

# ***What is Sonification ?***

# Sonification concept for educational purposes

## Music Group

Click below to  
find more on  
how it was  
done

<https://www.schoolofthefuture.eu/en/community/music-music-team-accompanying-performance-ghost-particles-creations-summer-school-2016-0>

The **symbolic** way of sonification in an educational setting we can say that fully rely on the creativity of teachers who encourage students to approach imaginative ways to convert ideas into sounds. Using basic concepts of the musical phenomenon as pitch (or even noise), notes (tone frequencies), note durations, Time signature (or other rhythmic or measure attributes), teachers guide the students to create sound designs, or musical pieces, expressing the required concepts.

The **mathematical** approach is associated with the direct sonification of data. Here the teacher explains the correlations between arithmetic or mathematical figures and the behavior of data flow (the parameters) of a scientific concept. Usually this method employs mathematical applications that can be associated with live coding, giving data conversions to audio directly via a computer application.

The **adaptive** approach is the combination of the two above methods. In the adaptive approach the teacher has the opportunity to choose how sonification can assist him/her depending both on the teaching needs and the learning environment. In this way purely mathematical approaches can be combined with creative solutions coming directly from a performance arts setting.

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## Music Group

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<https://www.schoolofthefuture.eu/en/community/music-music-team-accompanying-performance-ghost-particles-creations-summer-school-2016-0>

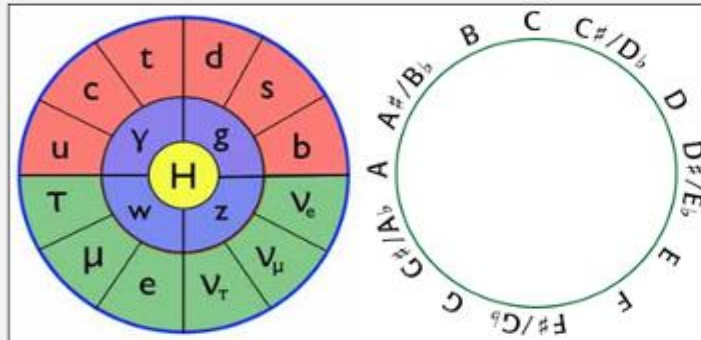
In mathematical terms, we define two sets, the set of the partides and the set of the musical notes. We call P the set whose elements are the partides:

$$P = \{u, d, c, s, t, b, e, \mu, \tau, v_e, v_\mu, v_\tau\}$$

We call N the set whose elements are the musical notes of the chromatic scale:

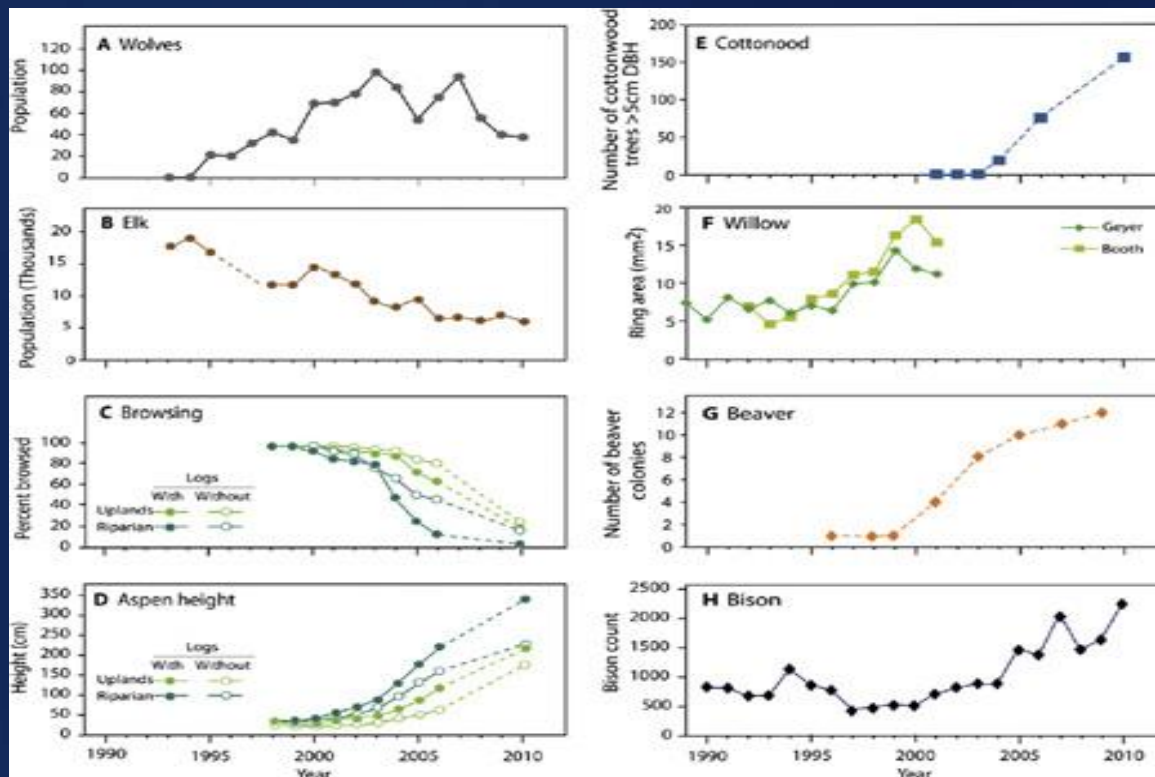
$$N = \{C, C\#, D, D\#, E, F, F\#, G, G\#, A, A\#, B\}$$

So, we have two sets of the same cardinality (twelve elements each) (Image 3) and we are looking for an order.



