

Scientific Creativity Live

4 experiments, 8 ways of knowing



8 ways

faith

reason

intuition

imagination

language

sense perception

memory

emotion

4 experiments

1. Searching for sun spots

using secondary data

2. Engineering a water wheel

solving problems

3. Colourful beetles

transferring knowledge

4. Osmosis

experiments in silico



IB AFRICA, EUROPE & MIDDLE EAST
REGIONAL CONFERENCE 2014
ROME • 16–19 OCTOBER

SEARCHING FOR SUNSPOTS USING SECONDARY DATA



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REGIONAL CONFERENCE 2014

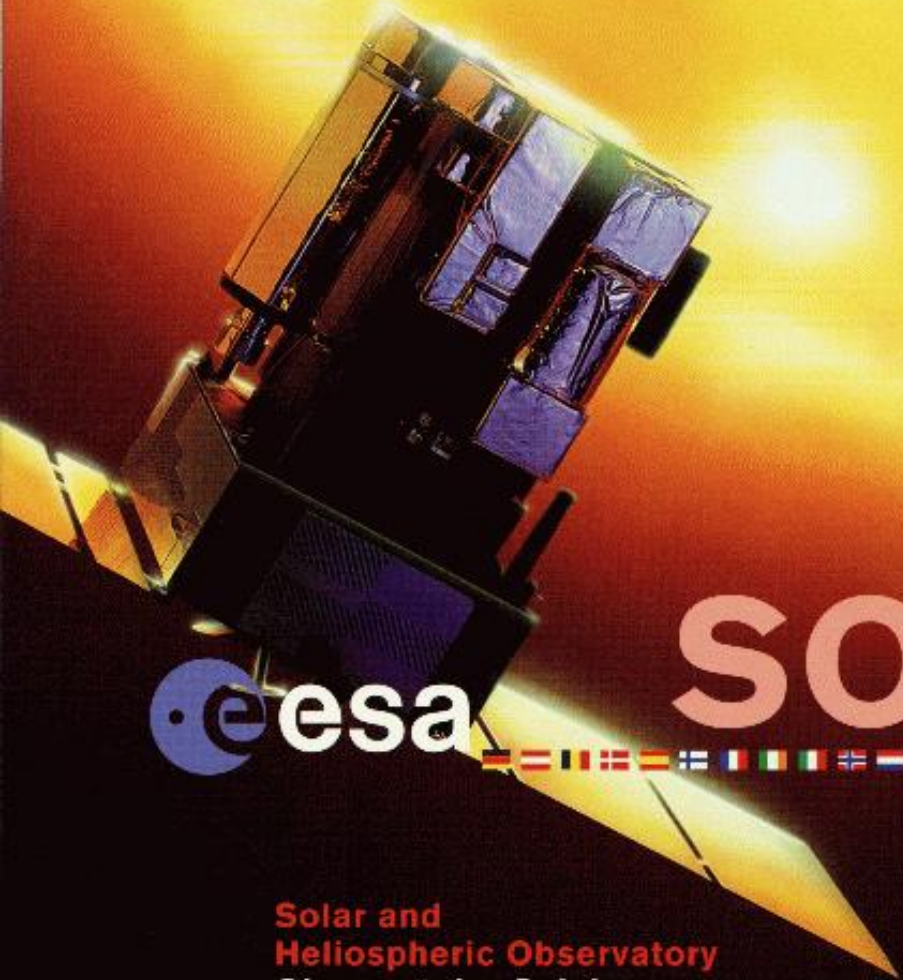
ROME • 16-19 OCTOBER

SEARCHING FOR SUNSPOTS



SEARCHING FOR SUNSPOTS

SOHO is a project of
international cooperation
between ESA and NASA.

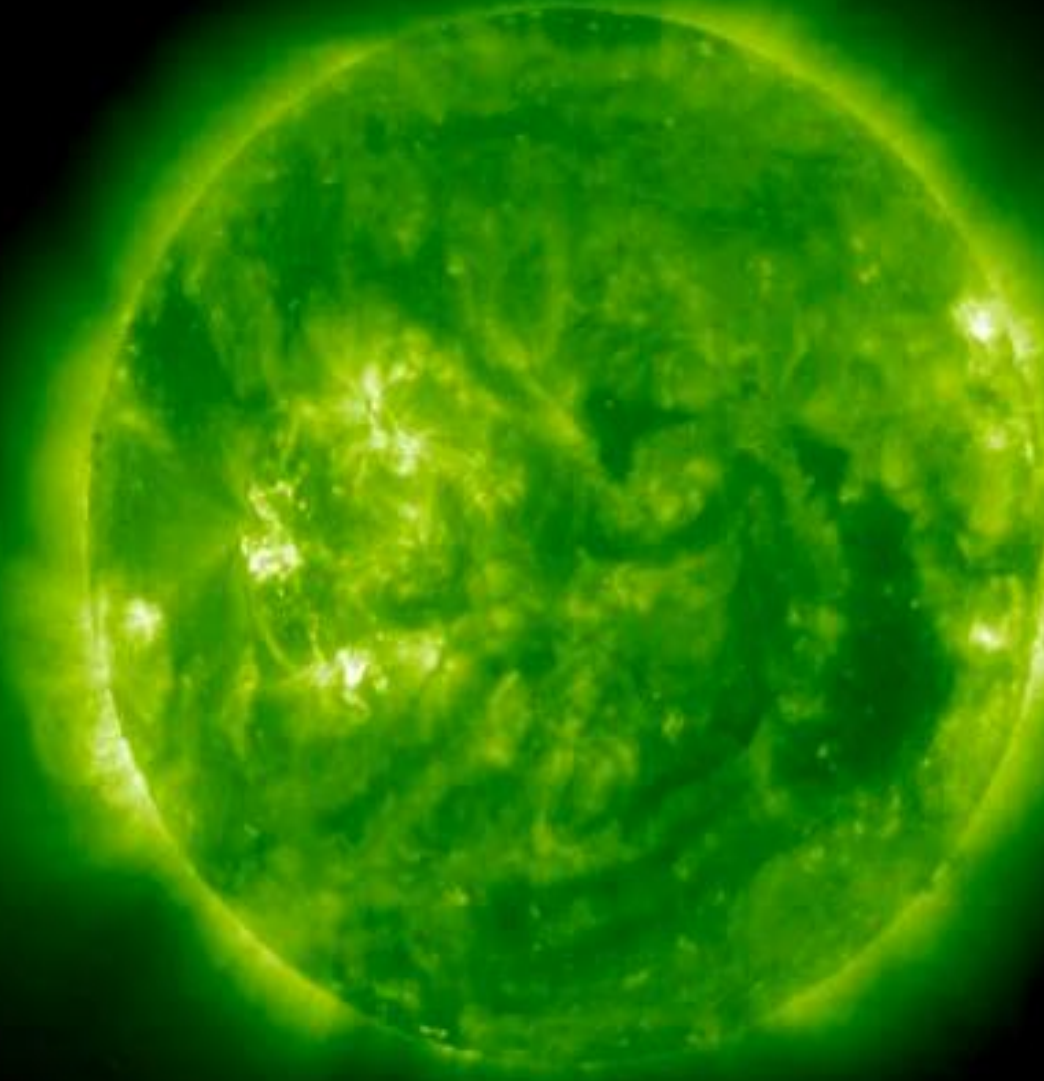


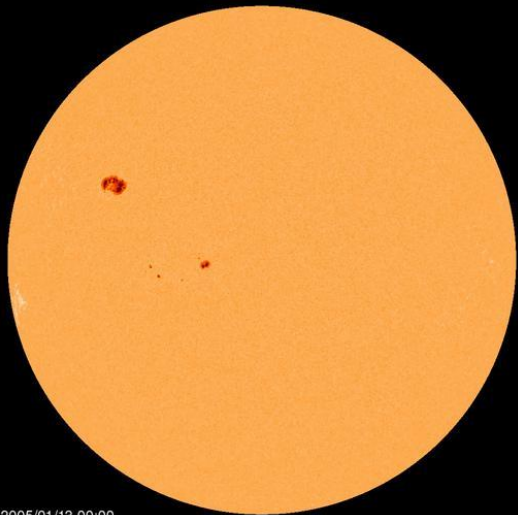
SOHO

**Solar and
Heliospheric Observatory**
Observatoire Solaire
et Héliosphérique

SEARCHING FOR SUNSPOTS

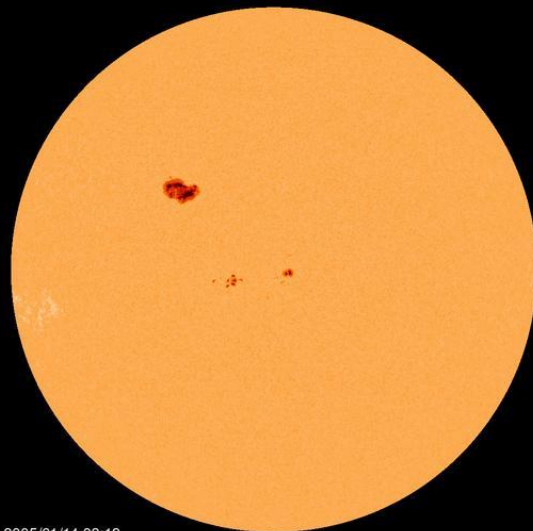
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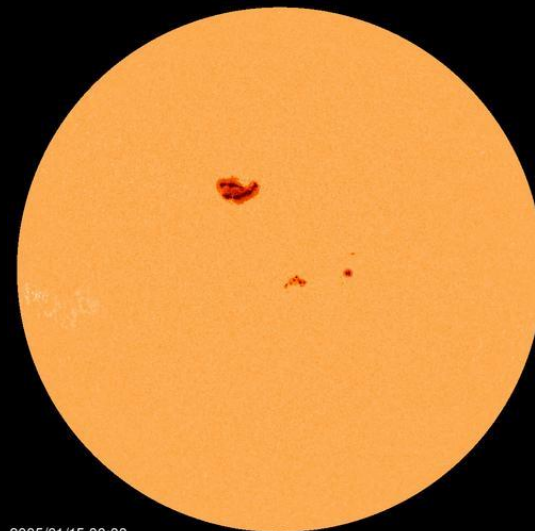
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13 Jan 2005



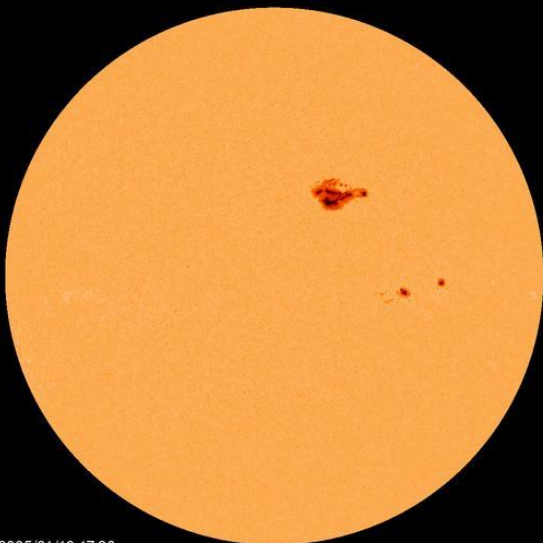
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14 Jan



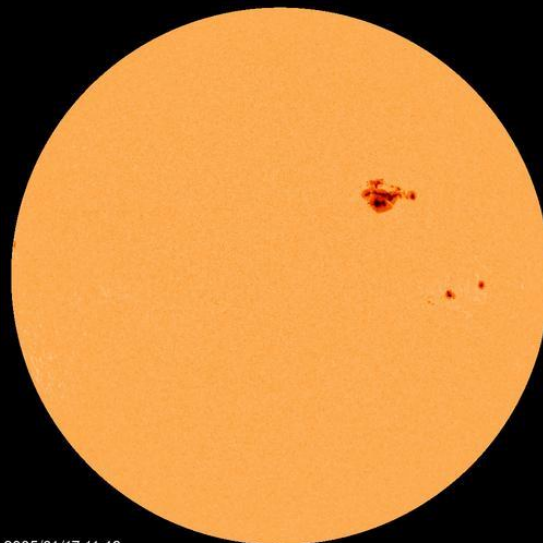
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15 Jan



