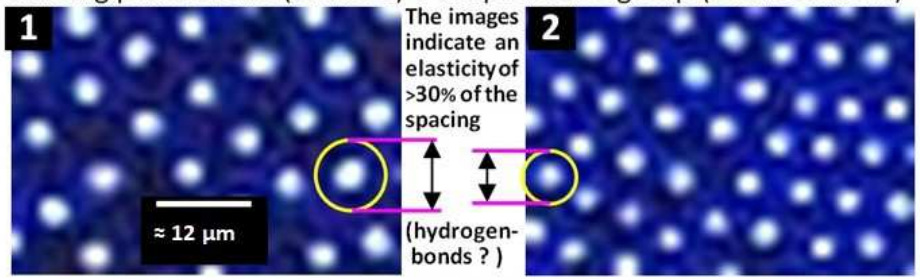
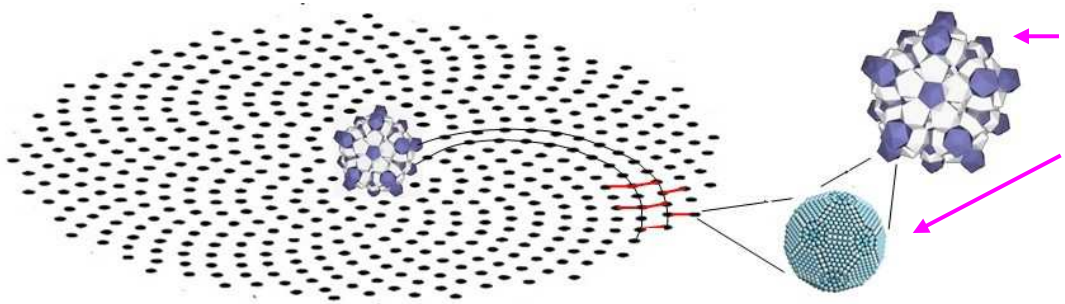


Fig 3 : Two same-size areas of the water-cluster-pattern that represents the evaporated water drop. The clusters in **area 1 & 2** are equally spaced but density is different. Large “**Super-Water-Clusters**“ probably originally occupied the positions in the crystal-like lattice first

Model of the Evaporated Water Drop :

There is a “**Super Water Cluster Crystal**“ in the center with either a dodecahedral shape or an icosahedral MacKay-Cluster. Each **“Super Water Cluster“** in this central **“Cluster Crystal“** is the starting point of a **“Super Cluster Chain“** which forms with other such chains the complete pattern.



The central Super Water Cluster Crystal may consist of a dodecahedral shell with **92 Icosahedral Super Water Clusters** This would fit to the number of cluster chains of ≈ 90 – 92.
→see 3D-animation of Cluster : **weblink**

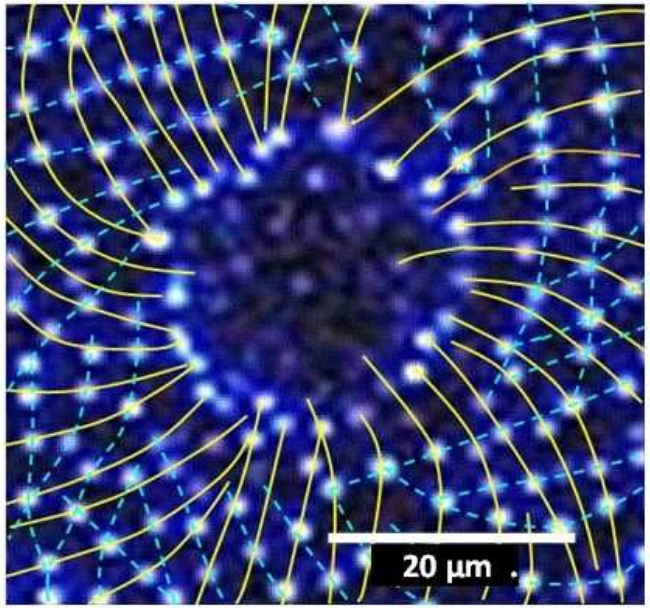
Fibonacci Numbers may be defined by a large central Water-Cluster with MacKay-Cluster Geometry

→ Each cluster of a central "Super Water Cluster Crystal" seems to be the start of a Water Cluster Chain (→yellow lines)

As the **Image** of the evaporated water drop shows (→**see right image** & last two pages) a large central **"Super Water Cluster Crystal"** seems to define the phyllotactic pattern. **From each "Super Water Cluster"** (→ white dots) of this "Cluster Crystal" **a "chain of Super Water Clusters" is leading nearly radially outward on a slightly curved spiral-path** (→yellow lines). **This set of "Super Water Cluster Chains" defines the first 1. Fibonacci-Number ! This number is precisely linked to the number of "Super Water Clusters " in the central "Super Water Cluster Crystal" which seems to be defined by icosahedral "MacKay"-Cluster geometry.**

A **MacKay Cluster** is a very stable **Nanoparticle**/**Cluster** due to its electron configuration. **It is important to note that the first two MacKay clusters are defined by the Fibonacci-Number 13 & 55 !** And an extreme stable variation of the third MacKay-Cluster (147) has the **Fibonacci-Number 144 !**

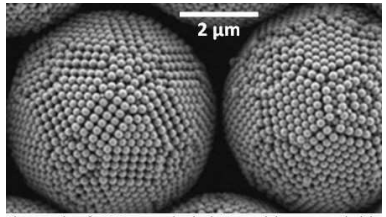
The **2. Fibonacci-Number** in the Fibonacci-pattern is defined by the **„Lattice of the Cluster Chains" (→ see next page !)**



1. Fibonacci Number (→ yellow chains) 2. Fibonacci Number (→ blue chains)

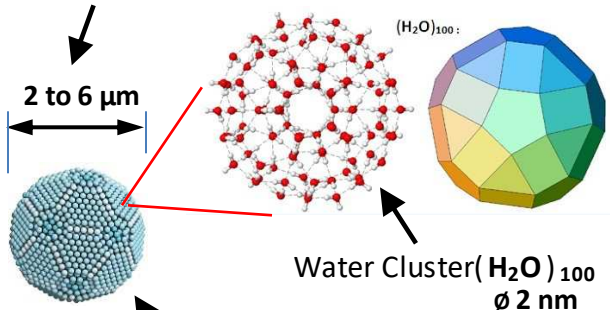
Fig 2 : Each cluster of the central "**Super Water Cluster Crystal**" is the start of a Water Cluster Chain

A study about icosahedral colloidal clusters indicates that $(H_2O)_{100}$ water-clusters can form perfect extremely large icosahedral super water-clusters of up to **6 µm** diameter! The shown colloidal clusters developed at **5°C** during water evaporation from a Polystyrene particle suspension.



Thousands of 0.25 µm spherical PS-particles suspended in water formed icosahedral clusters during water-evaporation

weblink to study :
Magic-number-colloidal-Clusters



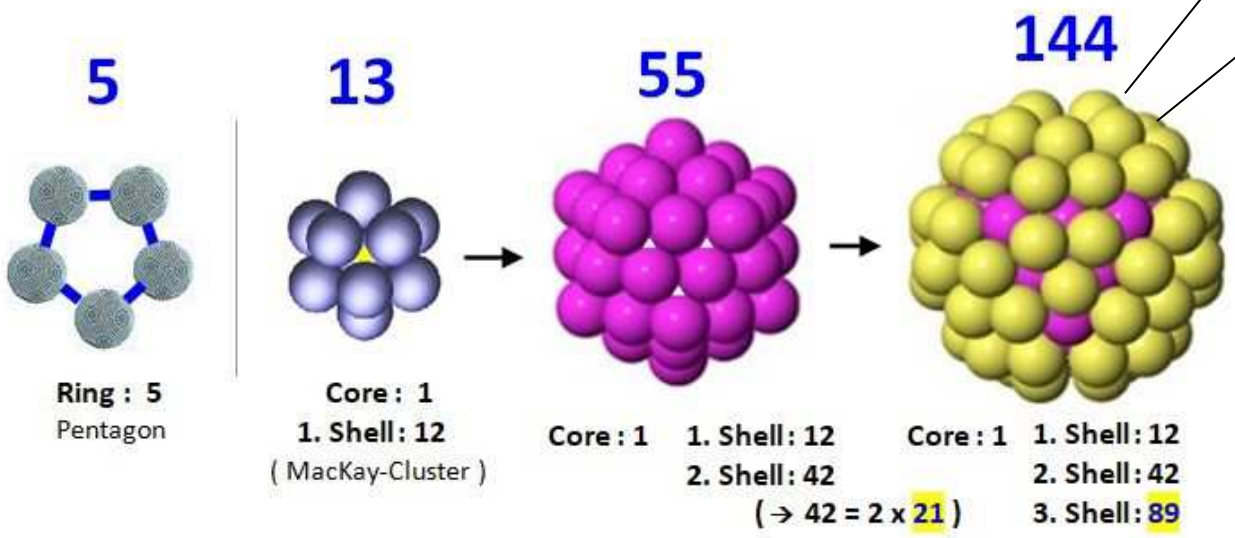


Fig 1 : The image on the left shows the Cluster-Geometry of the central "**Super Water Cluster Crystal**" that probably defines the "**1. Fibonacci-Spiral-Set**" of a **Fibonacci-Spiral-Pattern** with the described **„Super Water Cluster Chains"** which start at each of the "**Super Water Clusters**" in the **Central Cluster Crystal.**