# Sonification of data

Transfer points of origin of a cartesian diagram into a sequencer



# Sonification of data

Transfer points of origin of a cartesian diagram into a sequencer

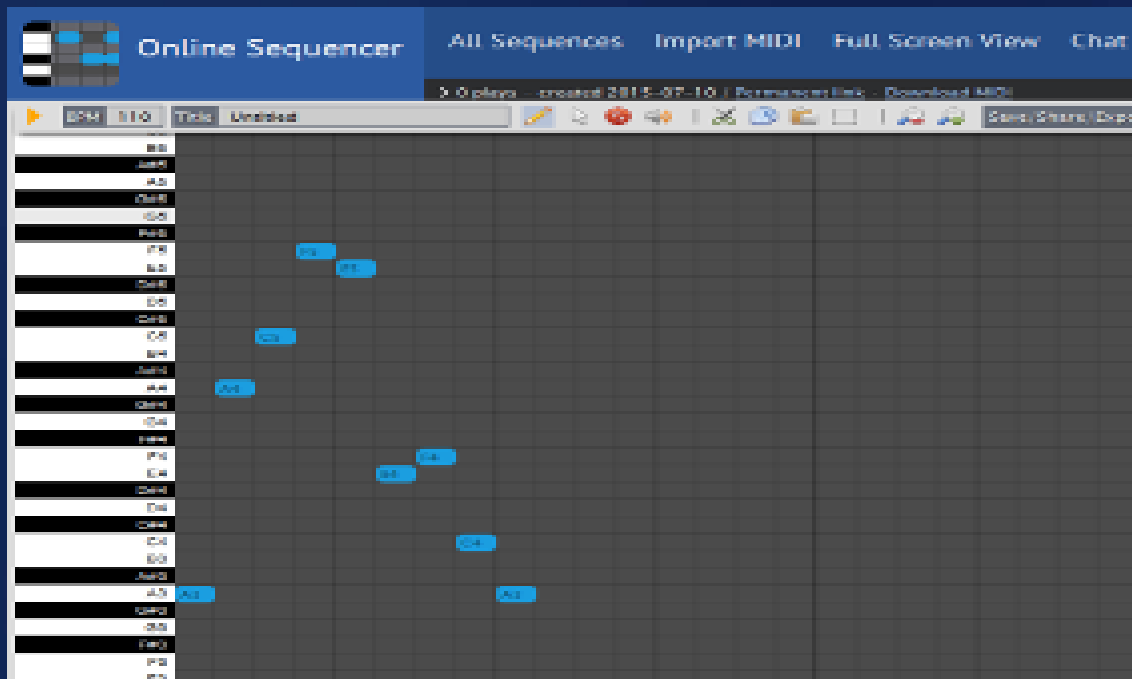
The screenshot shows a web browser window with the URL <https://onlinesequencer.net>. The main interface is for an online music sequencer. On the left, there is a piano roll with a vertical axis of notes from E8 to E4. A red arrow points from the 'C5' note on the piano roll to a data visualization window. The data window is titled 'F Willow' and shows a line graph with two series: 'Geyer' (green line) and 'Beeth' (yellow line). The graph has a vertical axis from 0 to 10 and a horizontal axis from 1 to 10. The 'Geyer' series starts at approximately 5, dips to 4, rises to 6, dips to 5, rises to 7, dips to 6, rises to 8, dips to 7, rises to 9, and ends at 8. The 'Beeth' series starts at approximately 4, dips to 3, rises to 5, dips to 4, rises to 6, dips to 5, rises to 7, dips to 6, rises to 8, and ends at 7. The sequencer interface also shows 'BPM: 110', 'Title: Untitled', and 'Instrument: Electric Piano'. The bottom of the browser shows the Windows taskbar with the date 1/12/2020 and time 7:13 pm.

## Sonification of data

Use your mouse to select the points of origin in an online MIDI sequencer and play the result

Publish your creation using a unique URL

Export the result into a MIDI file for further editing



<https://onlinesequencer.net/>

# Sonification of data

Play your  
MIDI file using  
3D Music  
Animation  
Software

## MIDItrail software

<https://osdn.net/projects/miditrail/>

## Video example

<http://dma.ea.gr/sites/default/files/Particle2-1.mp4>



With another  
3d Music  
Animation  
option

### Video example

[http://dma.ea.gr/sites/default/files/GSO-Sonifications\\_Educational-Festival-Agios\\_Nikolaos.mp4](http://dma.ea.gr/sites/default/files/GSO-Sonifications_Educational-Festival-Agios_Nikolaos.mp4)



Music  
Animation  
Software

and

Music  
Notation  
software

(Musescore)