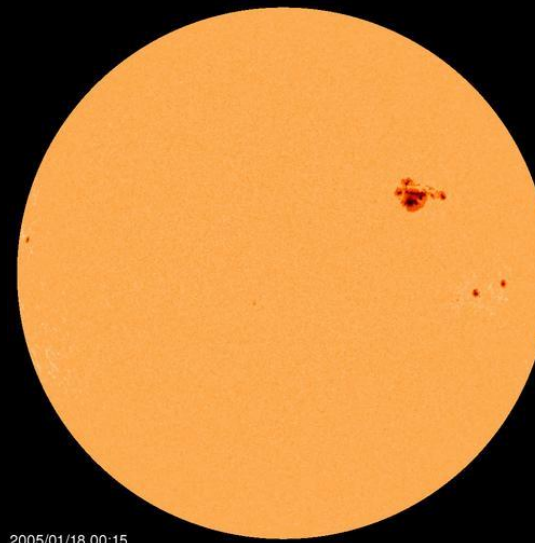
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16 Jan



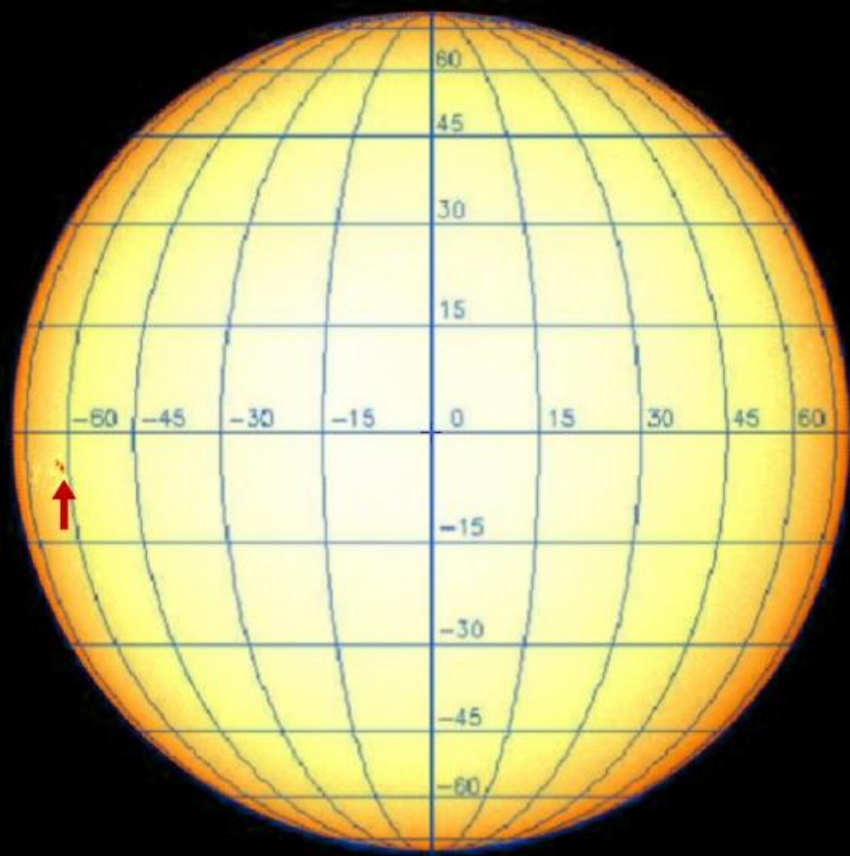
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17 Jan

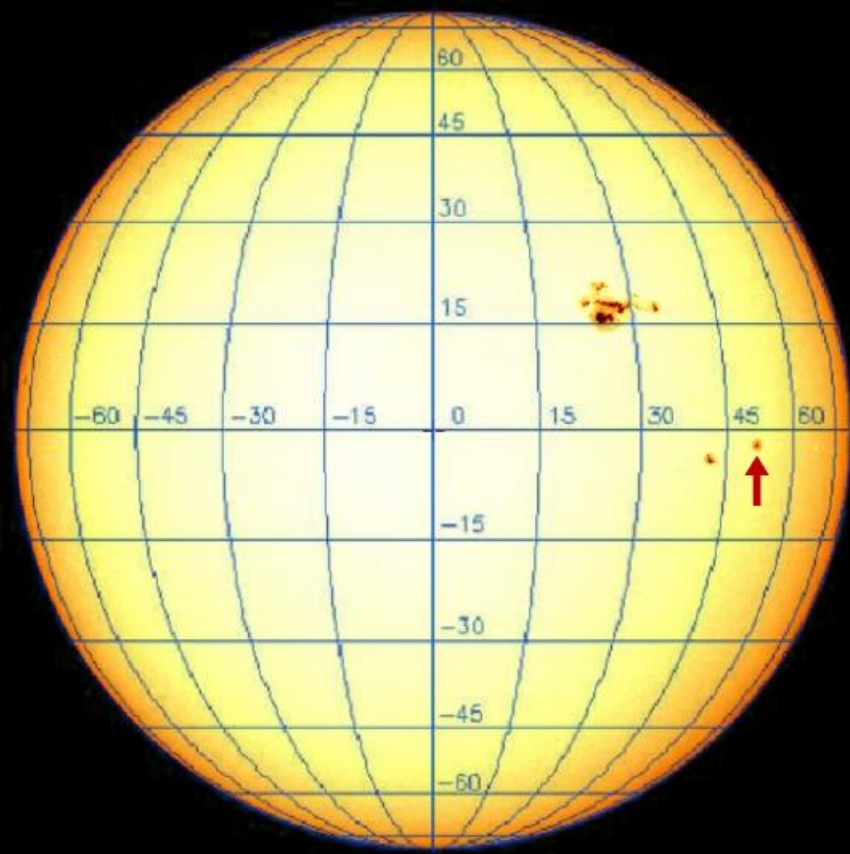


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18 Jan



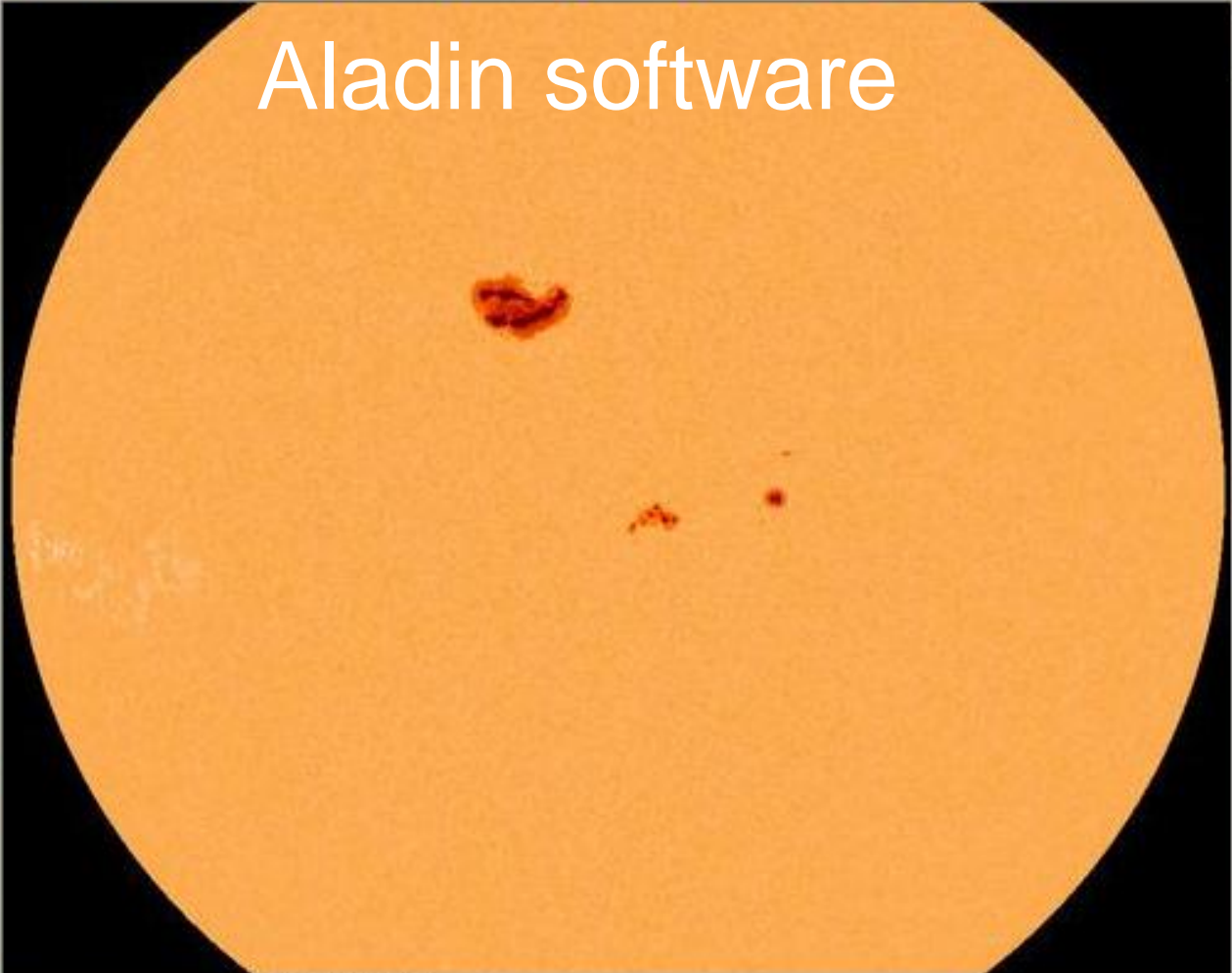
2005/01/09 06:24



2005/01/17 16:00



Aladin software



- select
- pan
- dist
- phot
- draw
- tag
- filter
- cross
- xy
- rgb
- assoc
- crop
- cont
- pixel
- prop
- del

Imagine your eye looking through a stack of planes.