Fibonacci Spiral Patterns seem to be the result of a circular crytal-like lattice of Water Clusters

1.Fibonacci-Number : defined by number of Super Water Clusters in Central Cluster. 2. Fibonacci-Number : defined by the "Water Cluster Lattice"

The **Pentagon** and the **Icosahedron** are the only two geometrical objects where the **Golden Ratio, the constant which defines Fibonacci-Numbers**, is directly **built into their geometrical structure !** Water molecules can form water clusters with icosahedral shape (large clusters) and water clusters with dodecahedral shape, made of pentagons (small clusters). **The following image describes in principle how a Fibonacci-Spiral Pattern can develop, based on a circular crystal lattice that either consists of icosahedral or pentagonal Water Clusters. The 1.Fibonacci-Number is defined by the number of Super Water Clusters in the Central Cluster. And the 2. Fibonacci-Number is defined by the "Water Cluster Lattice" which is surrounding the central cluster.** In the image every pentagon or icosahedron represents a cluster chain

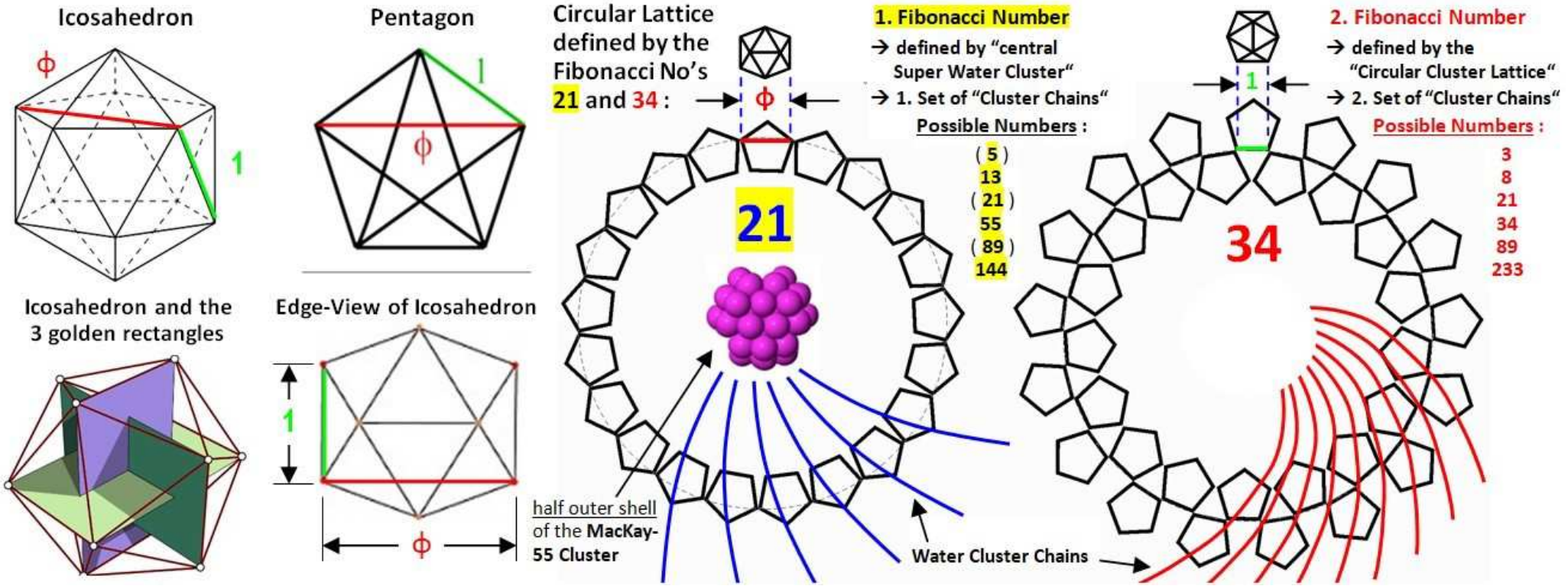
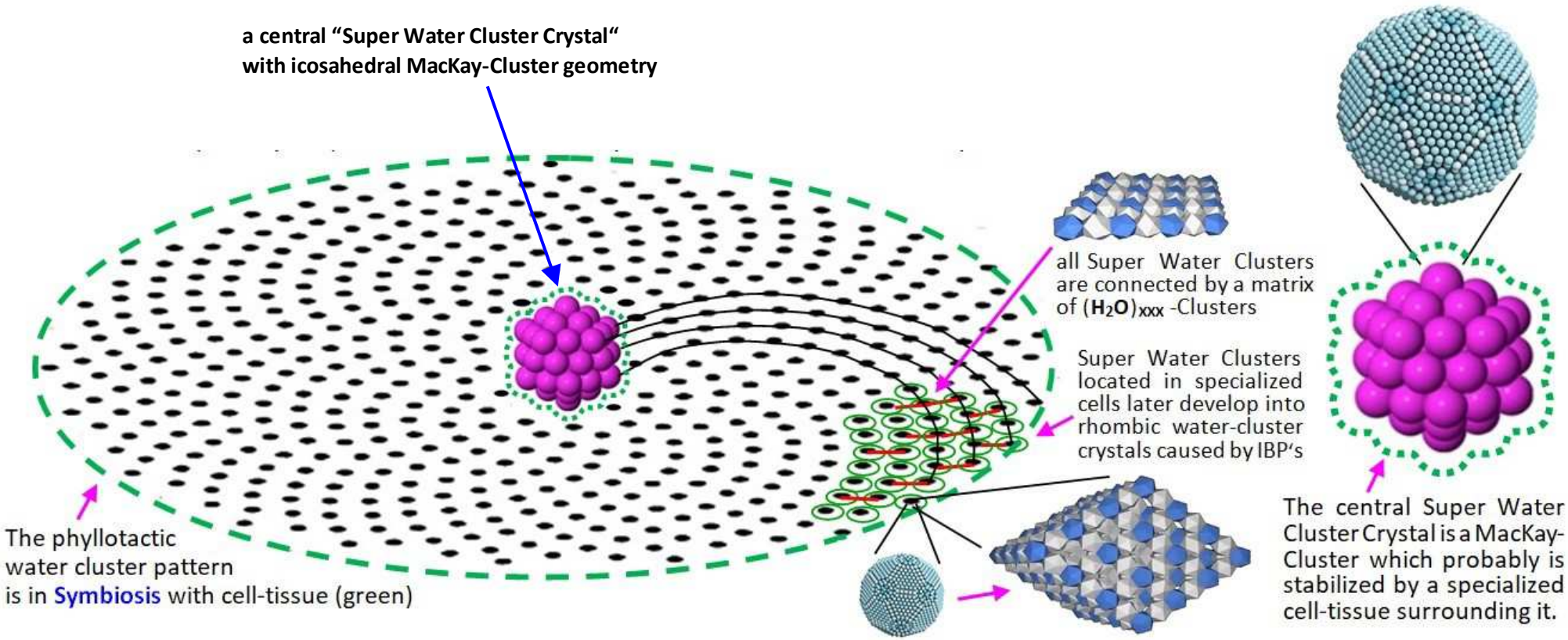


Fig 1 : shows how the **Golden Ratio** (→ **the ratio of constant Phi (ϕ) and 1**) is built into the Geometry of the **Pentagon** and **Icosahedron**

Fig 2 : A Fibonacci Spiral Pattern precisely defined by a circular crystal lattice that either consists of Icosahedral- or pentagonal Water-Clusters. The 1.Fibonacci-Number is defined by the number of Super Water Clusters in the central Cluster. The 2. Fibonacci-Number is defined by the "Cluster Lattice-(Geometry)" surrounding the central Cluster. The Fibonacci-Numbers **13, 55, 144** represent full Maykay-Clusters & **21, 89** represent full or half outer shells

Model of the phyllotactic pattern formation mechanism in the Sunflower meristem



Model of the proposed phyllotactic pattern structure in the Sunflower meristem :

There is a "**Super Water Cluster Crystal**" located in the center of the Sunflower meristem (capitulum). In all probabilty this cluster has an **icosahedral MacKay-Cluster-geometry**. And each **"Super Water Cluster"** in this **central Cluster Crystal** is the starting point of a **"Super Water Cluster Chain"** which forms the phyllotactic pattern, together with other such Cluster Chains which connect the main-chains. In this model the central cluster and the clusters of the cluster-chains are **stabilized by a specialized cell-tissue which uses special proteins** (**like IBP's**) that help to stabilize the structure of the central cluster and the clusters of the super water cluster chains. From each super water cluster of the phyllotactic pattern later a rhombic Super Water Cluster Crystal (or ice-crystal) evolves, with the help of IBP's, that defines the position of a floret primordia.

Fibonacci-Spiral-Patterns formed by Water Clusters may require the following conditions :

1.) All **water clusters** have an **icosahedral- or dodecahedral structure** and the phyllotactic lattice structure is based on **icosahedral- and/or pentagonal lattice-geometry**. A condition for a precise Fibonacci-spiral-pattern.