Open Source Music  
Notation Software

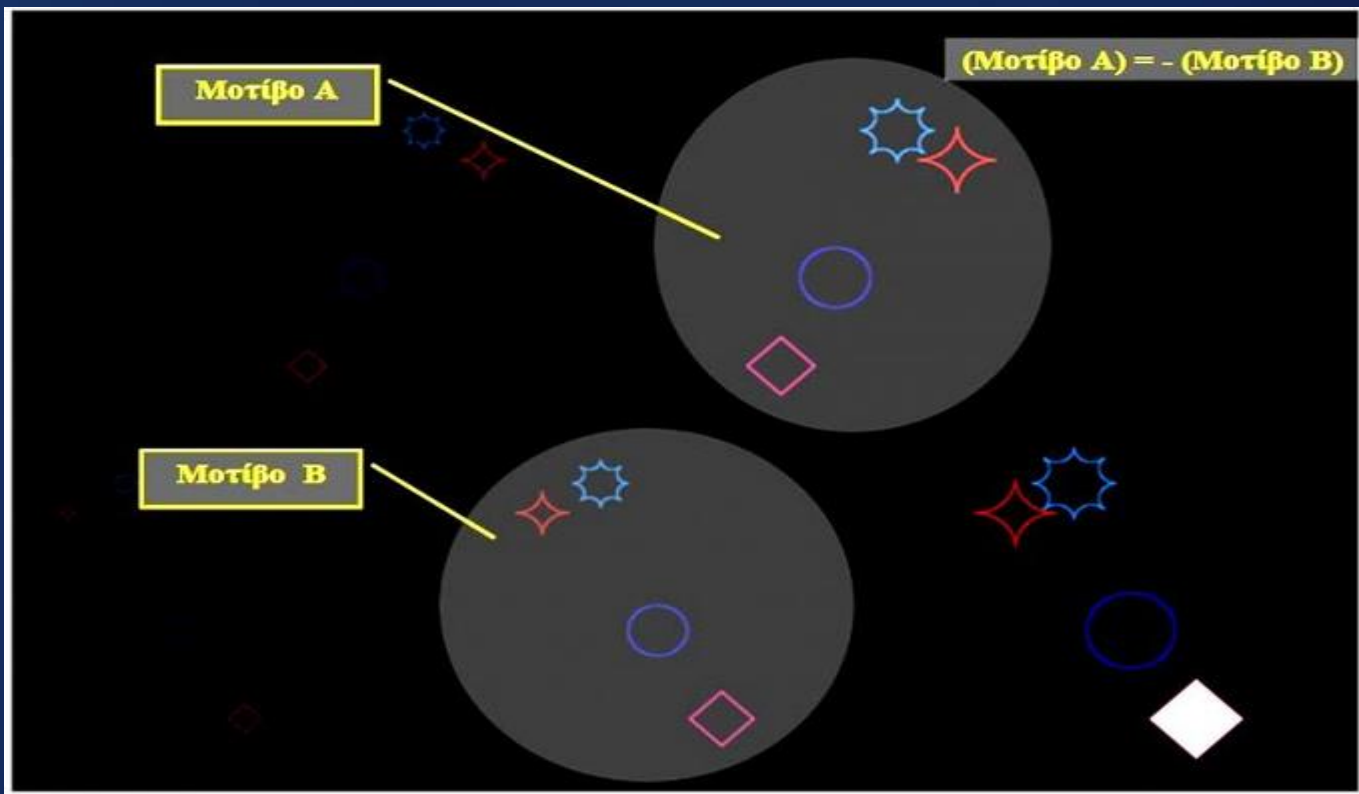
<https://musescore.org/en>

## Opposite Charges

$\text{♩} = 280$

9

17



Using  
Stephen  
Malinowski's

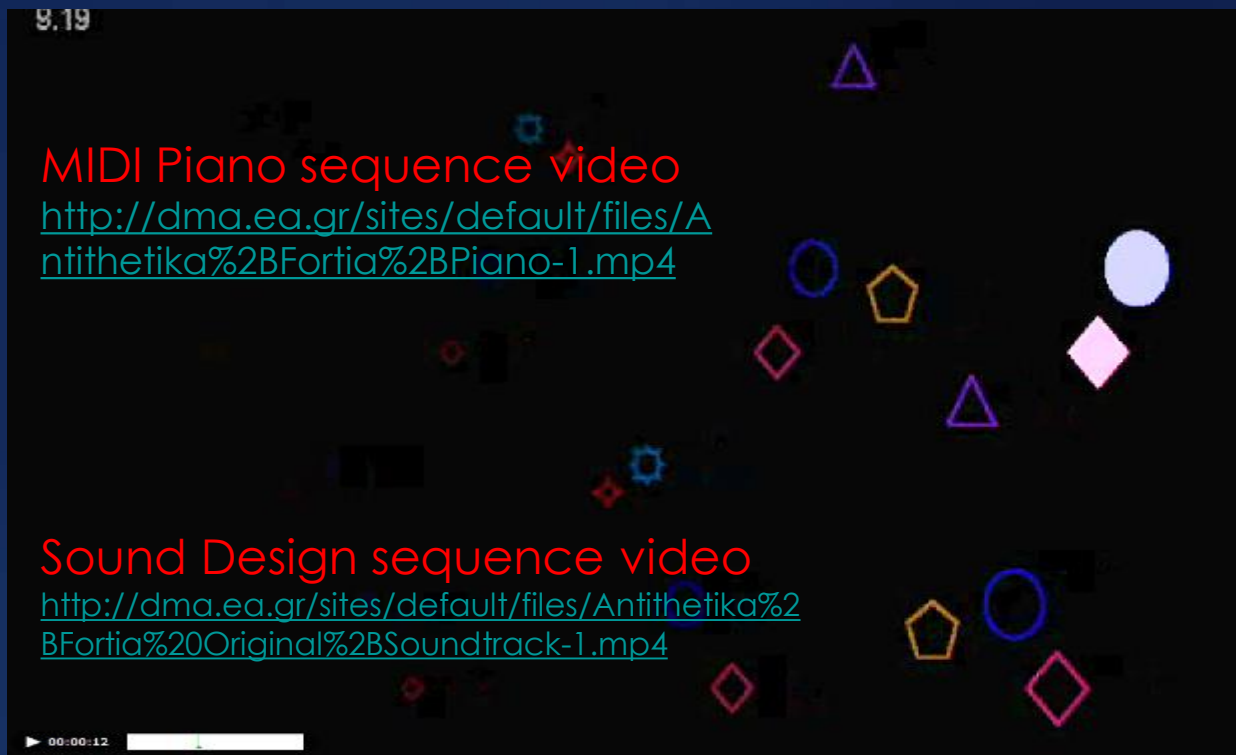
"Music  
Animation  
Software"

<http://www.musanim.com/all/>

Opposite  
Charges  
(Screenshot)

## Video examples

Click links to watch videos



9:19

**MIDI Piano sequence video**  
<http://dma.ea.gr/sites/default/files/Antithetika%2BFortia%2BPiano-1.mp4>

**Sound Design sequence video**  
<http://dma.ea.gr/sites/default/files/Antithetika%2BFortia%20Original%2BSoundtrack-1.mp4>

▶ 00:00:12

# Why using sonification techniques to create music in GSO?

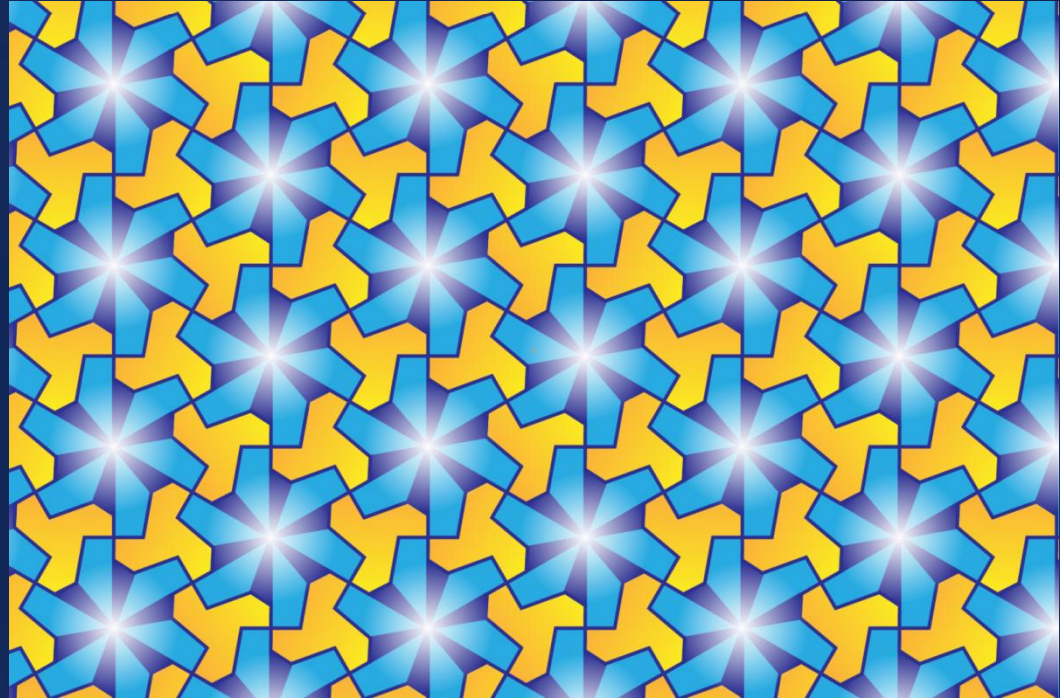
Because it helps students :

- to connect mathematical figures presented in a scene with sound or music
- to understand that a mathematical graph can also be expressed through sound or music that uses its own “cartesian coordinate system”  
(the simplest e.g. x axis: time, y: pitch)
- to identify their creative role as designers of their own ‘protocol’ of expression as a personal outcome directly related to the scientific notion they learn.