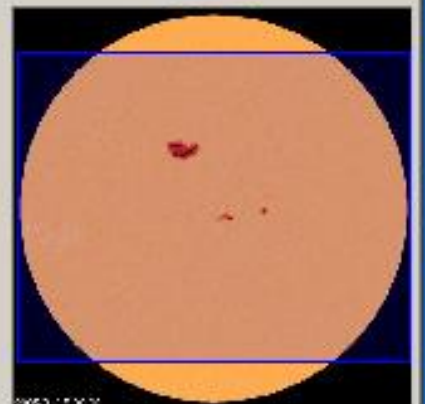
23-20050115_000

epoch

size

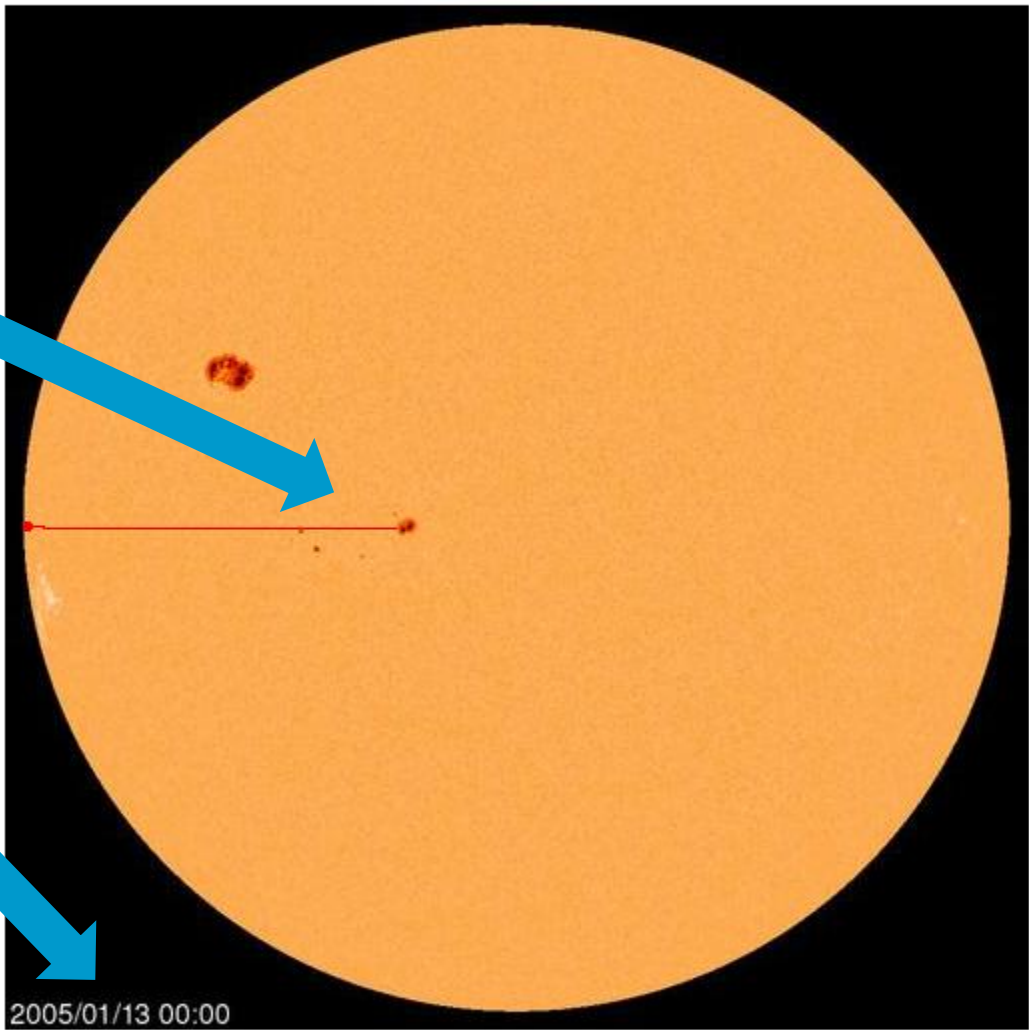
opac

zoom

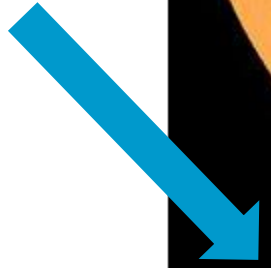
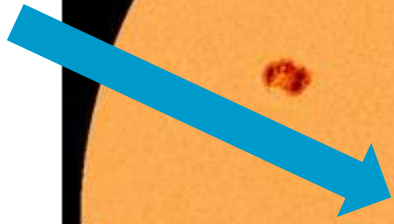


Location 200 269

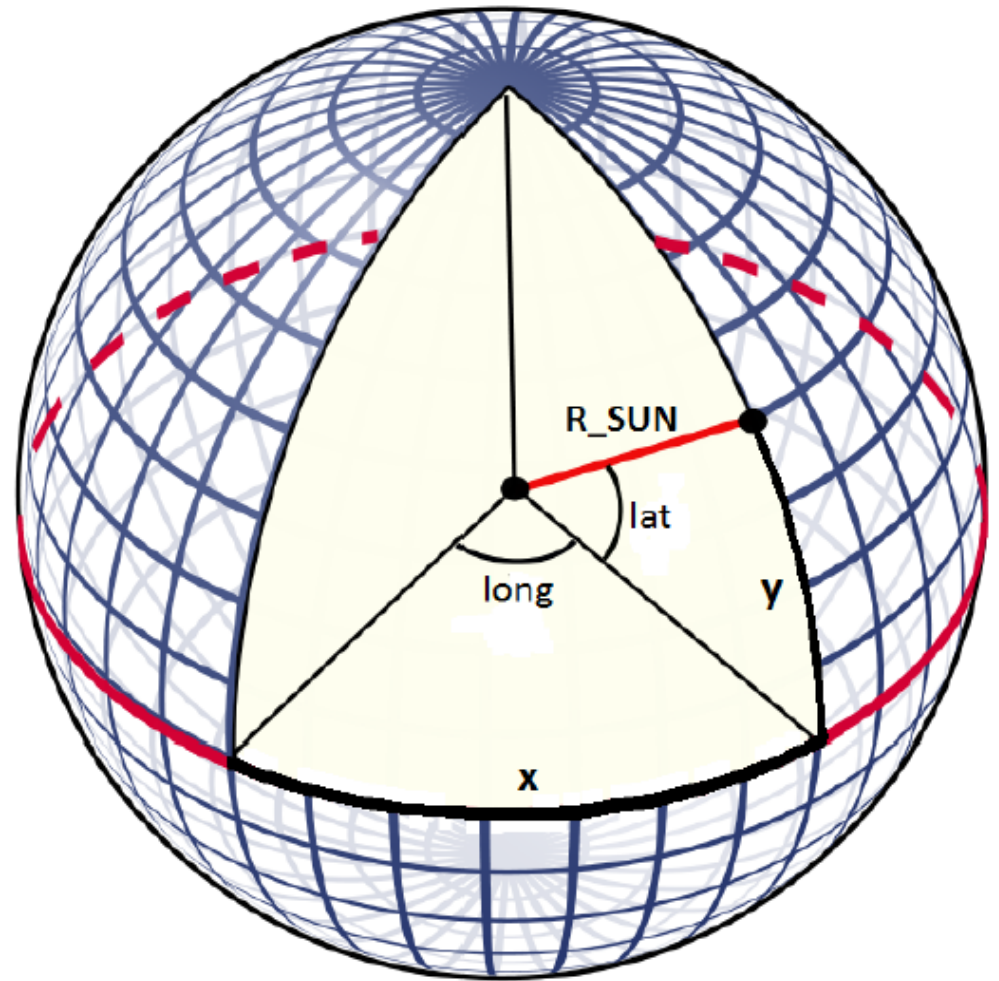
DSS SDSS 2MASS IISE GALEX PLANCK XMM Fermi Simbad NED +



Pixel location gives position
Clock data gives time data



Tracking sunspots in 3 dimensions





**ENGINEERING
DESIGN
GROUP 4 PROJECT
MAY 2014: WATER**



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**This is
Water
Wheel
Mark 4
(WW4)**