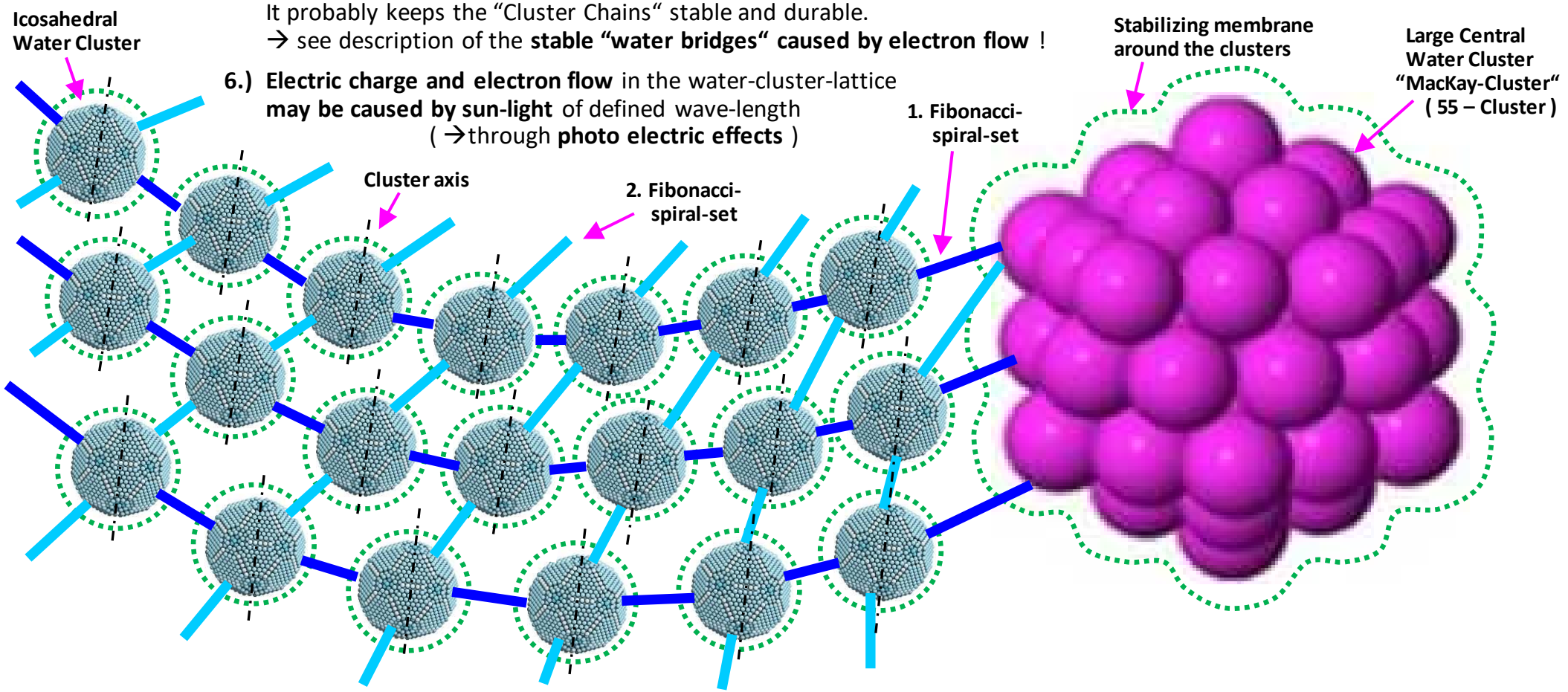
2.) The **axes of all water clusters** in the spiral pattern are **orientated in the same direction** . This unidirectional-orientation of the axes may be **caused by electron flow** (to or from the Central Cluster) **or by an electric field**.

3.) **The large central Cluster defines the 1. Fibonacci Number**. It probably has an icosahedral MacKay-geometry. Very stable **MacKay clusters** have „Fibonacci"-**Cluster Numbers** of **13, 55** and **144**

4.) **From each Sub-Cluster** of the Central Cluster **a "Cluster-Chain" starts**. In this way the **1.Fibonacci spiral-set** is created. **Through connections between these cluster chains the 2. Fibonacci spiral-set is created**, because of the icosahedral- and/or pentagonal lattice-geometry. (→ ratio Phi / 1 defines the geometry of such a lattice)

5.) **Electron flow** to or from the central cluster **probably is the driving force for such a stable water-cluster lattice**. It probably keeps the "Cluster Chains" stable and durable.
→ see description of the **stable "water bridges" caused by electron flow** !

6.) **Electric charge and electron flow** in the water-cluster-lattice **may be caused by sun-light** of defined wave-length (→through **photo electric effects**)



Microscopic Experiments No. 1 – 6 : Evaporating water droplets observed through the microscope

Microscopic Experiment 1 :

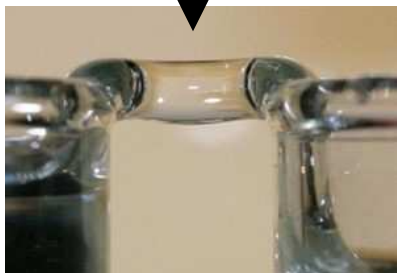
Evaporation of a water drop on a gold surface.
The evaporated water drop left behind a circular pattern of water clusters (Ø 5 - 10 µm) which are surrounded (coated) by thin membranes. "Water-bridges" were visible between individual clusters

➔ See **Movie 1** : https://www.youtube.com/watch?v=rk9w1jke9BM

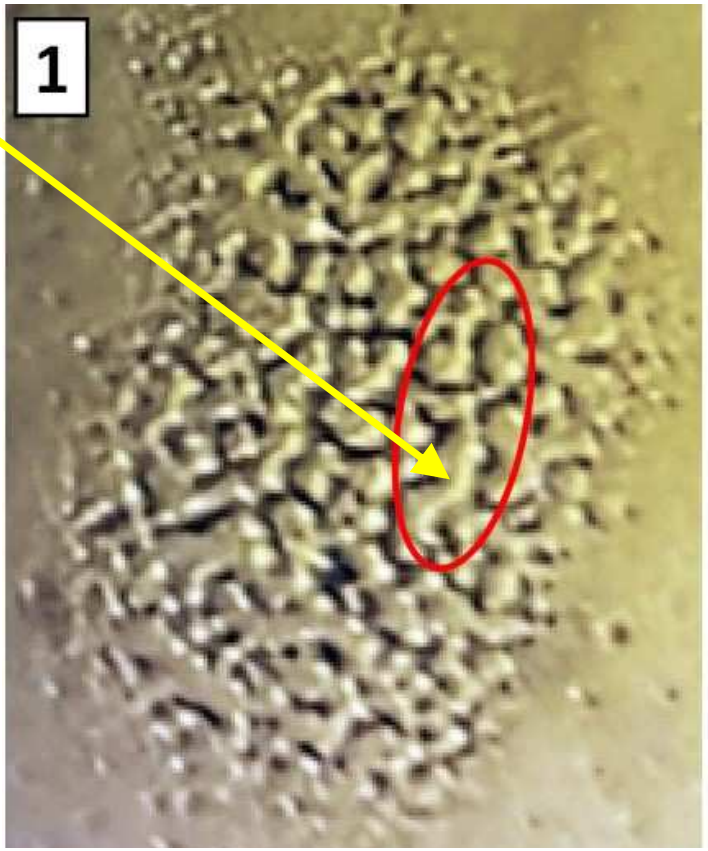
See also infos about charged water here : **Interfacial water**

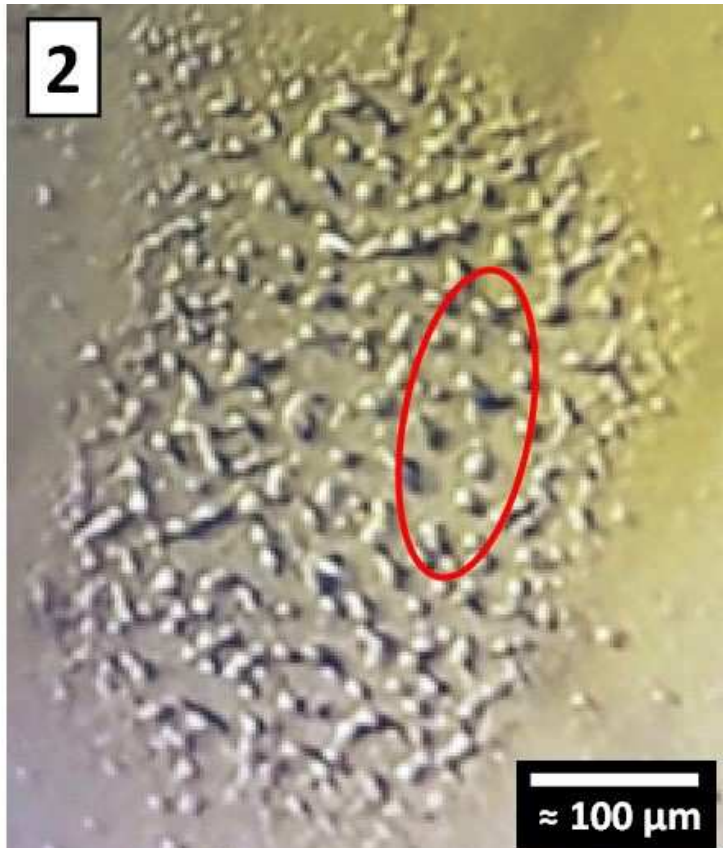
"**Water-Bridges**" are visible in the last stage of the evaporation of the drop.