# What is leitmotiv?

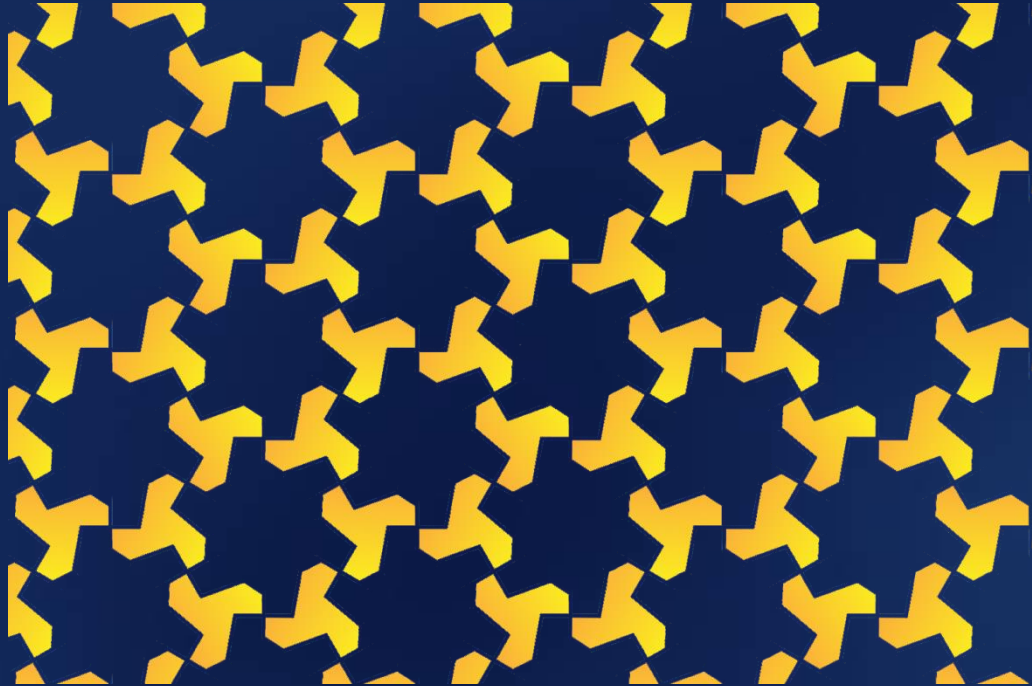
## What is leitmotiv?

Let's suppose that this is a picture  
of a character



# What is leitmotiv?

We can identify some of its characteristics



# What is leitmotiv?

And then we can focus on a small pattern



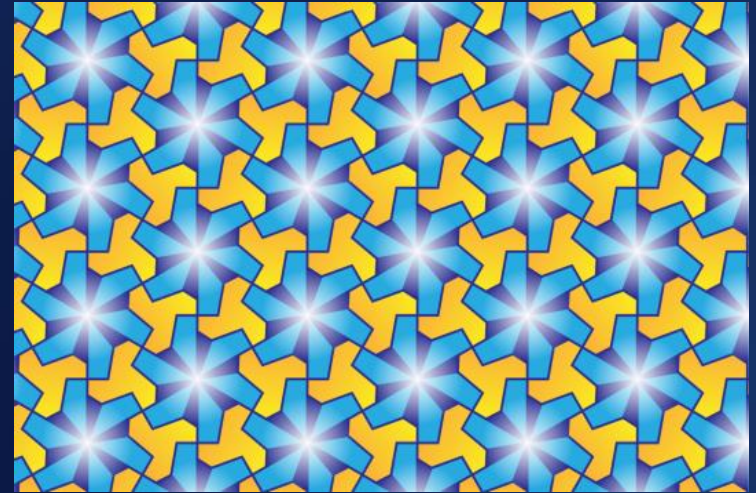
# What is leitmotiv?

... like this one



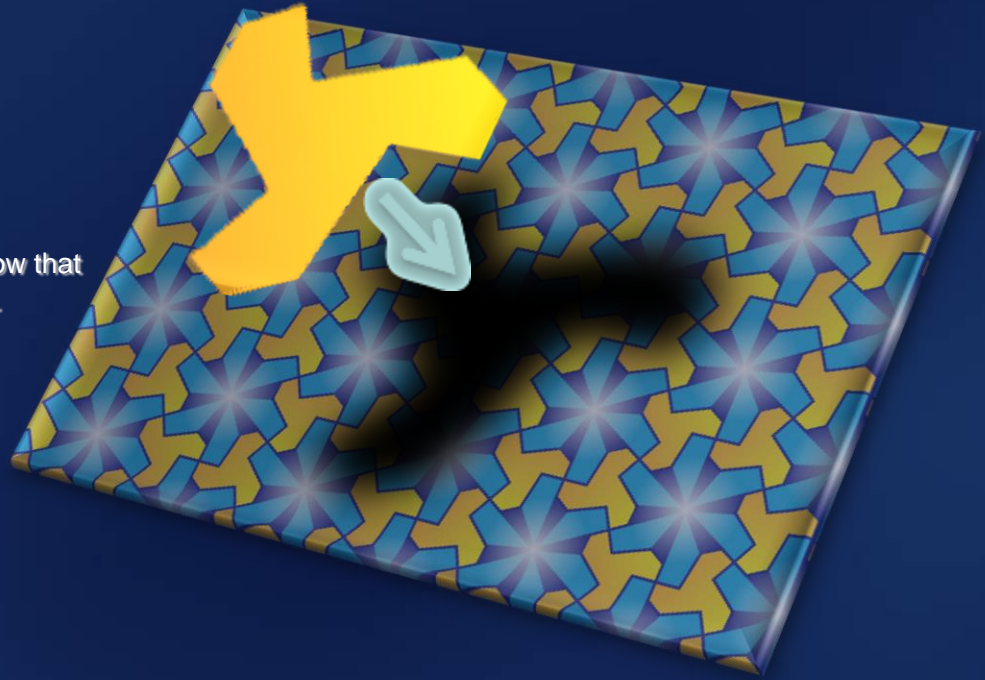
# What is leitmotiv?

Now, if I present this pattern once next to its “root” picture, then the viewer can easily identify that both shapes are connected.



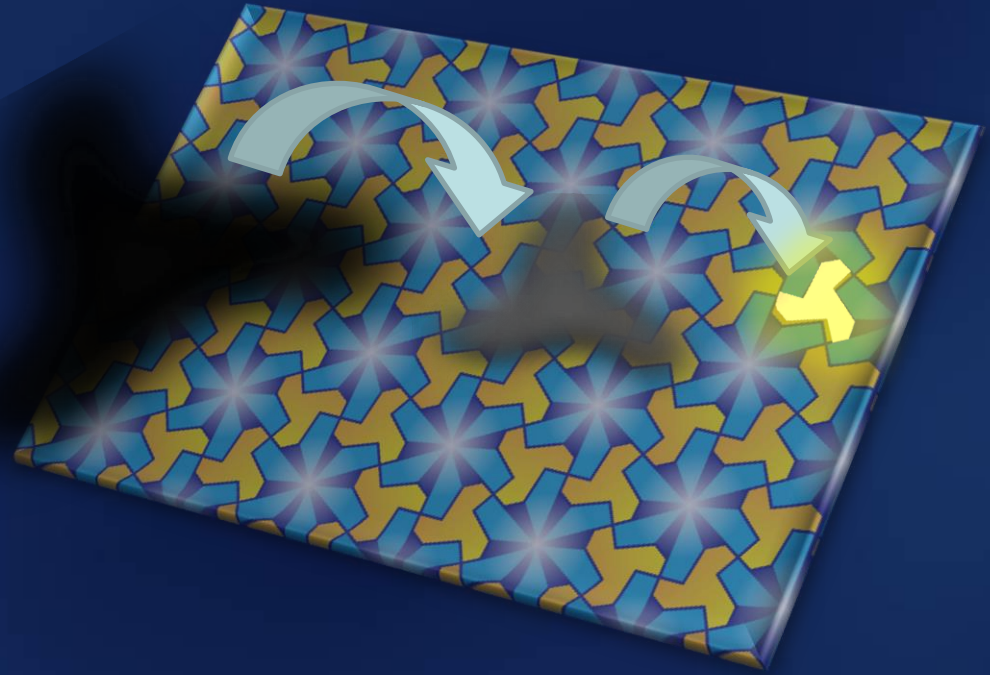
# What is leitmotiv?