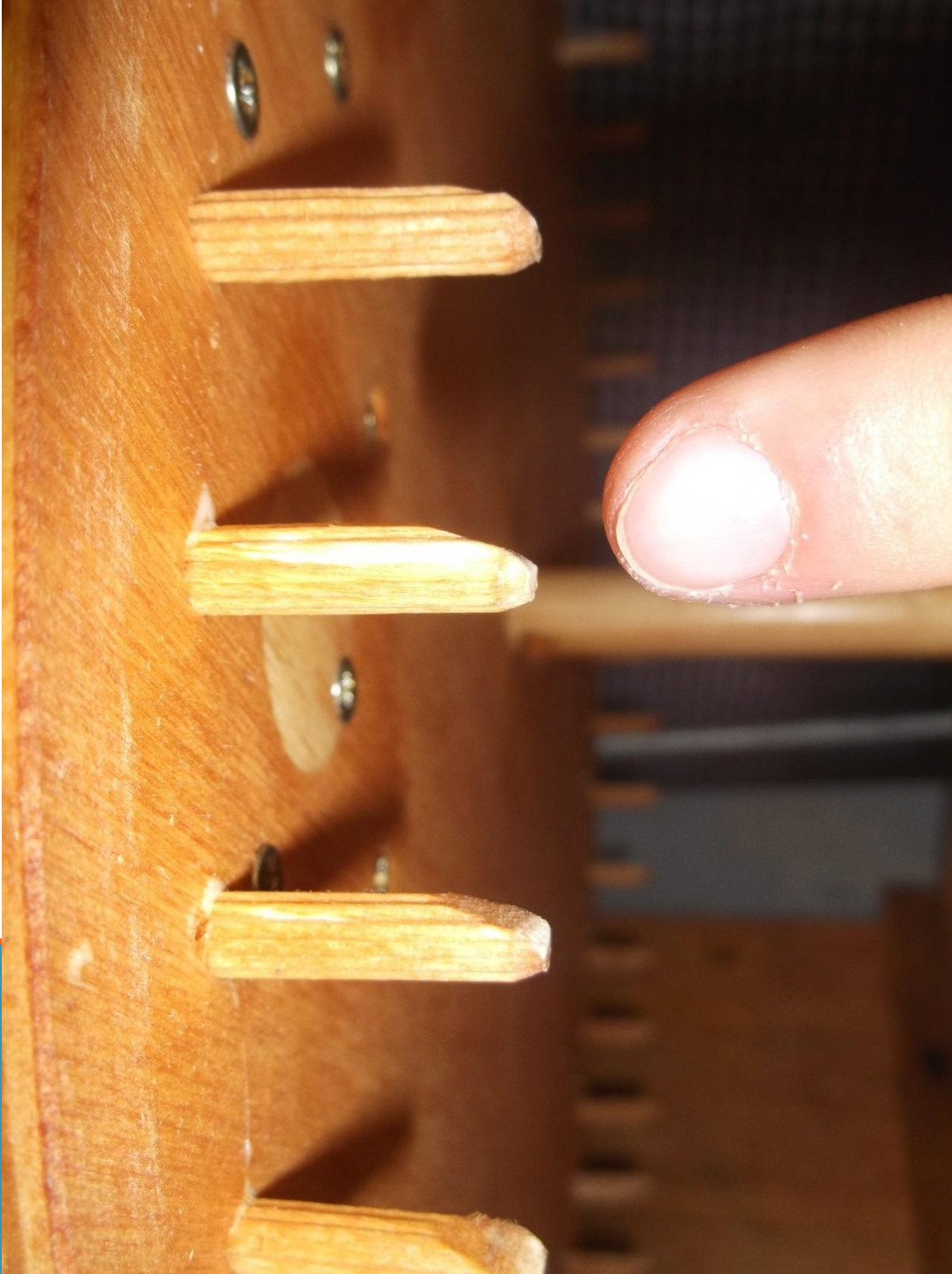
Water Wheel 1



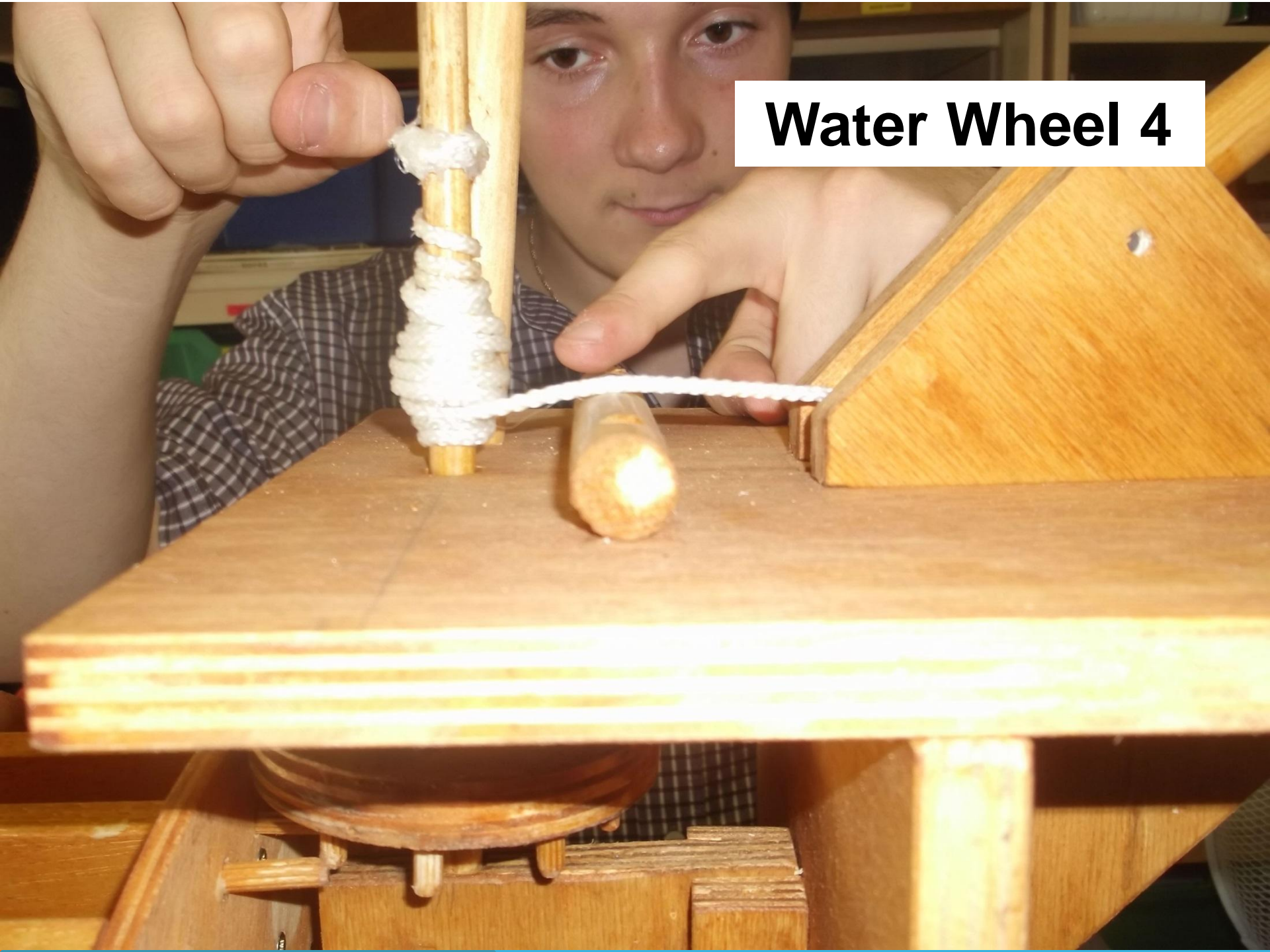
Water Wheel 2

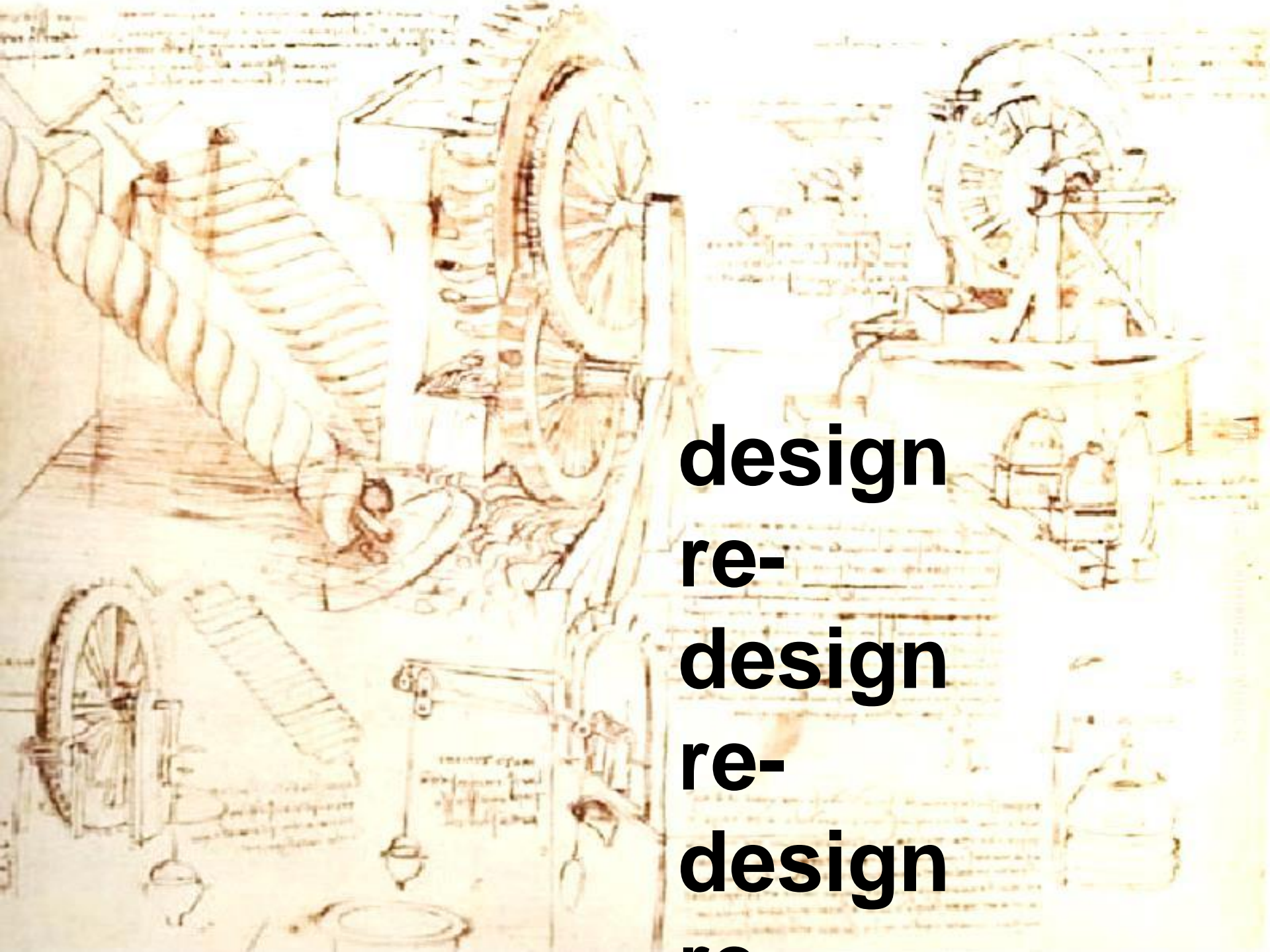


Water Wheel 3



Water Wheel 4





**design
re-
design
re-
design**

**COLOURFUL
BEETLES**

**BIOLOGY MEETS
PHYSICS**



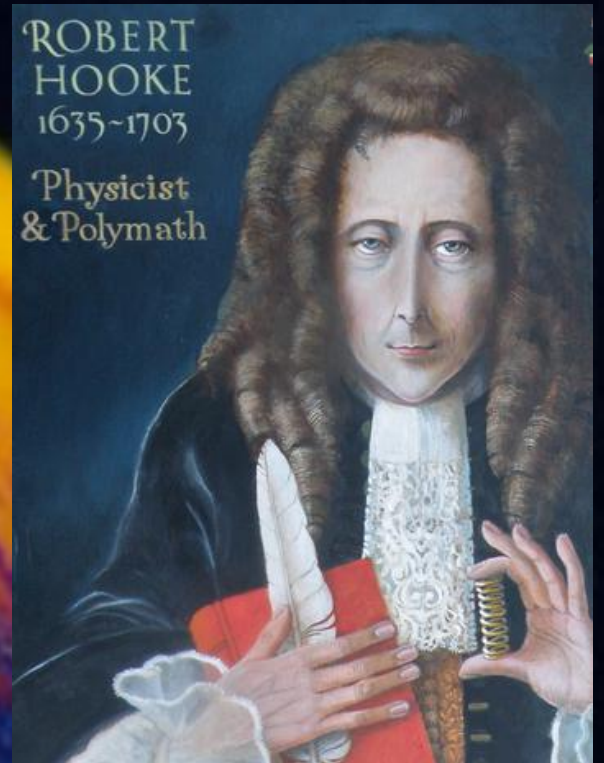
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COLOURFUL BEETLES