These **"Water-bridges"** may transport **charge** (**electrons**) from one cluster to the other as indicated by another study : (see more information at the end of this lecture !)



When water in two glasses is exposed to a high voltage, a stable floating „water bridge" forms between the glasses !





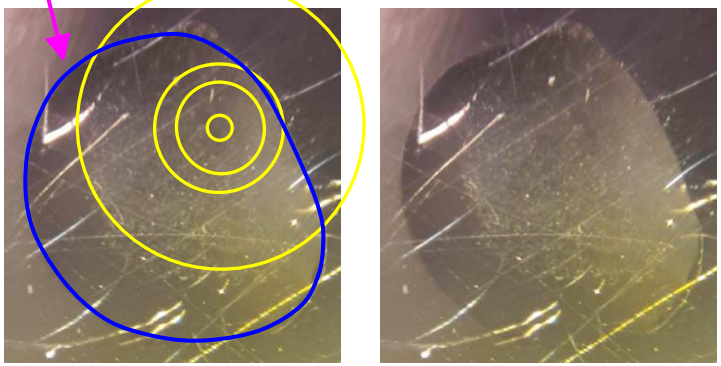
After the evaporation of the water drop (Ø 1.7 mm) a circular pattern with Ø 0.5 mm is visible, which is consisting of clusters with diameters of approx. 5-10 micrometers. These clusters mainly consist of distilled water, and they are probably surrounded (coated) by thin membranes.
A Raman Spectrum indicates that **peptides, surfactant, polyamides or similar molecules form these membranes**, which surround (coat) the water clusters and keep them stable and durable. The Raman Spectrum also indicated, **Hydroxy-groups & hydroxides (OH-).** The membrane material (fibre material & surfactant (washing powder) ?) probably came from a cotton cloth which I used to clean the container where I stored the distilled water. A very small amount of this material must have contaminated the water ! → see Raman Spectrum on previous page !

Microscopic Experiment 5 : **Evaporation of a water drop on a silicon surface.**

The evaporated water drop left behind a 120° sector of a circular pattern of water clusters (Ø 5 - 10 µm).
The fact that the circular pattern only partly overlaps with the water drop indicates that the cause of the pattern must be located in the silicon (surface), inside the shown yellow marked circle !!

Cicular pattern area electrically charged ?
→ charge may be caused by evaporation or by a photo-electric effect

Drop outline

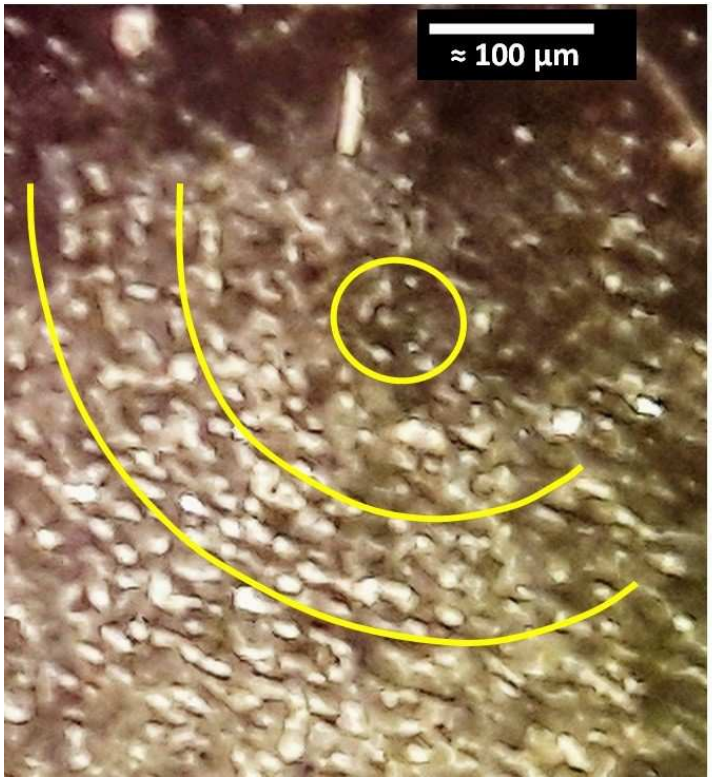


➔ See **Movie 5** : https://www.youtube.com/watch?v=hwBn3ugqA-4

See also infos about charged water here : **Interfacial water**

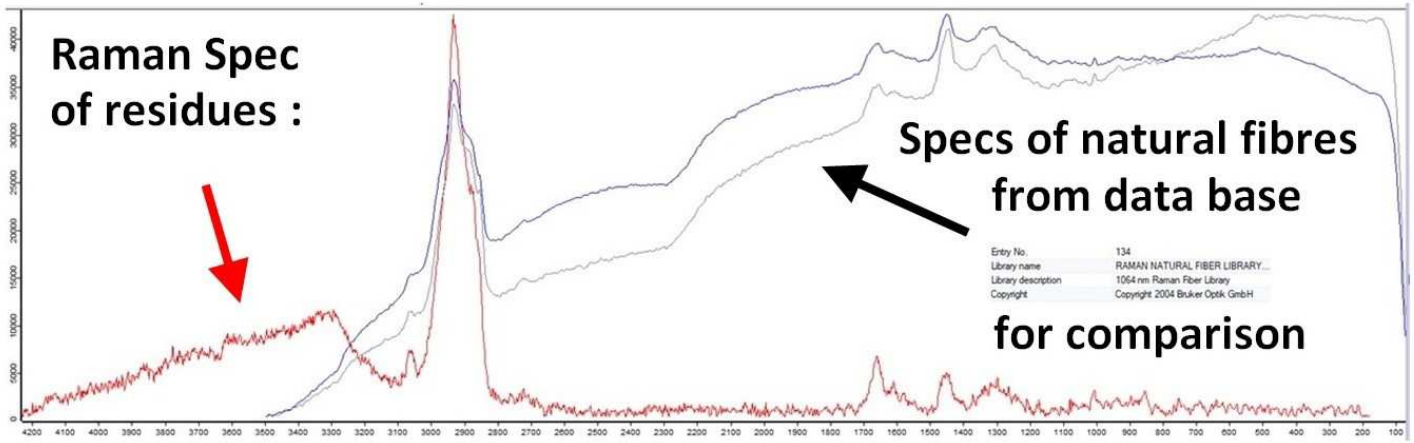
Unlike the experiments where I used a gold surface, in which the circular pattern always was pretty concentric to the water drop, in this experiment Nr. 5 where I used a silicon surface, the circular pattern clearly formed off-center ! , as the images on the left show ! → The blue line markes the drop outline.
The yellow concentric circles mark the circular pattern of small clusters that formed inside of the water drop.
Outside of the water drop there is nothing to see from the rest of the circular pattern (a circular charged area?)
A circular electric charged area on the silicon surface could be responsible for the pattern formation.

In the movie it is visible that the small clusters in the drop already arrange in a circular pattern before the drop is evaporated ! After the drop is evaporated a 120° sector of a circular pattern (lattice) is visible !
Even the center of the pattern can be identified. The original drop had a diameter of ≈ 1.2 mm.



The small clusters probably consisted of distilled water, and they were surrounded (coated) by a thin membrane (a layer of membrane forming molecules). **A Raman Spectrum (see below)** of the visible residue of the circular pattern indicates that peptides, surfactant, polyamides or similar molecules must have formed membranes which surrounded (coated) the small water clusters and kept them stable and durable. The Raman Spectrum also indicated, Hydroxy groups & hydroxides (OH-).
The membrane material probably came from a cotton cloth which I used to clean the container where I stored the distilled water. A very small amount of this material must have contaminated the distilled water.

The silicon sample that was used : a Silicon Broad Band Window with ~ 5 µm monocrystalline SI-coating was used
The following lamp was used as microscope light : a Osram LED light AC08022 36°, 220V, 29mA, 3.3W, 2700K (230 lm) at around 80mm distance to the sample.