In this way we trigger a “recall” mechanism like a shadow that creates a connection between this small pattern...



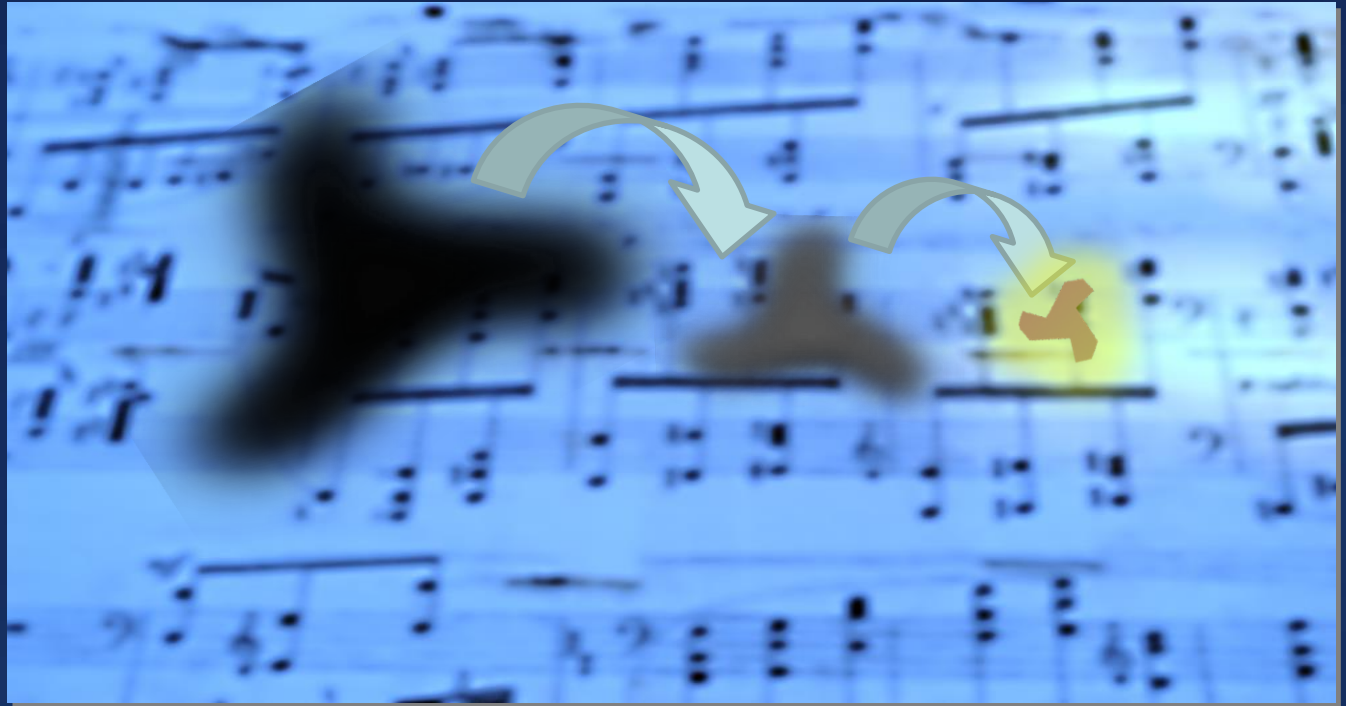
# What is leitmotiv?

...and its original counterpart .



# What is leitmotiv?

In Music this “recall” mechanism is triggered using notes



# What is leitmotiv?

So the notes used  
to trigger this reaction, create a  
brief musical pattern called

Motiv  
(or “motive”)



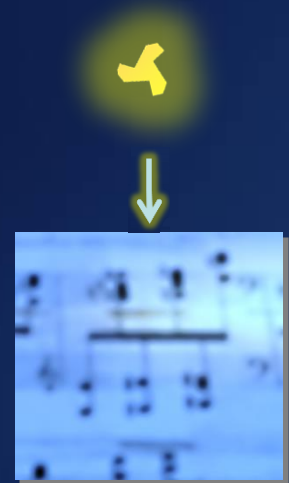
# What is leitmotiv?

Richard Wagner extensively cultivated this technique.

In his Operas, motives defined his leading characters. The motive was the leading feature of his heroes and therefore analysts of his time added the word “Leit” in front, which means “leading”.

So his brief musical pattern took the name:

Leitmotiv



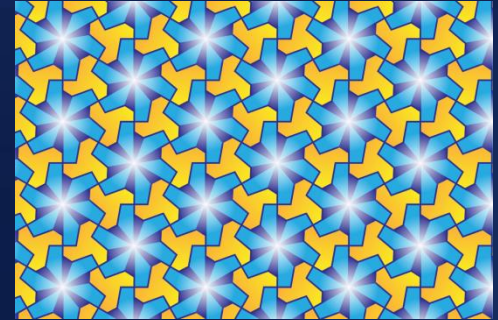
# What is leitmotiv?

So "leitmotivs" can repeat themselves  
whenever there is need

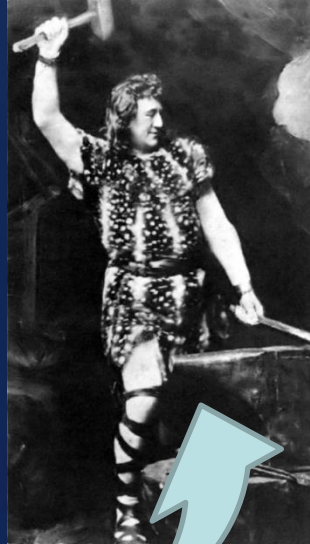


# What is leitmotiv?

The way “shapes” are structured within a creation,  
helps us identify their “root” easier



Heinrich Wilhelm Gudehus  
(1842-1909)  
as Siegfried



Scene from the Opera "Siegfried"  
Painting by Otto von Richter, (1892)