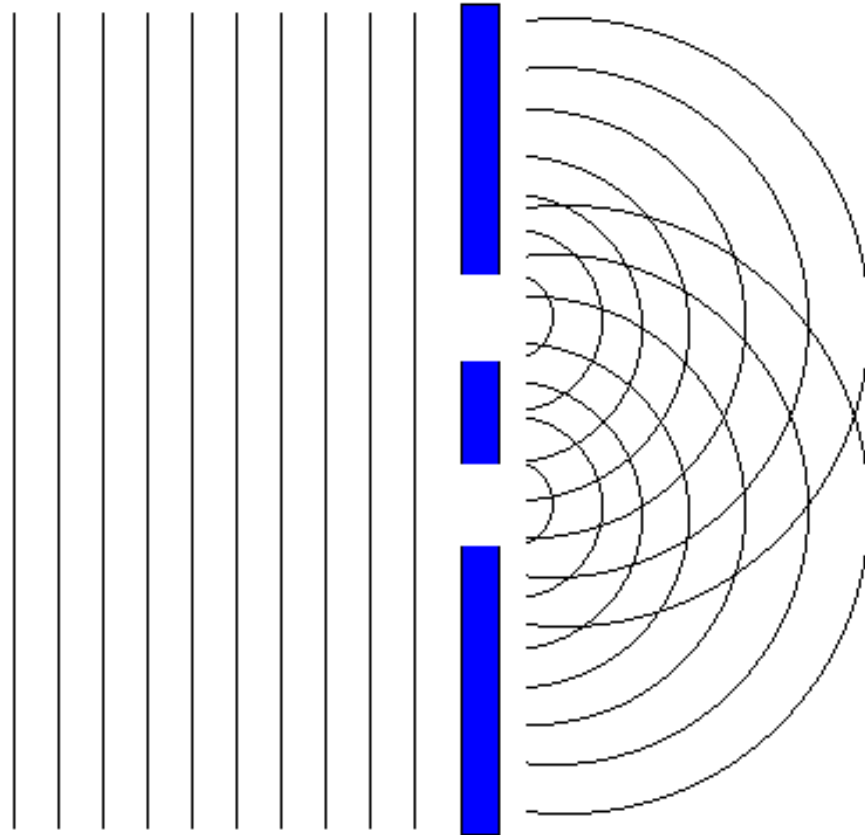


ROBERT
HOOKE
1635-1703
Physicist
& Polymath



COLOURFUL BEETLES

Interference

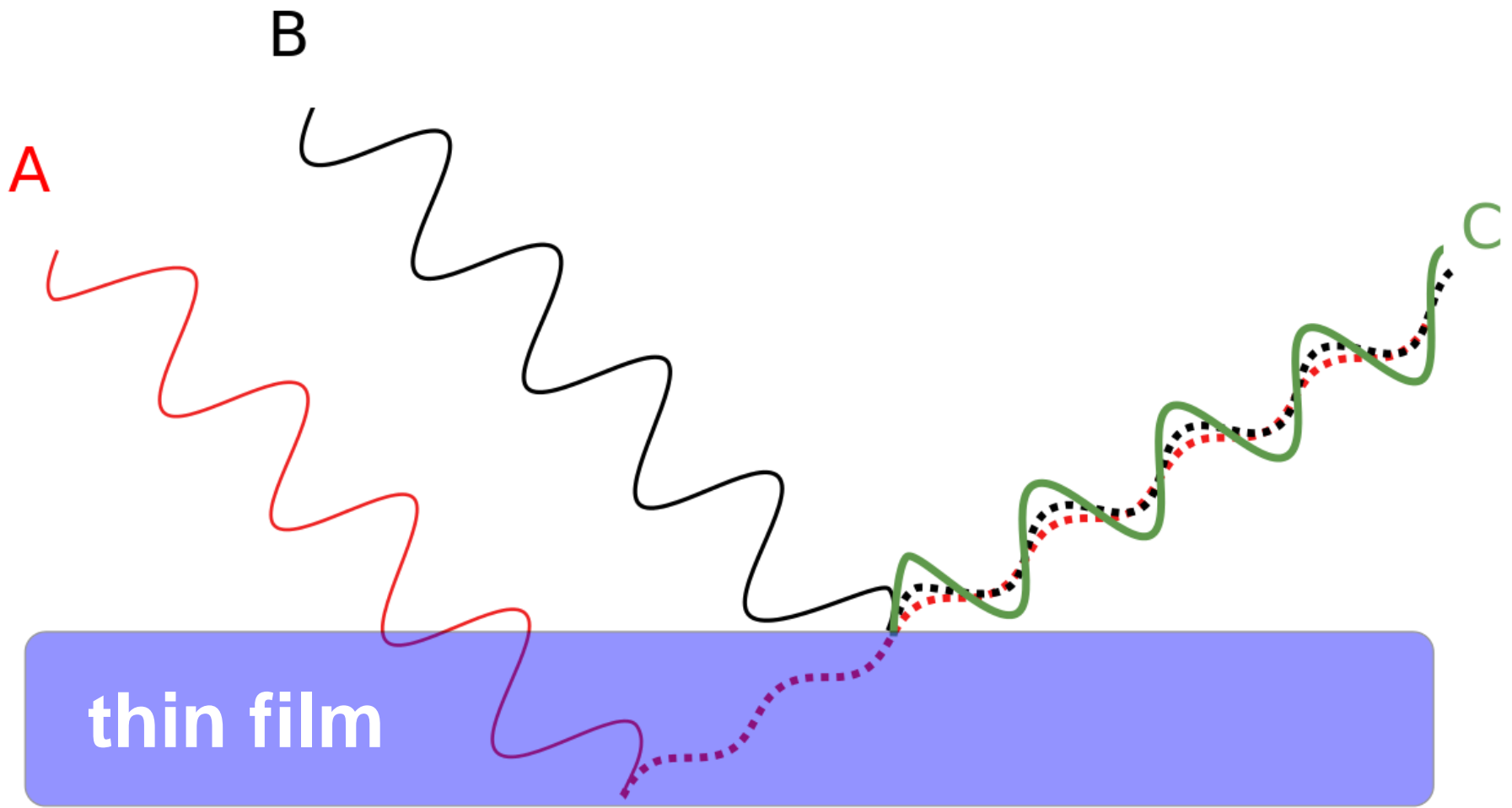


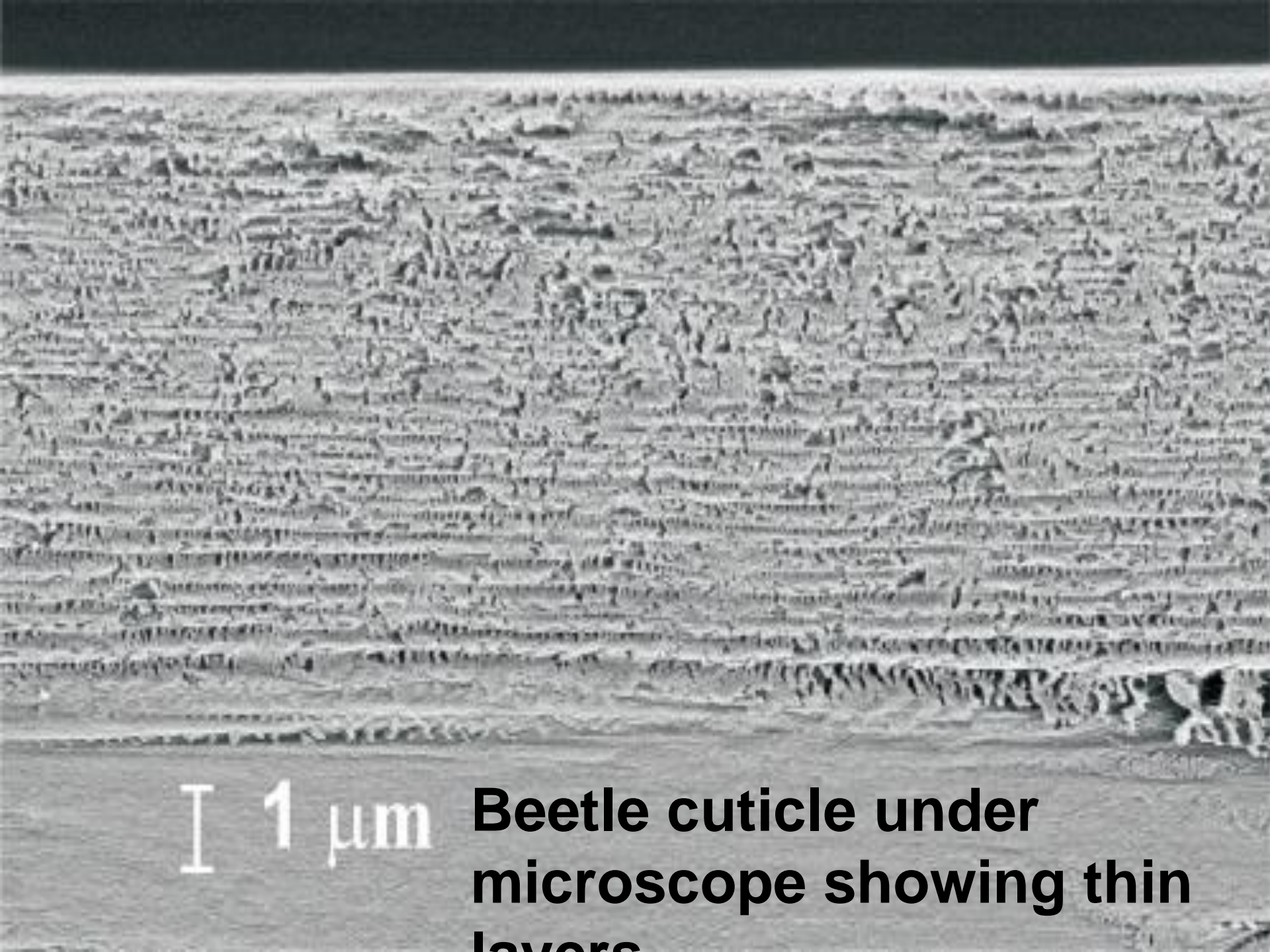
light waves

barrier



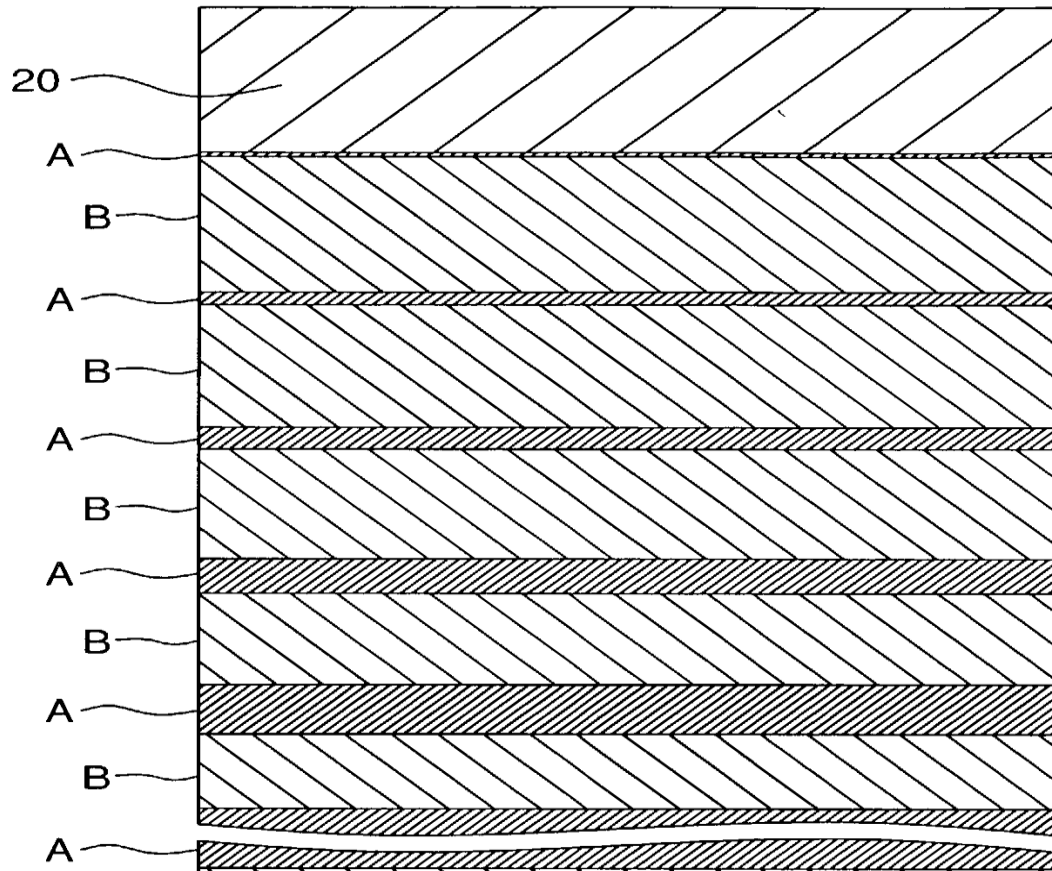
interference
pattern



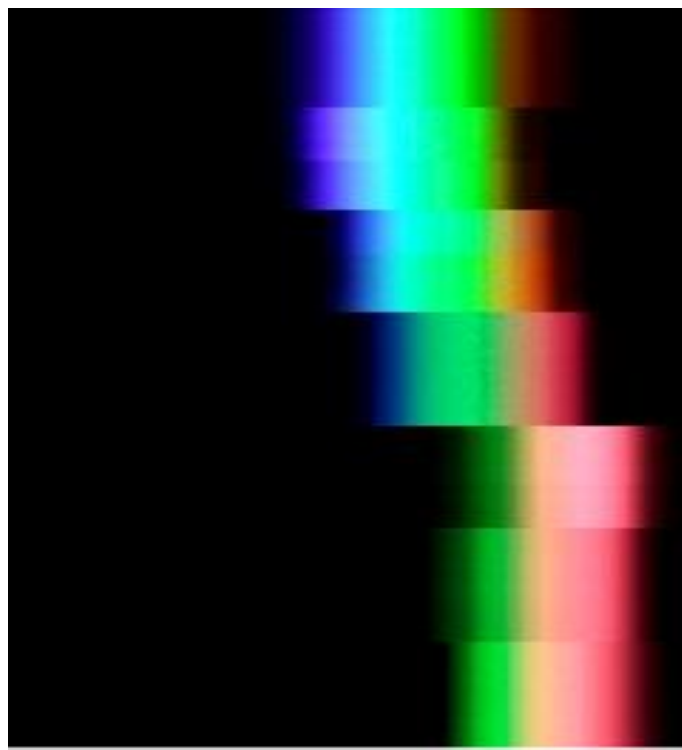
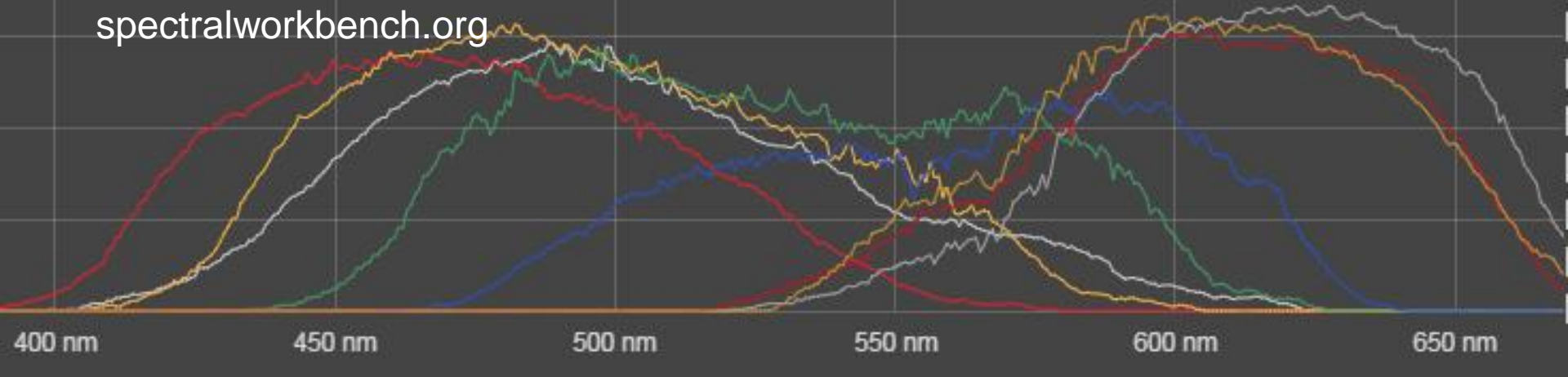


I 1 μm

**Beetle cuticle under
microscope showing thin
layers**



**Structure of
my plastic
film
showing
thin layers**



**Angle 80
deg**

**Angle 70
deg**

**Angle 60
deg**

**Angle 50
deg**

**Angle 40
deg**

**Angle 30
deg**

COLOURFUL BEETLES



OSMOSIS IN SILICO

USING SIMULATED EXPERIMENTS



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**lettuce leaf
before immersion**

**lettuce leaf
immersed in
water for 3 hours**



A simple simulation

Membrane Channels (1.00)