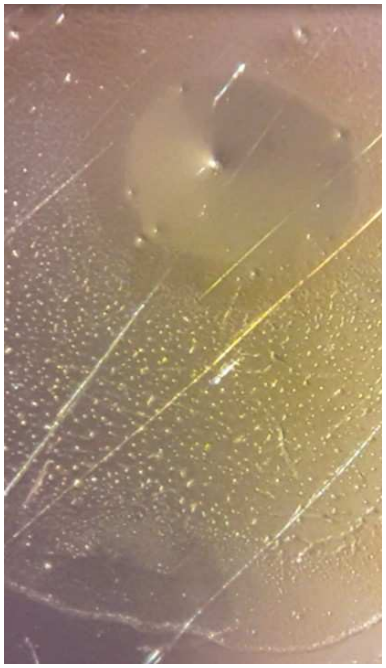


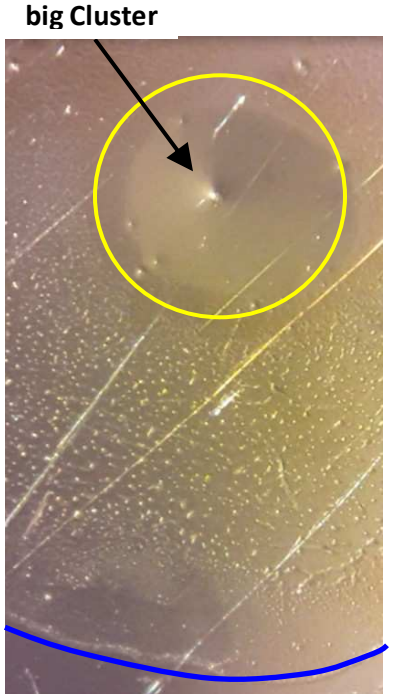
Microscopic Experiment 2 : **Evaporation of a water drop on a gold surface.**

The evaporated water drop left behind a circular pattern of small clusters which are probably coated by thin membranes made of surfactant. The water drop finally shrinks (evaporates) around a larger cluster

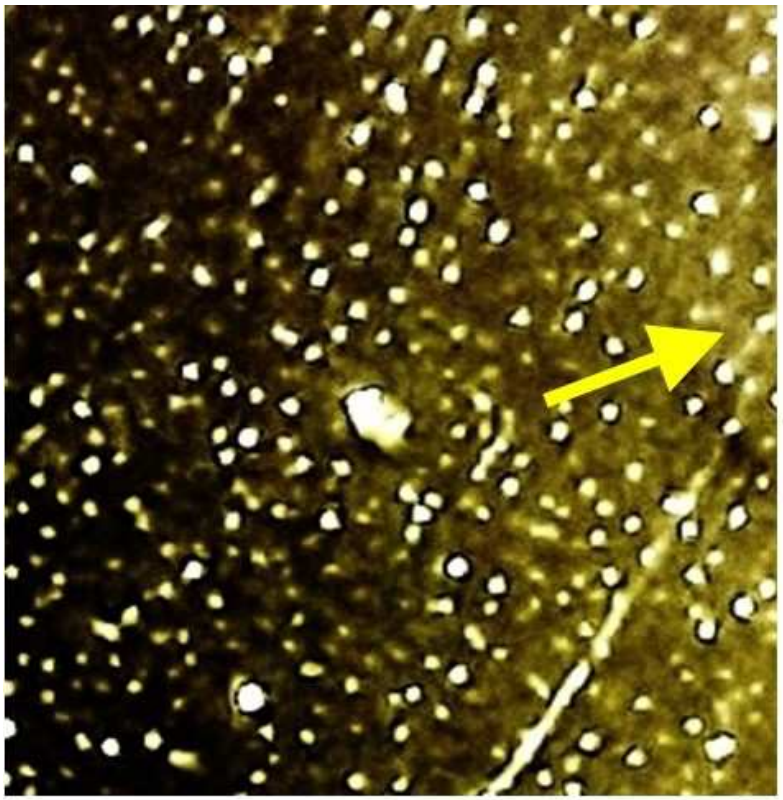
➔ See **Movie 2** : https://www.youtube.com/watch?v=iXKRFX7RSiU

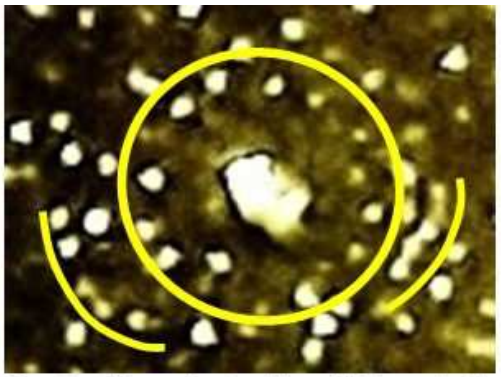
The movie shows how the water drop finally shrinks (evaporates) around a larger cluster. (see the two images on the left).
During the evaporation of the water drop a pattern consisting of small clusters is developing. These small clusters probably consist of water clusters coated by membranes. In this case the membranes that coat the small water clusters probably consist of surfactant. Because I added a very small amount (~0.1 vol%) of washing powder (Persil) to the distilled water. A detail view of the big cluster that was the final center of the evaporating water drop shows how a concentric ring and a few chains of the small clusters formed around this larger cluster, that probably is a remain of the washing powder material ➔ **This detail view shows a few similarities in comparison with the central area of the photo made by Devin Brown**





The yellow circle marks the rest of the water drop that shrinks around a big cluster. The blue line marks the original drop outline





Detail : detail of the big cluster that was the final center of the evaporating water drop Shows how a con-centric ring & chains of micelle-, liposom- or cell-like-objects formed around the large cluster

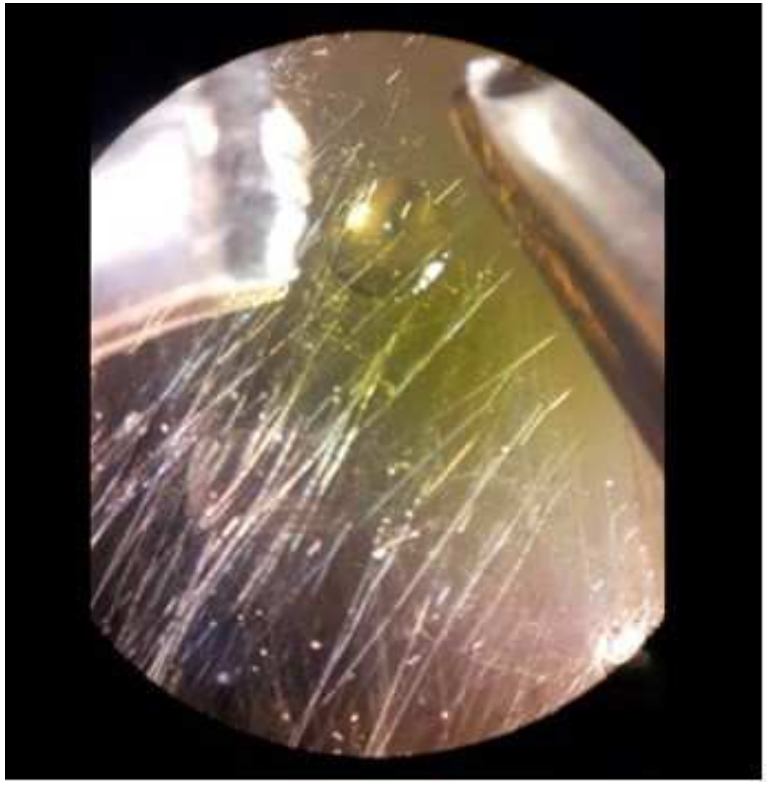
Microscopic Experiment 3 : **Evaporation of a water drop on a gold surface.**

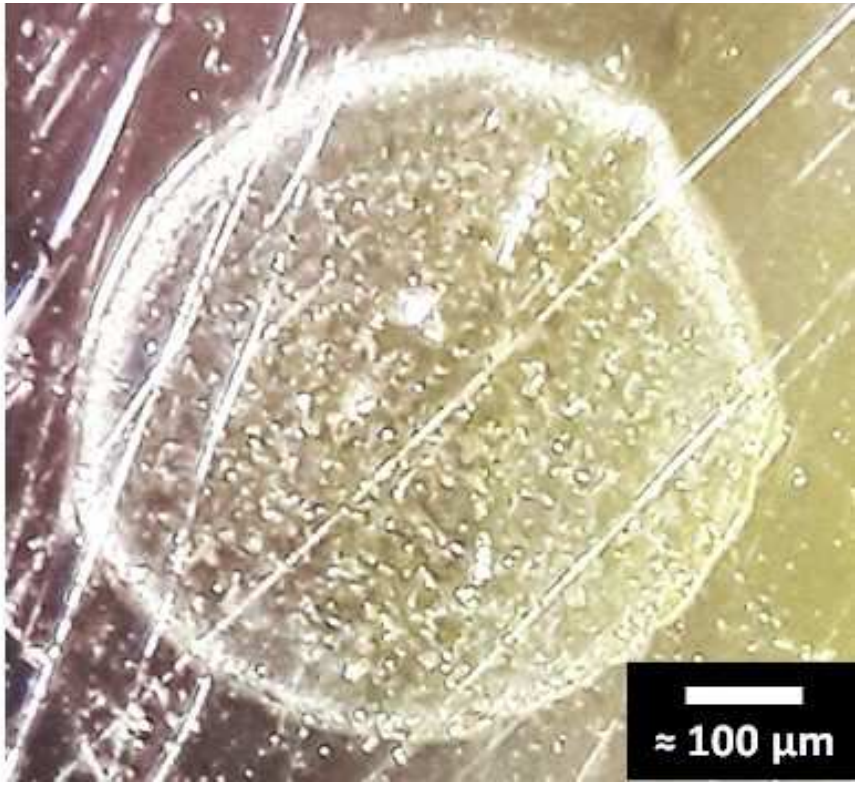
The movie shows how electron flow on the surface accelerates evaporation by a factor of 10-20 !
The evaporated water drop left behind a circular pattern of small clusters which probably consisted of surfactant (washing powder : Persil) and distilled water.