## What is leitmotiv?

So are leitmotifs in an Opera



Siegfried's leitmotiv

# Soundscapes

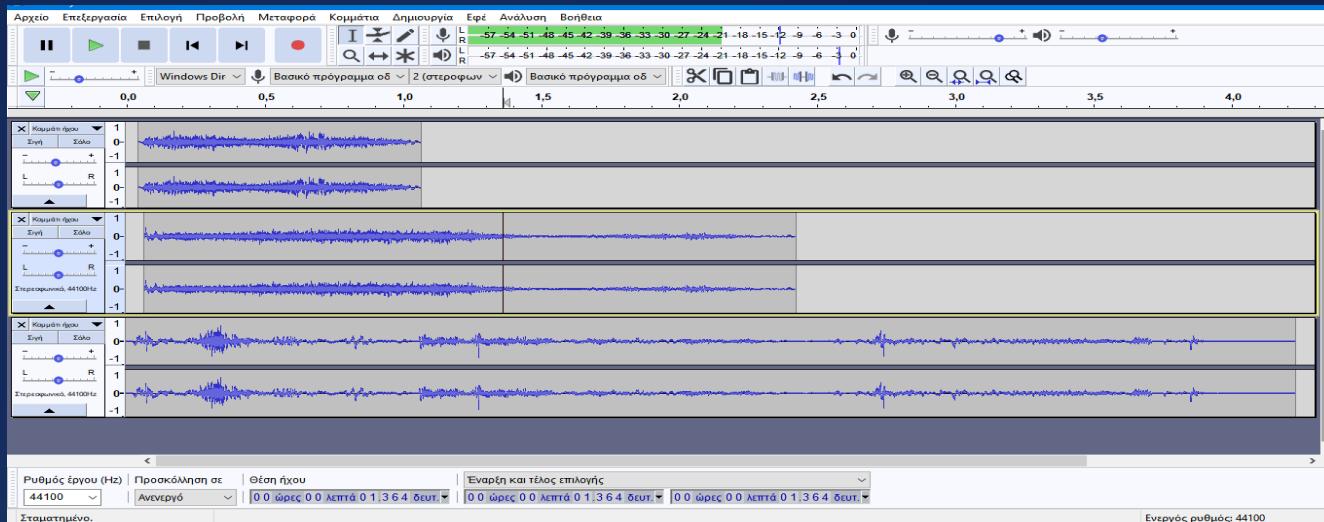
# Soundscapes

with  
smartphone  
recordings



# Soundscapes

## Using Digital Audio Workstations



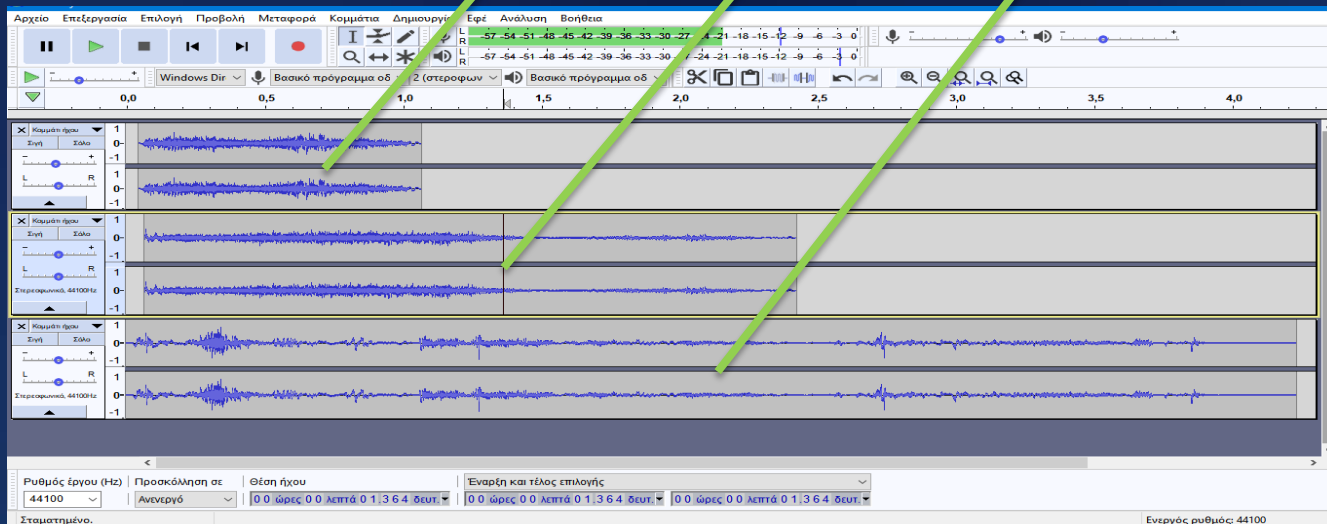
**Audacity Software**

<https://www.audacityteam.org/download/>

# Soundscapes

with  
smartphone  
recordings

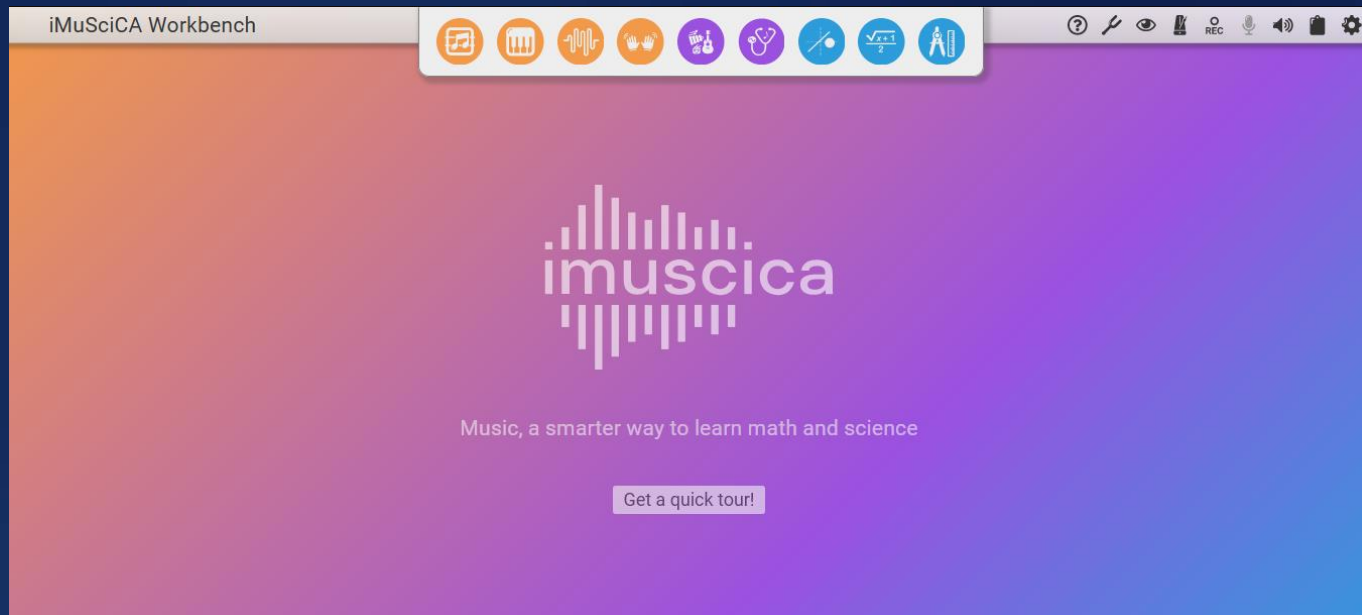
**Audacity Software**  
<https://www.audacityteam.org/download/>