File Help

Membrane

Leakage Channels

Gated Channels

PHET

Open Channels

Close Channels

Clear Particles

Show Concentrations

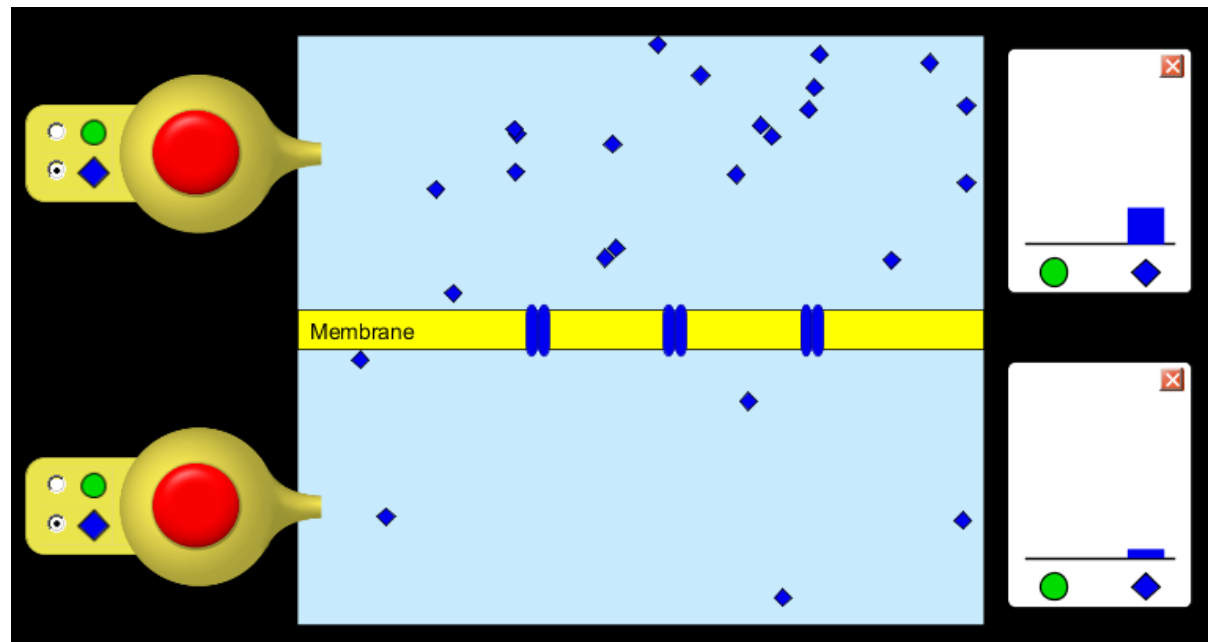
Reset All

DIFFUSION EXPERIMENT

Start:

20 particles above

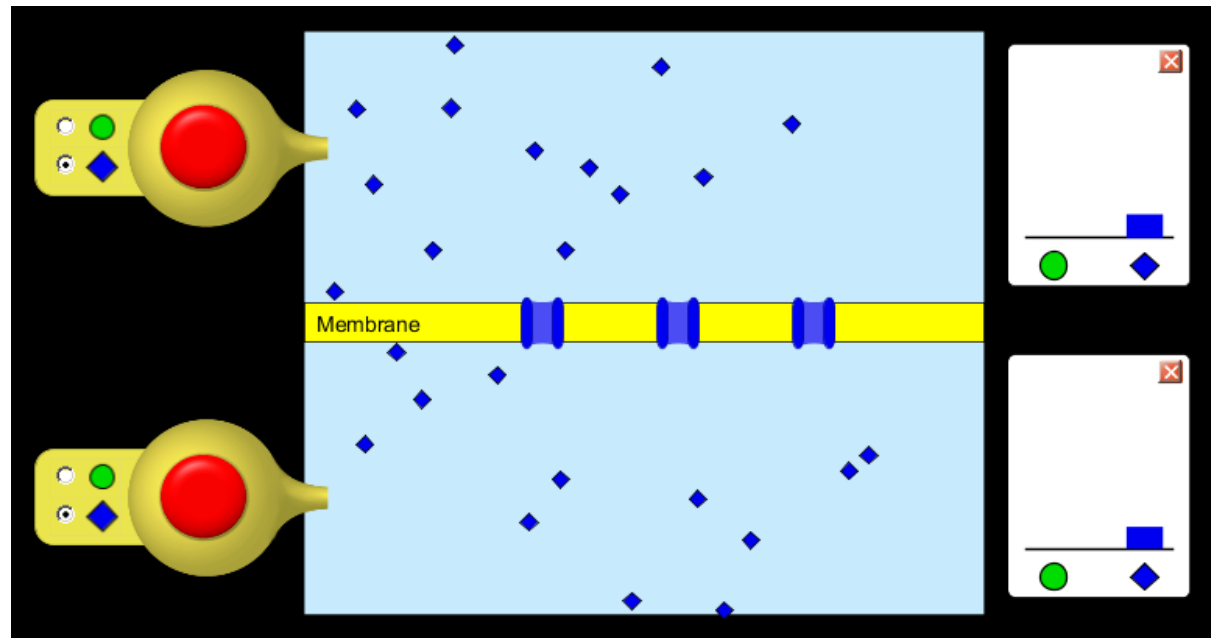
5 particles below



Finish:

13 particles
above

12 particles
below

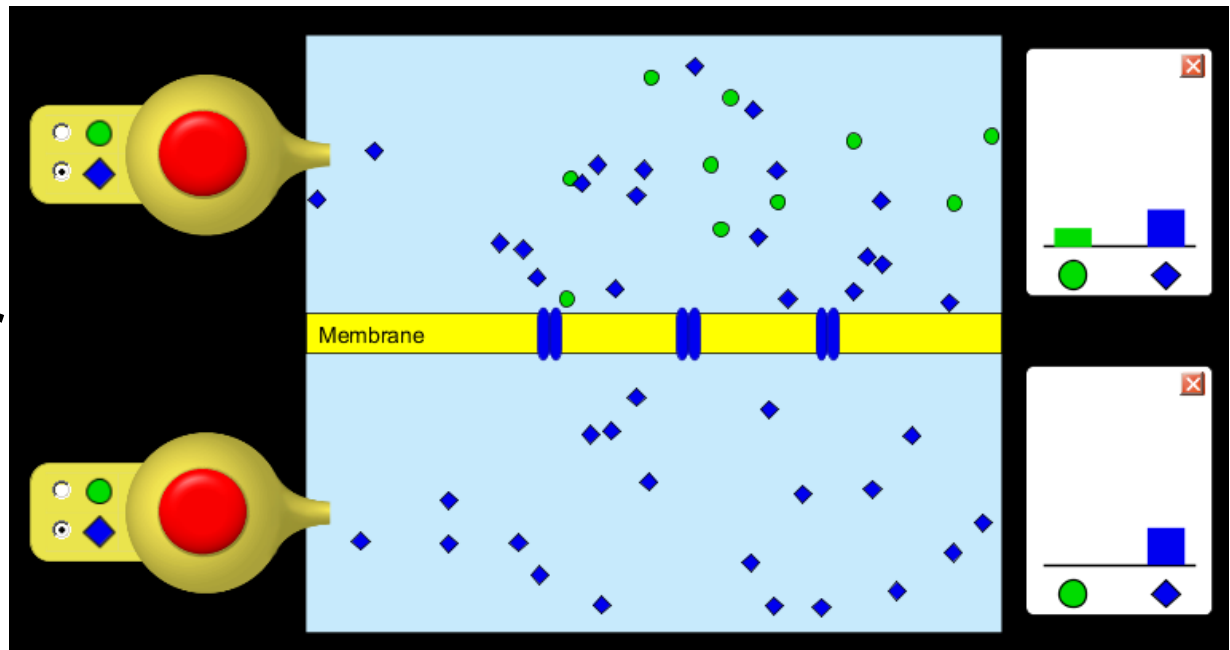


OSMOSIS EXPERIMENT

Start:

20 water, 10 sugar
above

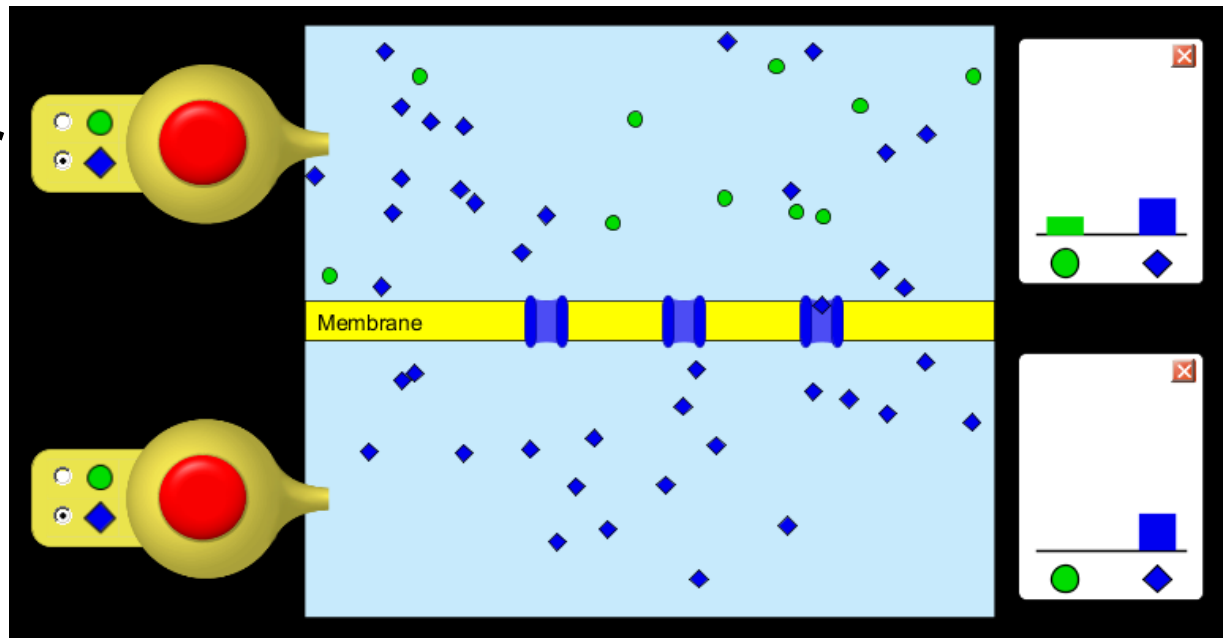
20 water below



Finish:

19 water, 10 sugar
above

20 water below



Edit Delete Add

abc Button | normal speed | view updates | on ticks | Settings

A more sophisticated simulation

Take the slider below and adjust the simulation speed until movements are smooth.

setup

start / stop

osmolarity_left 6.00 | osmolarity_right 2.00

initial characteristics of solutions given the osmolarities (solute = glucose)

solute / liter solution [g] left 1080	solute / liter solution [g] right 360
water / liter solution [g] left 317.2	water / liter solution [g] right 772.4
weight per liter solution [g] left 1397.2	weight per liter solution [g] right 1132.4
density [g/cm3] left 1.4	density [g/cm3] right 1.13
weight percentage solutes left 77.3	weight percentage solutes right 31.8
molecule ratio water : solute left 2.9	molecule ratio water : solute right 21.5

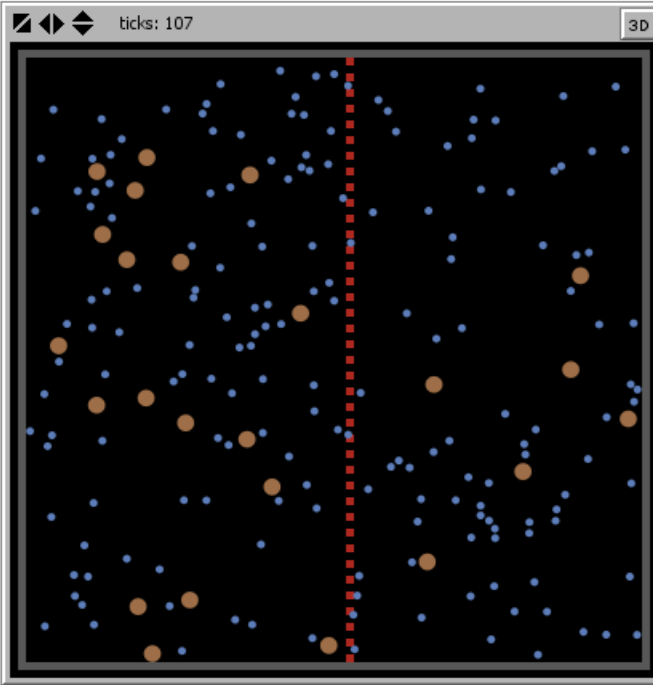
number_dissolved_particles_left
18

number_water_molecules_left
101

water_concentration_left*
0.849

*) "water concentration" means the mole fraction of water

On
 Off membrane-arrested?