➔ See **Movie 3** : https://www.youtube.com/watch?v=41Q0c6NosJ4

See also infos about charged water here : **Interfacial water**

This experiment shows the evaporation of a water drop on a gold surface under the microscope. After the evaporation of the water drop (original diameter 0.7 mm) a circular pattern is visible, that consists of residue from the washing powder (Persil - 0.1 vol%) which I added to the water. **A current of 1.5 VDC** (from an alkaline battery) which I **applied on the surface** near the drop rapidly **accelerated the evaporation of the water drop**. This clearly shows that an electron flow on the support surface of the drop (gold or silicon) has a great impact on the evaporation rate of the water in the drop !



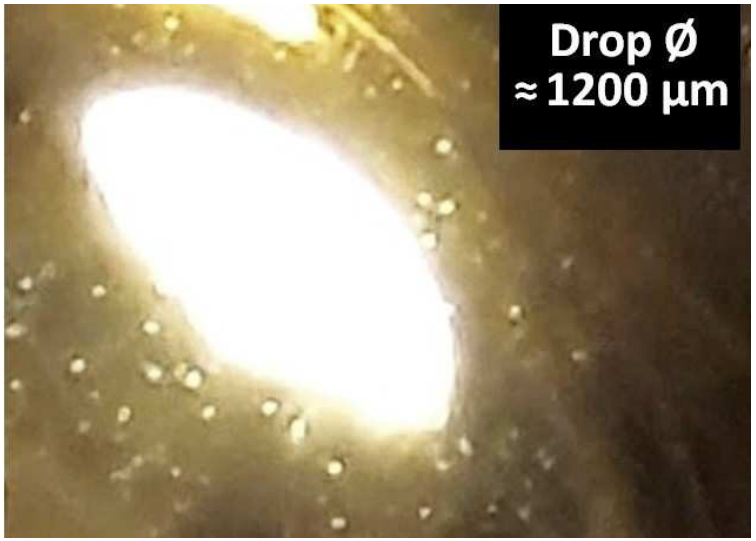


Microscopic Experiment 4 :

Evaporation of a water drop on a gold surface. The movie shows how small micelle- or liposome-like clusters move around in the drop. The evaporated water drop left behind a circular pattern of small clusters which probably consisted of surfactant (washing powder : Persil) and distilled water.

See **Movie 4** : https://www.youtube.com/watch?v=WHQIaOOIp9g

Here a water drop is shown before it evaporated, in an early state of the evaporation. It normally takes around 5 minutes until a water drop of diameter 1.5 to 2mm is evaporated. Small Clusters in the water drop reflect the light of the light source. It is noticeable that the clusters keep approximately constant distances to each other. This indicates that coloumb forces (repulsive forces caused by electric charge) may act between the clusters. These small **micelle- or liposom-like clusters** probably consist of distilled water, that is surrounded by a thin membrane (a layer of membrane forming molecules). A Raman Spectrum indicates that peptides, surfactant, polyamides or similar probably formed this membranes which surround (coat) these small water clusters and keep them stable and durable. The Raman Spectrum also indicated, Hydroxy groups & hydroxides (OH-). The membrane material probably came from a cotton cloth which I used to clean the container where I stored the distilled water. A very small amount of this material must have contaminated the water.



Microscopic Experiment 6 :

Evaporation of a water drop on a gold surface.
The evaporated water drop left behind a ring of larger water clusters which are surrounded (coated) by thin membranes.

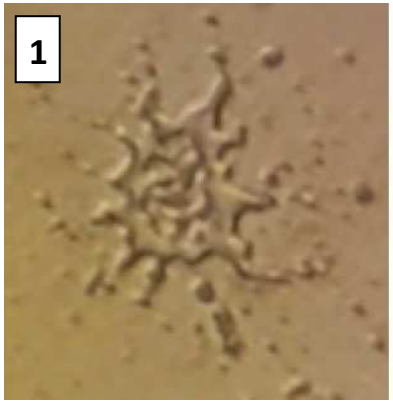
See **Movie 6** : https://www.youtube.com/watch?v=uS6TdPqc_sk

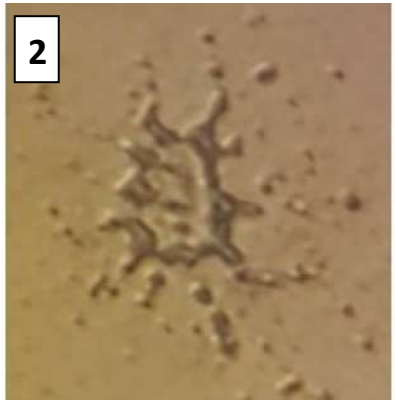
The remaining clusters mainly consist of distilled water, and they are probably surrounded (coated) by thin membranes.
A Raman Spectrum indicated that **peptides, surfactant, polyamides or similar molecules form these membranes**, which surround (coat) these water clusters and keep them stable and durable. The Raman Spectrum also indicated, **Hydroxy-groups & hydroxides (OH-).** The membrane material (fibre material & surfactant (washing powder) ?) probably came from a cotton cloth which I used to clean the container where I stored the distilled water. A very small amount of this material must have contaminated the water !

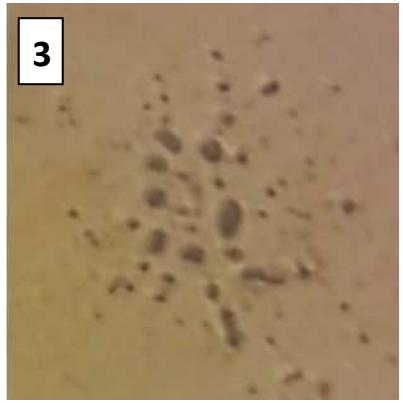
→ **see Raman Spectrum presented in the experiment No. 5 !**

See also infos about charged water here : **Interfacial water**

These three images show the last fraction of a second of the evaporation of the water drop.
The state shown in image 3 is stable and durable and doesn't change anymore







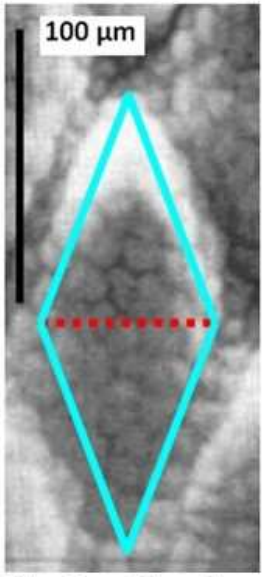
Possible cause of rhombic primordia (Phyllotaxis) in the Sunflower capitulum : Scenario 1

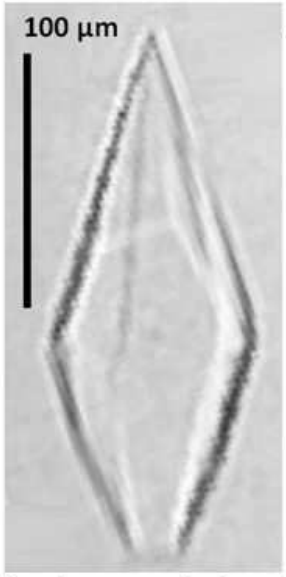
This is a short description of a possible bio-physical mechanism that could produce rhombic (bi-pyramidal) primordia

Water evaporation from the meristem and exposure to radiation of a defined wave-length range (e.g. IR-radiation with >750 nm wave-length) may also play an important role for starting this biophysical mechanism (Phyllotaxis).

The water evaporation and/or the IR-radiation may provide electric charge (electron flow) required for this process.

First Scenario : The rhombic crystals are indeed made of Water-Ice. This means the rhombic or bi-pyramidal crystal would have a **hexagonal crystalline structure** internally, denoted as ice Ih. The three-dimensional crystal structure of H_2O-ice is composed of bases of H_2O ice molecules located on lattice points within a two-dimensional hexagonal space lattice (→ left image). The bi-pyramidal crystal is then formed by hexagonal ice-plates which grow on top of each other, fixed in place by ice-binding-proteins.