# Other ideas

# iMuSciCA Workbench

A quest for  
deeper learning

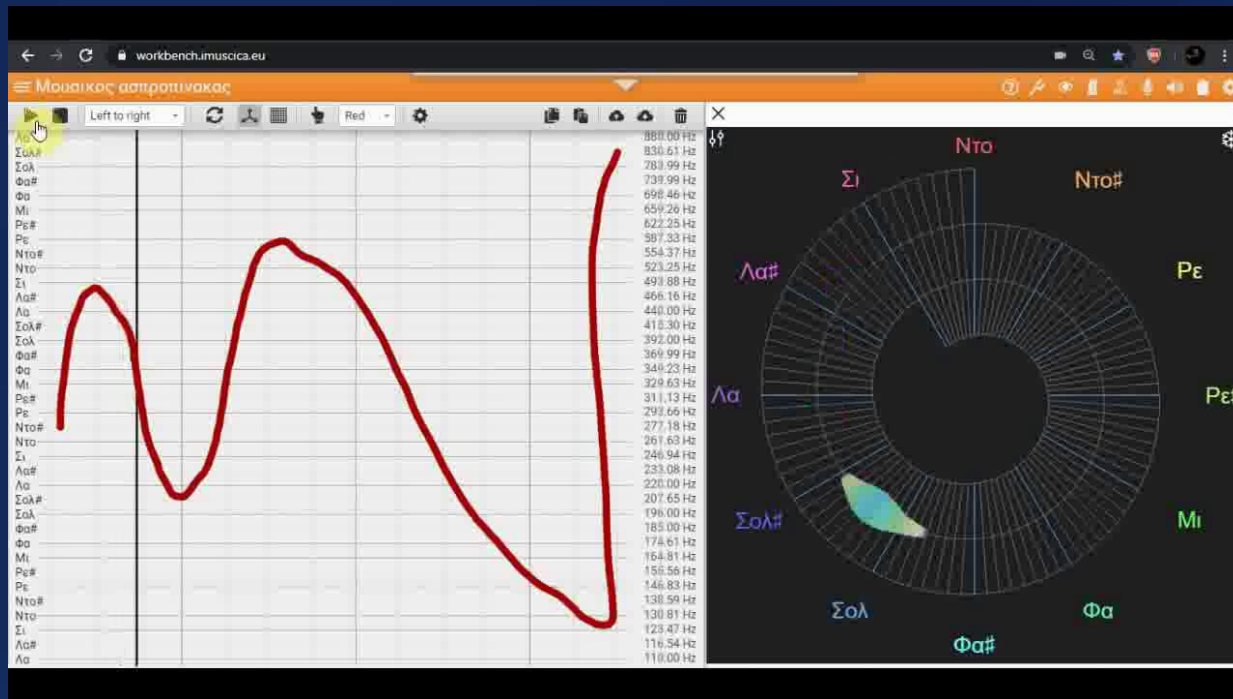


<https://workbench.imuscica.eu/>

# iMuSciCA Workbench

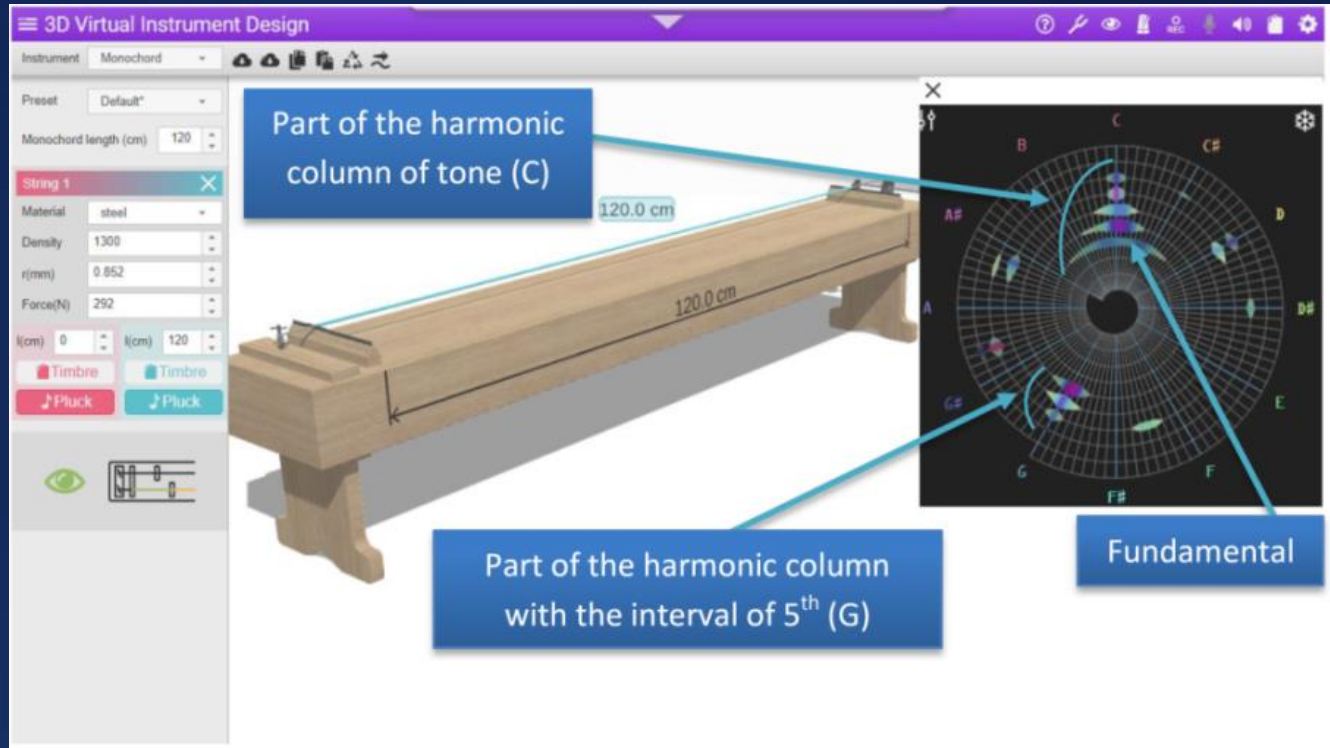
A quest for  
deeper learning

[“Creating conditions for  
Deeper learning in Science”  
Conference proceedings](#)