number_dissolved_particles_right
6

number_water_molecules_right
81

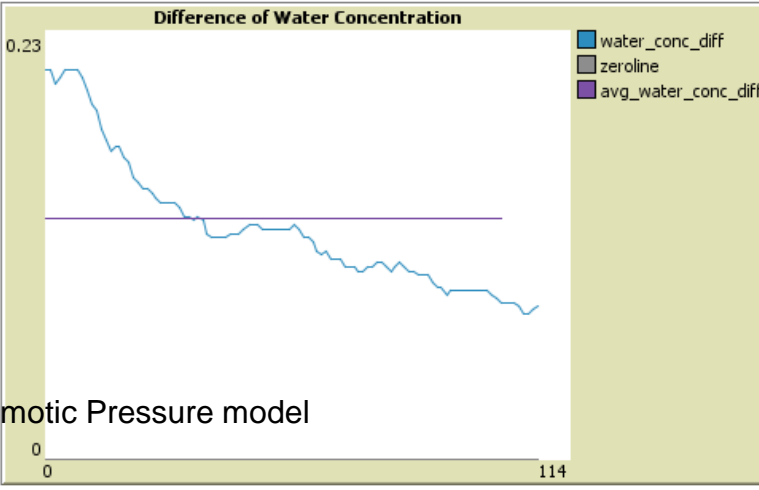
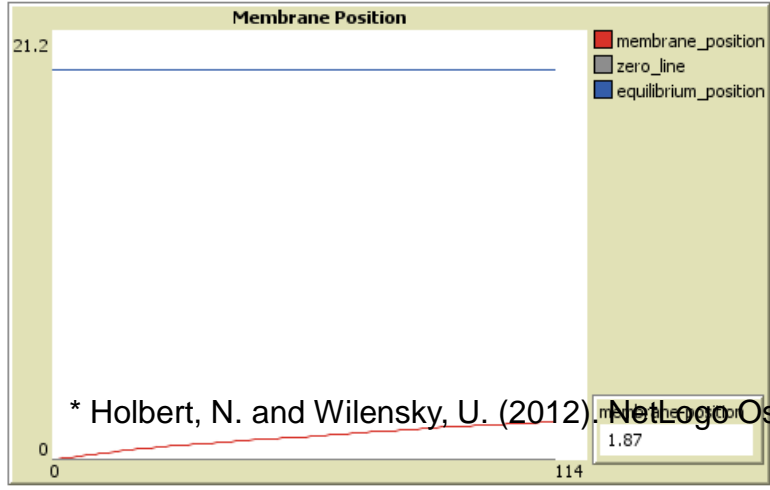
water_concentration_right*
0.931

start / stop traces

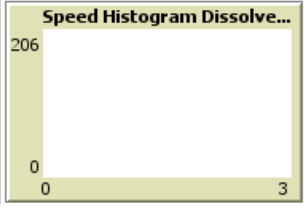
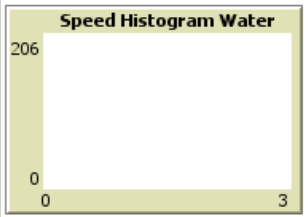
clear traces

average "speed" of osmosis**
0

** distance of membrane walk after 1000 time ticks



On
 Off see_speed_histograms



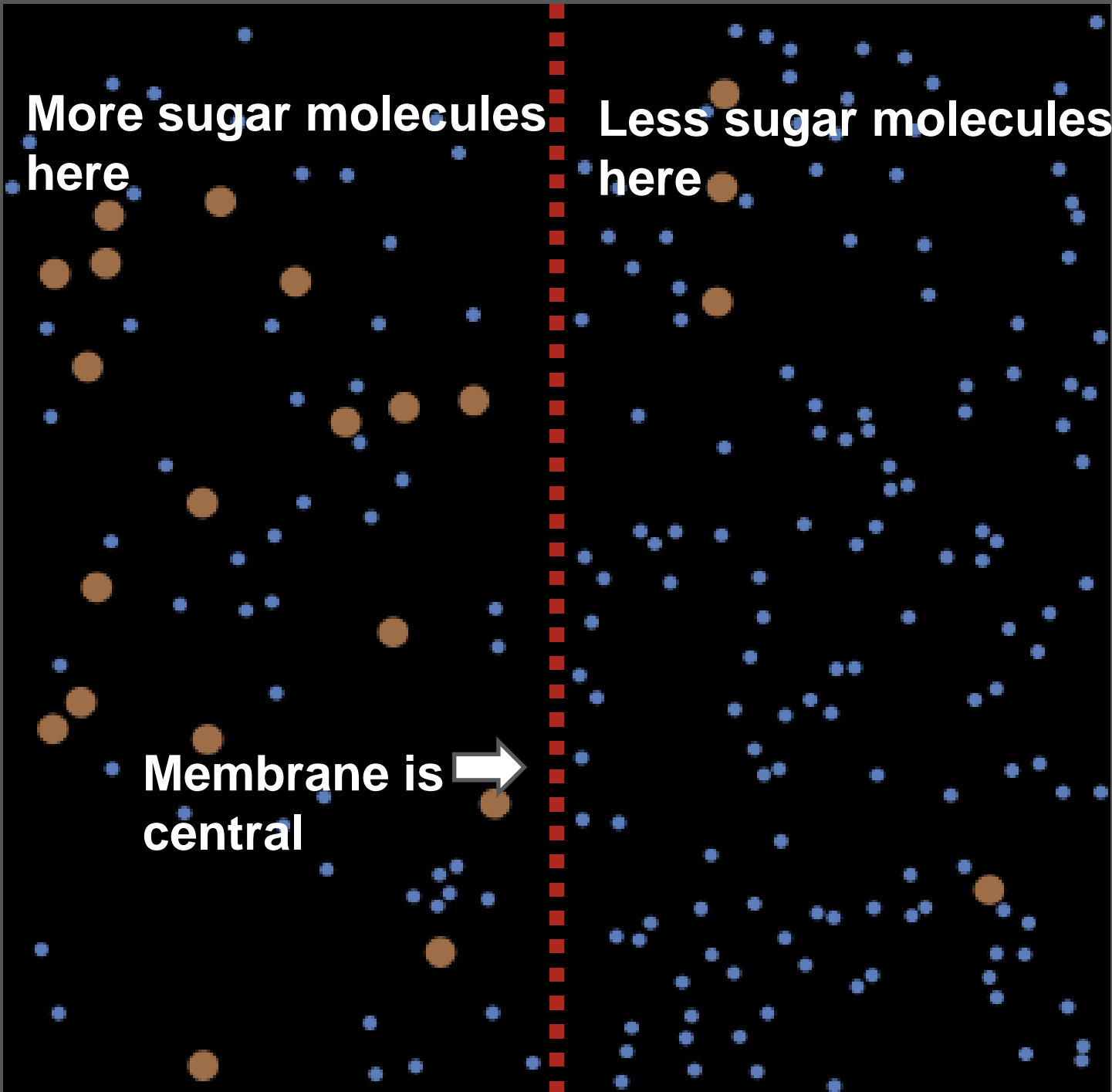
* Holbert, N. and Wilensky, U. (2012) NetLogo Osmotic Pressure model