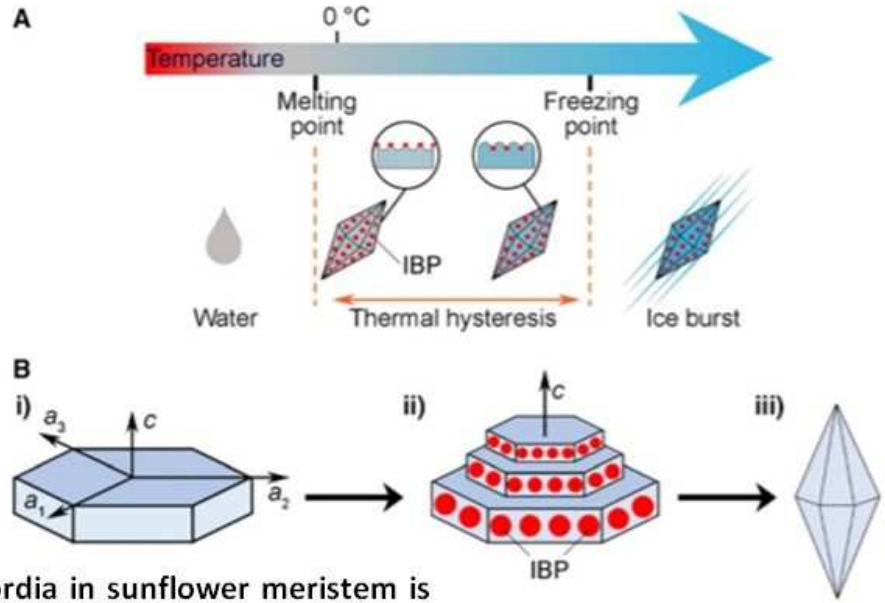


Fig. 1. Activities of IBPs. (A) TH. The adsorption of IBPs to the ice surface induces the lowering of the water freezing point and the raising of the ice melting point. At temperatures below the freezing point, it is possible to observe the growth of ice crystals in an explosive manner (ice burst). (B) Ice shaping. The morphology of ice crystals is strictly related to the ability of an IBP to bind one or more specific ice crystal planes. The hexagonal ice unit (i) is defined with *a* and *c* axes. The basal plane of the ice crystal is coloured blue, while the prismatic planes are light blue. IBPs bound to prismatic planes inhibit ice growth along the *a*-axes (ii), generating hexagonal bipyramid ice crystals (iii). IBPs stabilize small ice crystals and inhibit their growth into larger ones. IBPs are indicated as red spheres.

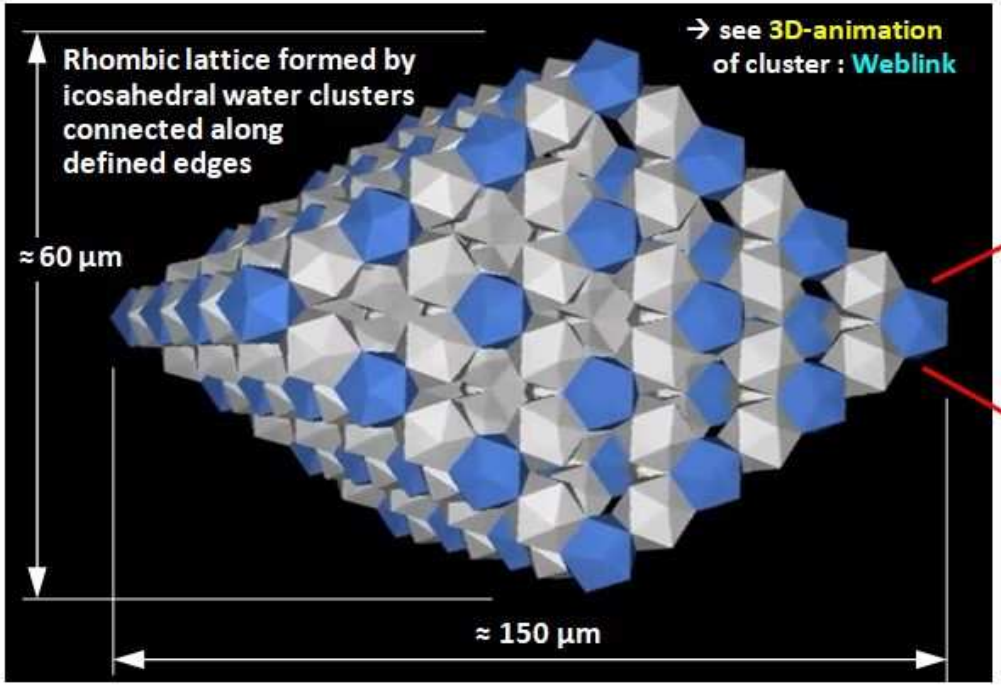
Fig. 2 : **The rhombic shape and size of primordia in sunflower meristem is similar to bi-pyramid water-ice-crystals grown in Ice-binding protein solutions.**

Possible cause of rhombic primordia (Phyllotaxis) in the Sunflower capitulum : Scenario 2

Water evaporation from the meristem and exposure to radiation of a defined wave-length range (e.g. IR-radiation with >750 nm wave-length) may also play an important role for starting this biophysical mechanism (Phyllotaxis). Water evaporation and/or IR-radiation may provide electric charge required for the process

Second Scenario : The rhombic crystal-like structures which form the primordia are caused by a **„Water-Cluster-(Crystal)-lattice“**.

Here we must consider the most stable water-clusters as base units for a large „Water-Cluster-Crystal“ with a multi-level structure as indicated in the images below. The small Pentamer $(H_2O)_5$ and the pancake-shaped $(H_2O)_{25}$ water-clusters, which are both **stable even in the vacuum and up to ≈ 25°C** , are the base elements of the much larger Icosahedral Water-Clusters $(H_2O)_{100}$ and $(H_2O)_{280}$. These stable **Icosahedral-Water Clusters** seem to be able to form thousand-times larger **“Icosahedral Super-Clusters“**, which then may form a **„Rhombic-Super-Water-Cluster Crystal“** as shown below The image on the bottom right shows a **6 µm** cluster of polystyrene particles which probably was formed by $(H_2O)_{100}$ or $(H_2O)_{280}$ Clusters → see **Chapter 11** and **7 : “Magic number colloidal clusters ....“**



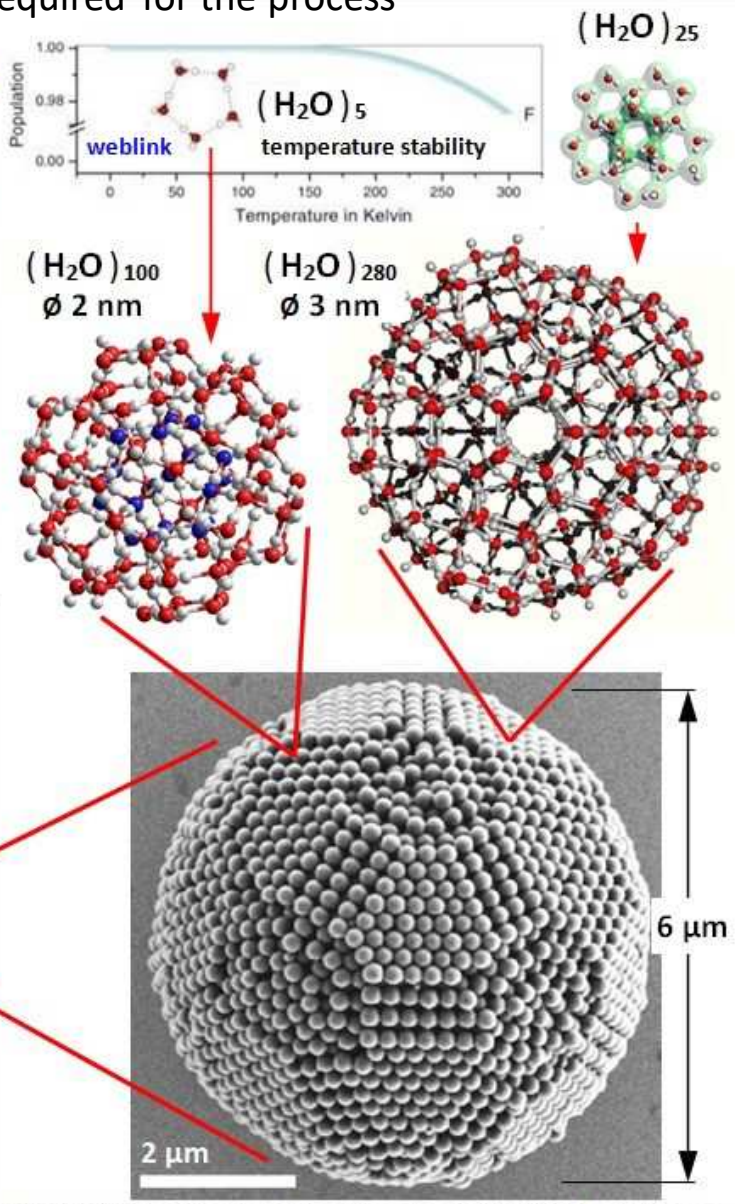


Fig. 3 : An icosahedral Cluster made of spherical Polystyrene particles (Ø240nm), formed during the evaporation of a Water / PS-particle suspension at ~ 5°C (→ Chapter 7 & 11)

Water exposed to high-voltage (electron flow) can form extremely stable „Water Bridges“

The described experiments show that water that is exposed to electron flow behaves completely different in comparison to neutral water. This indicates that water in the micro-scale, exposed to charge and electron flow, will also behave different compared to neutral water !

Weblink to study : https://www.researchgate.net/publication/231015252_The_floating_water_bridge

Abstract :

When high voltage is applied to **distilled water** filled into two glass beakers which are in contact, a stable water connection forms spontaneously, giving the impression of a floating water bridge. A detailed experimental analysis reveals static and dynamic structures as well as heat and mass transfer through this bridge.