# iMuSciCA Workbench

A quest for  
deeper learning

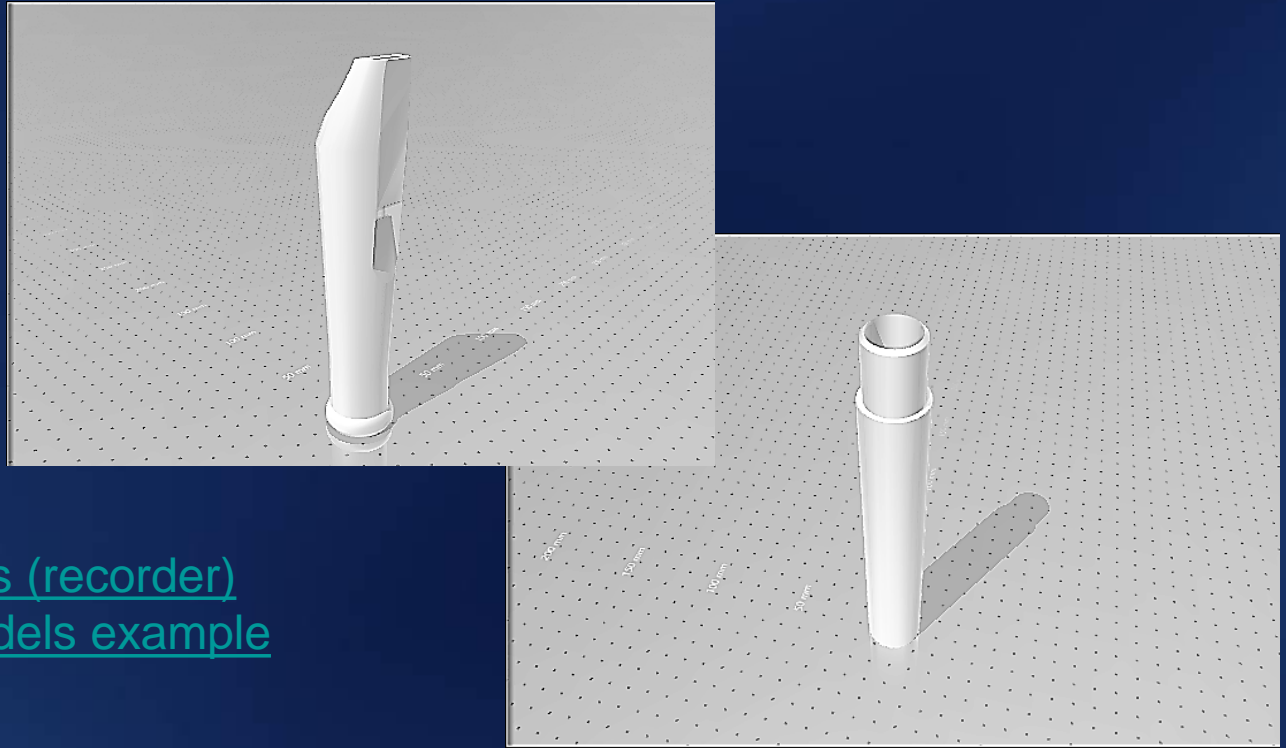


[Video example](#)

# iMuSciCA Workbench

A quest for  
deeper learning

## Aulos (recorder) 3D models example



# iMuSciCA Workbench

A quest for  
deeper learning

ϸ ζ̄ ζ̄̄ κ̄ιζ̄ῑ κ̄ ῑ ζ̄ ῑ κ̄ ο̄ τ̄ ο̄ φ̄  
Ὁ σον ζῆς, φαί νου, μη δέν ὄλ ως σὺ λυ ποῦ.  
ϸ κ̄ ζ̄ ῑ κ̄ ῑ κ̄ τ̄ ο̄ φ̄ ϸ κ̄ ο̄ ῑ ζ̄ κ̄ ϸ ϸ ϸ χ̄ ῑ  
πρὸς ὄλ ἰ γον ἐ στί τὸ ζῆν, τὸ τέ λος ὁ χρόνος ἀπαι τεί.



Ὁ σον ζῆς φαί νου μη δέν ὄλ ως σὺ λυ ποῦ πρὸς ὄλ ἰ γον ἐ στί τὸ ζῆν τὸ τέ λος ὁ χρόνος ἀπαι τεί.

“While you live, shine, have no grief at all, life exists only for a short while and time demands its toll”

Find more about Seikilos [here](#)

Seikilos epitaph circa 200 BC

# iMuSciCA Workbench

A quest for  
deeper learning

**ΟΣΟΝ ΖΗΣ ΦΑΙΝΟΥ,  
ΜΗΔΕΝ ΟΛΩΣ ΣΥ ΛΥΠΟΥ.  
ΠΡΟΣ ΟΛΙΓΟΝ ΕΣΤΙ ΤΟ ΖΗΝ,  
ΤΟ ΤΕΛΟΣ Ο ΧΡΟΝΟΣ ΑΠΑΙΤΕΙ**

Στήλη του Σεΐκιλου  
Τράλλεις Μικράς Ασίας 3<sup>ος</sup>-2<sup>ος</sup> αι. π.Χ

iMuSciCA project for MINT EC 2019 | Petros Stergiopoulos | Ellinogermaniki Agogi | June 24, 2019



**Ο ΣΟΝ ΖΗΣ ΦΑΙΝΟΥ,**

**Ο ΣΟΝ ΖΕΙΣ ΦΑΙ - ΝΟΥ,**



Στήλη του Σεΐκιλου  
Τράλλεις Μικράς Ασίας 3<sup>ος</sup>-2<sup>ος</sup> αι. π.Χ

iMuSciCA project for MINT EC 2019 | Petros Stergiopoulos | Ellinogermaniki Agogi | June 24, 2019



Click images to redirect to the Seikilos' [Karaoke Video tutorial](#)

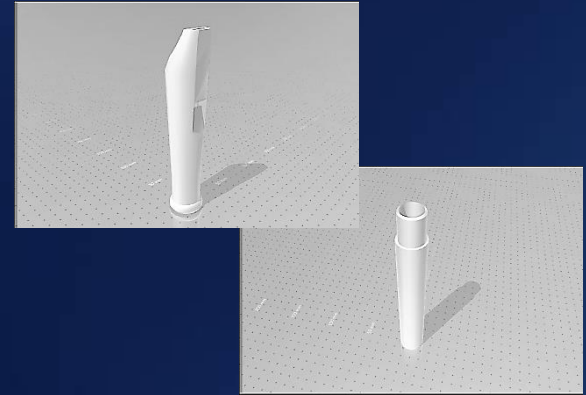
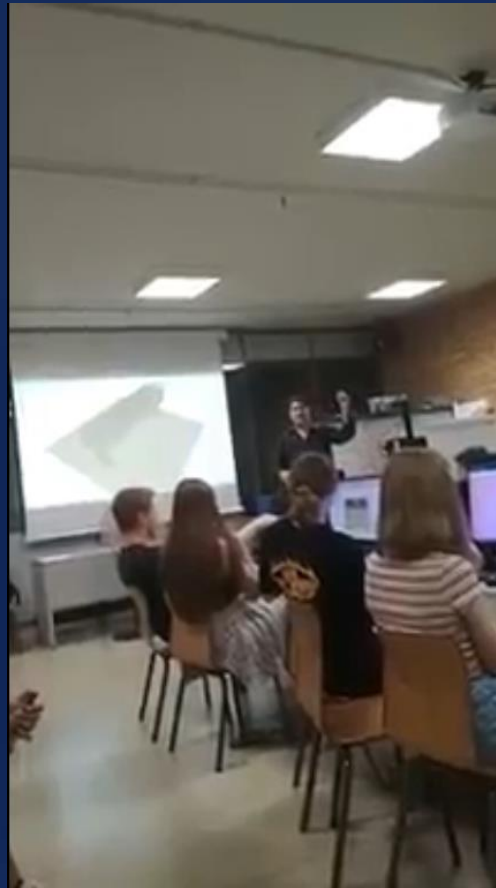
“While you live, shine, have no grief at all, life exists  
only for a short while and time demands its toll”

Seikilos epitaph circa 200 BC

# iMuSciCA Workbench

A quest for  
deeper learning

Students combined recorders of  
different lengths to accompany  
the melody of Seikilos



[Video example](#)

*Thank you*

***Petros Stergiopoulos***  
[plagiavlitis@ea.gr](mailto:plagiavlitis@ea.gr)