Start

**More sugar molecules
here**

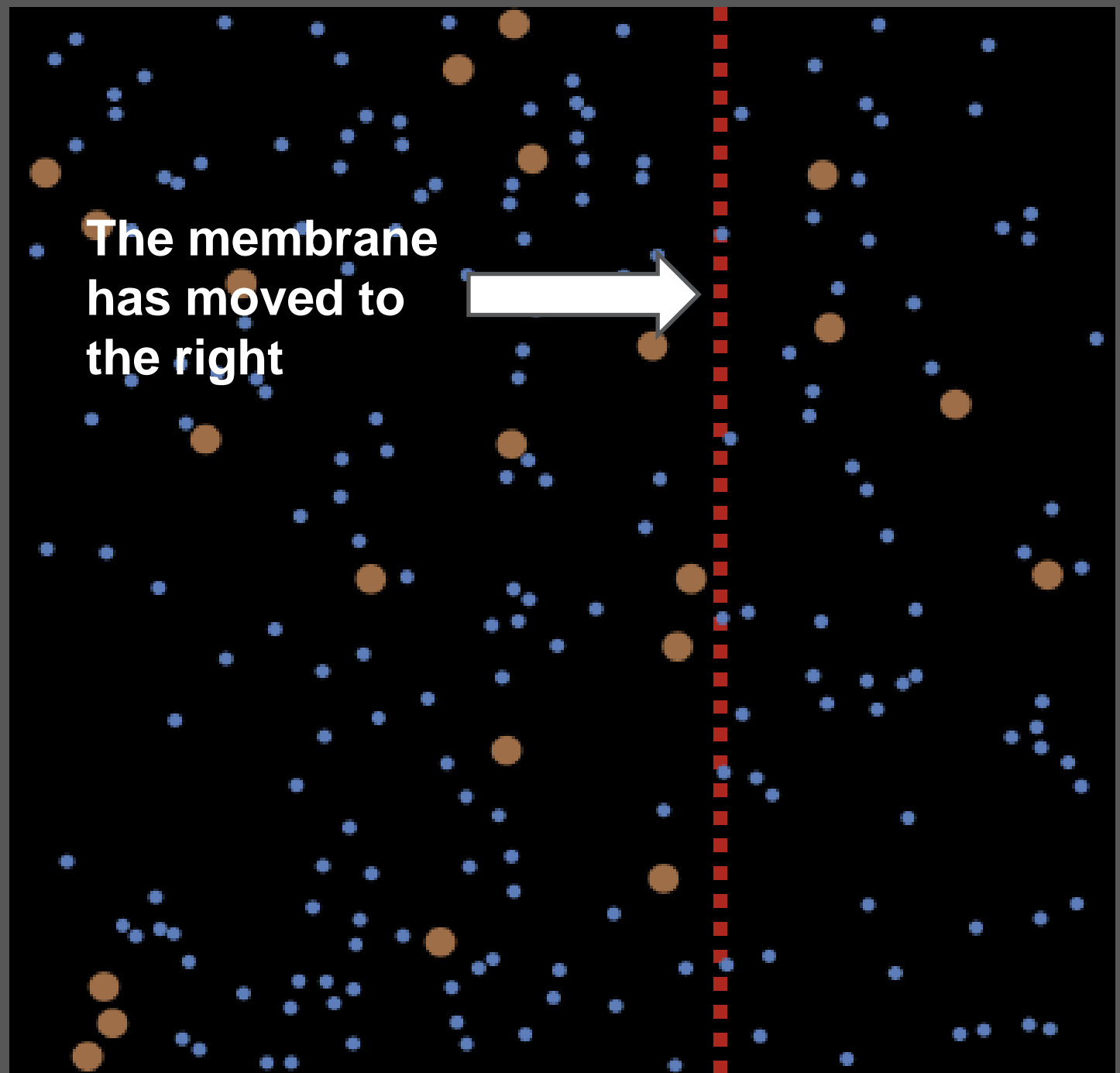
**Less sugar molecules
here**

**Membrane is →
central**



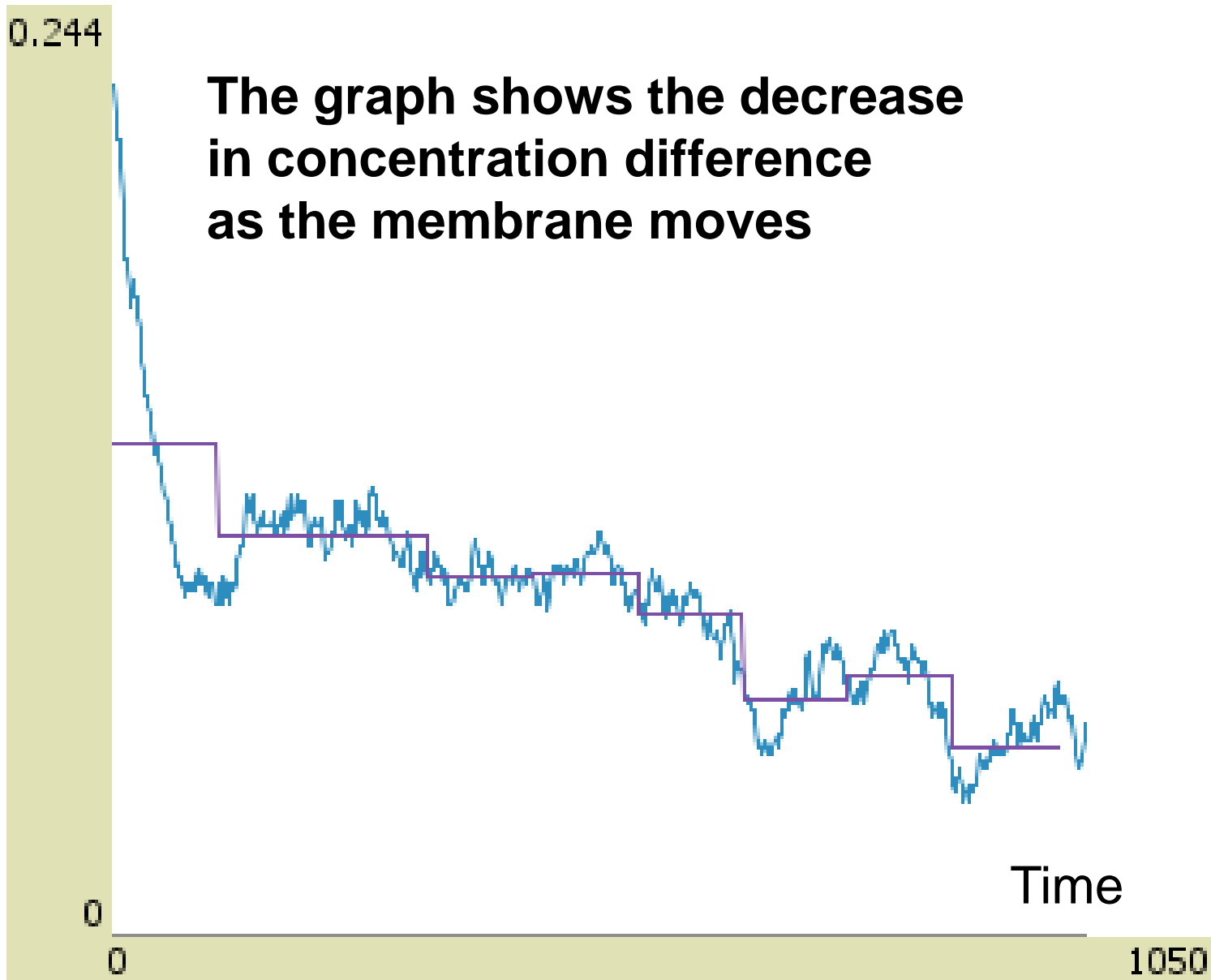
Finish

**The membrane
has moved to
the right**



OSMOSIS IN SILICO

Difference in concentrations



Data can be extracted from the simulation :

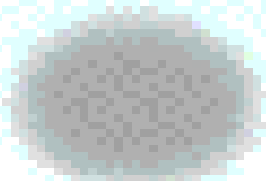
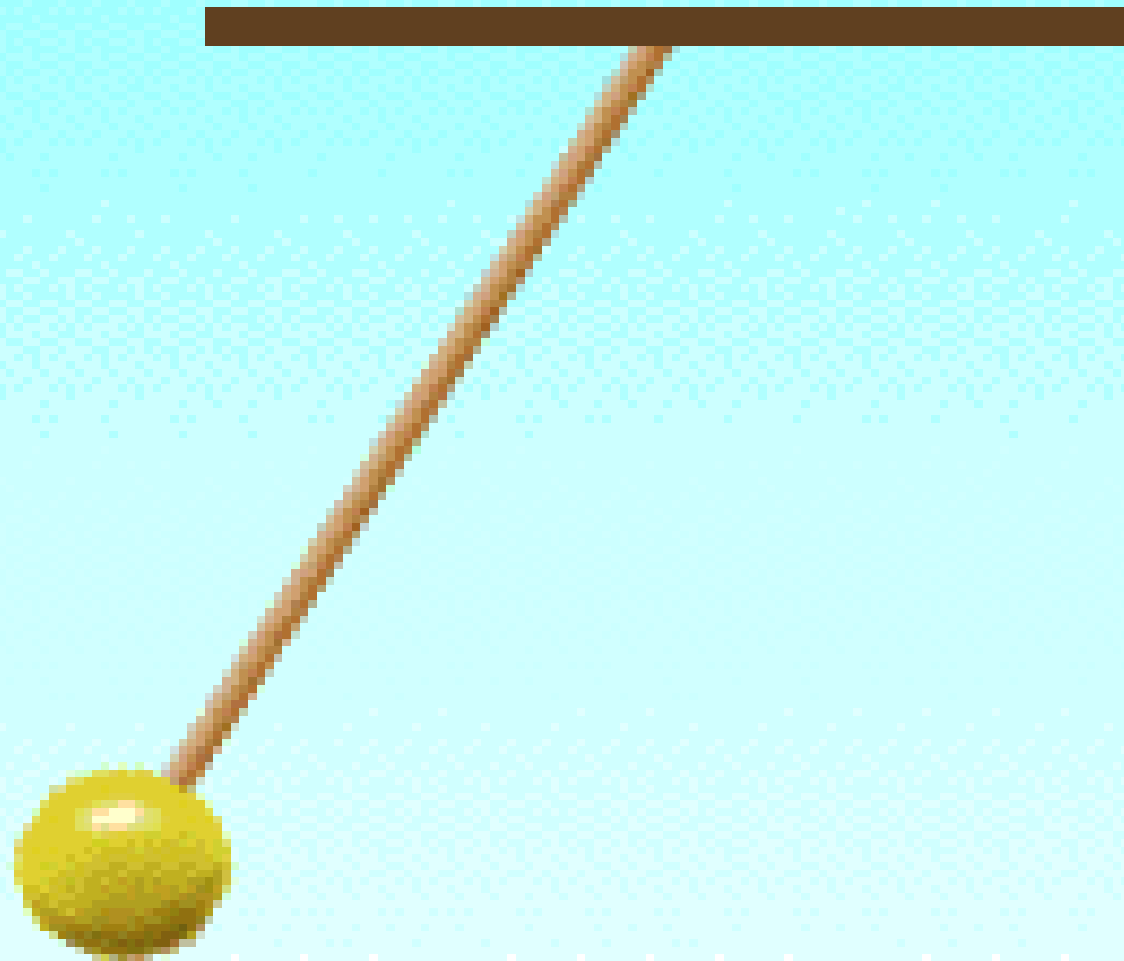
The graph shows the decrease in concentration difference as the membrane moves

**So we can
describe osmosis.**

**Now can we
explain osmosis?**

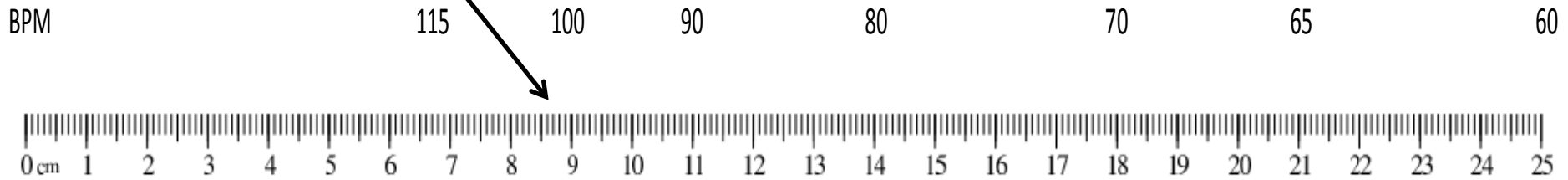


Galileo and medicine



Instructions for using your Personal Galilean Pulsometer (PGP)

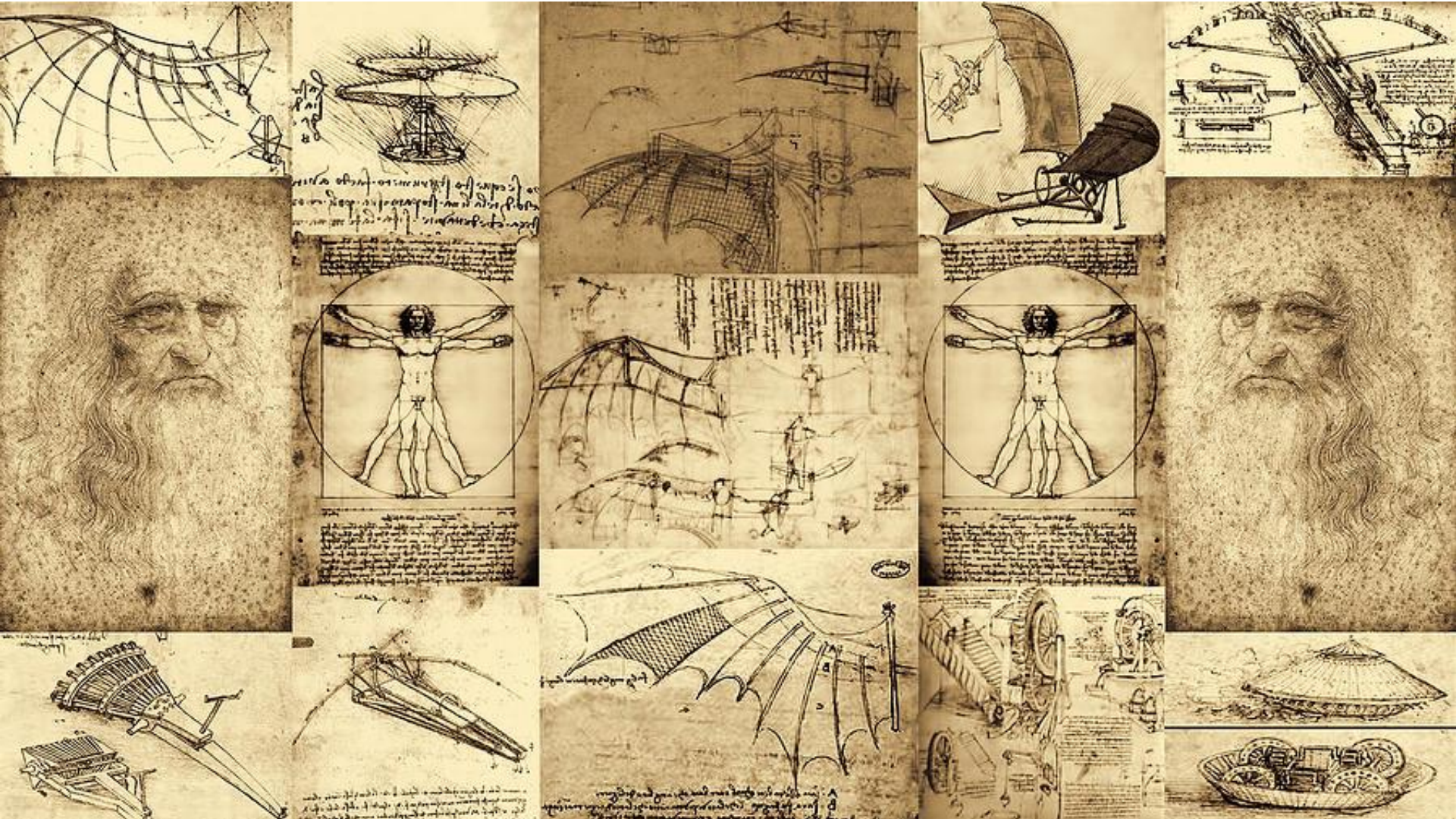
Measure length of
pendulum here



length(cm)	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
BPM	150	134	122	113	106	100	95	90	86	83	80	77	75	73	70	69	67	65	64	62	61	60

Find your heart-rate
here

Galileo and medicine



Scientific Creativity Live

4 experiments, 8 ways of knowing