Results and Discussion :

Almost no electrolysis was observed and **the bridge did not form**, respectively, was destroyed **when ions were added to the water or if water of higher conductivity was used !!** With glass beakers of 6 cm in diameter, the bridge had a cylindrical form with a diameter of 1 to 3 mm. If the movable beaker was pushed away from the fixed one, the bridge remained intact up to an extension of 25 mm if the voltage was raised to 25 kV (figure 1c).

When the voltage is shut off instantaneously, the surface tension turns the bridge into a series of falling droplets. The bridge is also highly sensitive to additional external electric fields. When an electrostatically charged glass rod was brought close to the bridge, the polar water molecules were aligned due to the inhomogeneous electrostatic field of the surface charges on the rod, resulting in an attractive force between the rod and the bridge. This caused the bridge to bend towards the glass rod forming a water arc. Independent of the length of the bridge, an effective transport of water from one vessel to the other was observed, usually from the anode to the cathode beaker. Generally the direction of mass transport cannot be predicted. The bridge was stable up to 45 minutes but eventually broke down. This is probably due to the heating of the water within the bridge

Figure 1. Water bridge formation: (a) Rise of water in both beakers after a high voltage was applied and a first ignition spark was observed , (b) spontaneous formation of a connection which remains stable after (c) pulling the beakers apart .

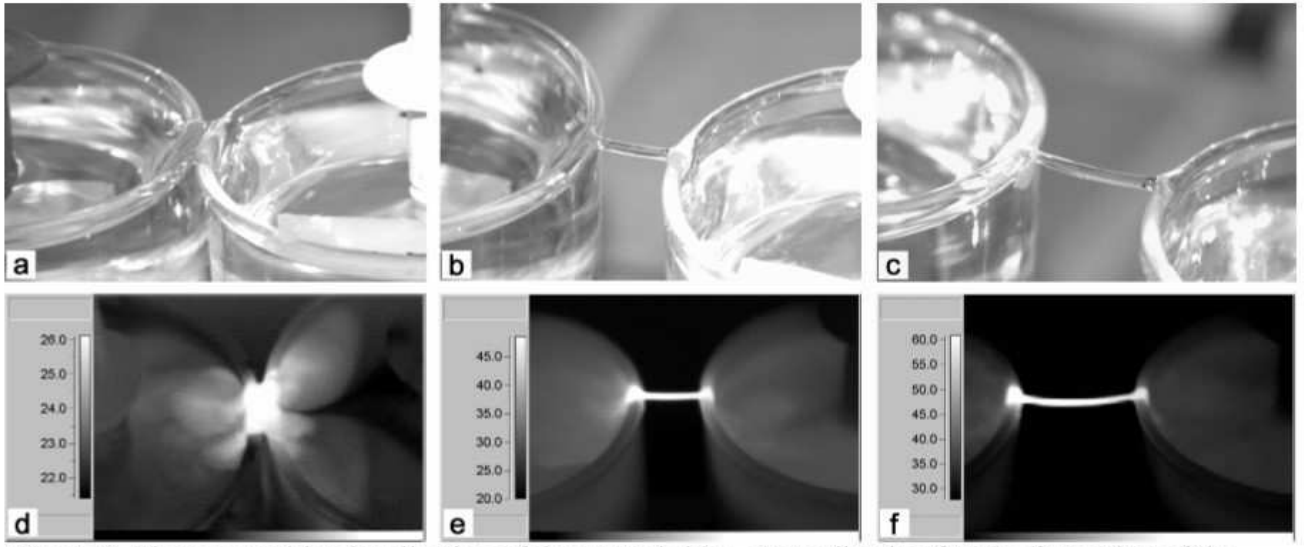


Figure 2. Thermographic visualisation of the water bridge. Immediately after the formation of the bridge (a) a slightly raised temperature (26°C) was observed (d), after 15 minutes of operation and a length of 10 mm (b) a higher temperature (46°C) was measured (e). With a longer, but thinner bridge (c, 15 mm length) the local surface temperature increases up to 60°C with “hot spots” at thinner diameters (f).

Appendix : Phyllotatic-Patterns (Phyllotaxis) visible in Coscinodiscus - Diatoms :

The following images show microscopic photographs of the small micro-algae Coscinodiscus which is a Diatom. Diatoms are a class of unicellular microalgae, found in the oceans, waterways and soils of the world. They exist for ≥ 200 million years in the world's oceans. Individual cells (diatoms) range in size from 2 to 200 micrometers. The shown phyllotactic patterns represent the cellwall of the Coscinodiscus Diatom which is made of Silica : SiO_2 (or more precise hydrated silicon dioxide). → The Images which all show **phyllotactic patterns** are from different Coscinodiscus Species.

Diatoms may be the plant ancestor that first developed phyllotactic patterns (Phyllotaxis) ! Therefore a microscopic live-observation of the dynamic formation of the phyllotactic patterns in Diatoms may solve the Phyllotaxis Mystery ! Because only few Coscinodiscus Diatoms show real phyllotactic patterns, far-red- or IR-radiation may be required for the formation of a perfect phyllotactic pattern, and diatoms may have to be close to the water-surface in this process !

Weblink 2

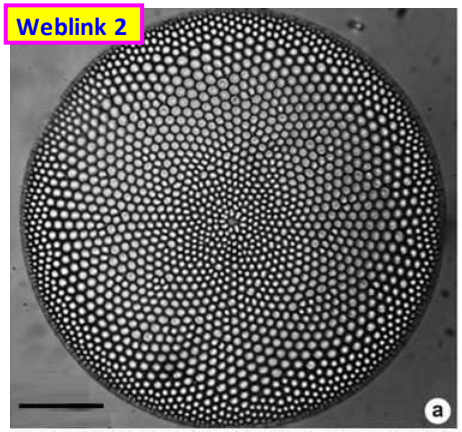
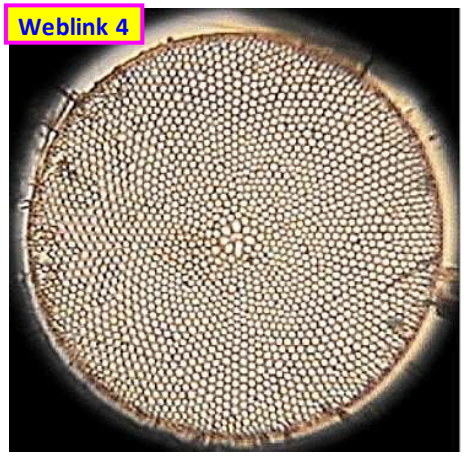


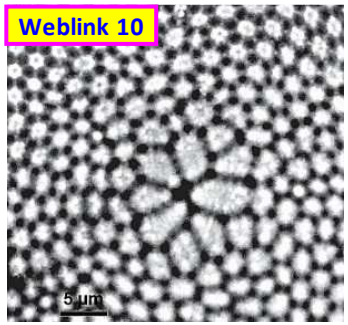
Figure a epilithic diatom flora of the Cali River basin, Colombia - a. *Coscinodiscus kurzii*; Scales: 30 µm.

Weblink 3

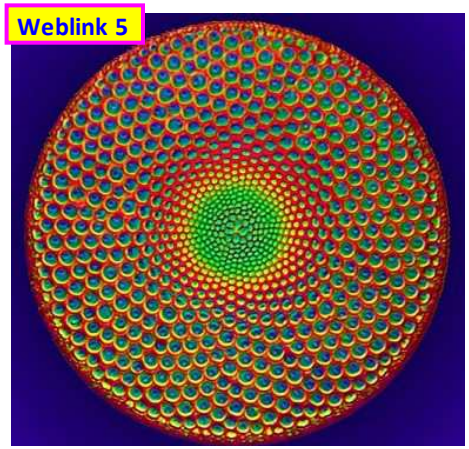
Weblink 4



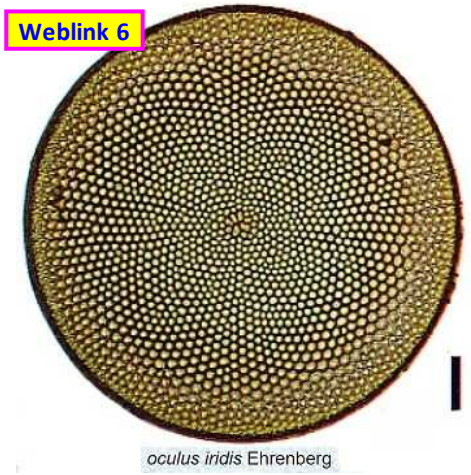
Weblink 10



Weblink 5

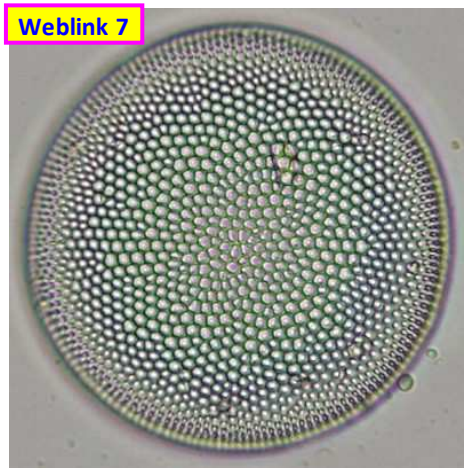


Weblink 6



oculus iridis Ehrenberg

Weblink 7



Weblink 11