

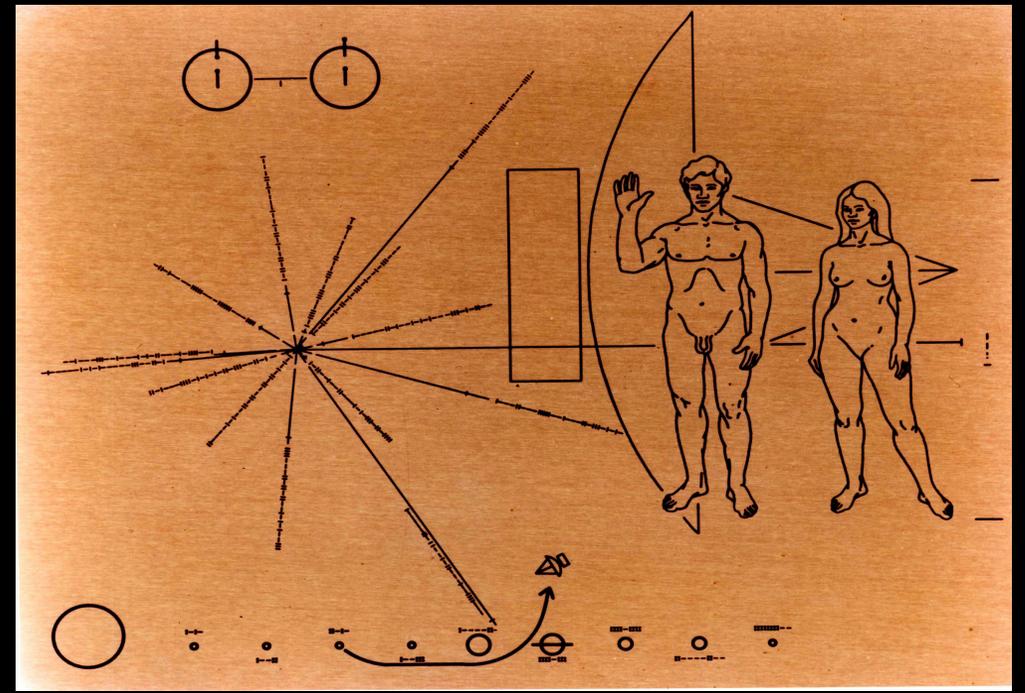
# THE VOYAGER GOLDEN RECORD

Brandon Park, William Yau, Lakshman Peri



# THE ORIGIN OF VOYAGER PROJECT

Pioneer 10 and 11 carried small metal plaques that included small bits of information about life on Earth, in hope that the probes would one day be found by extraterrestrials.



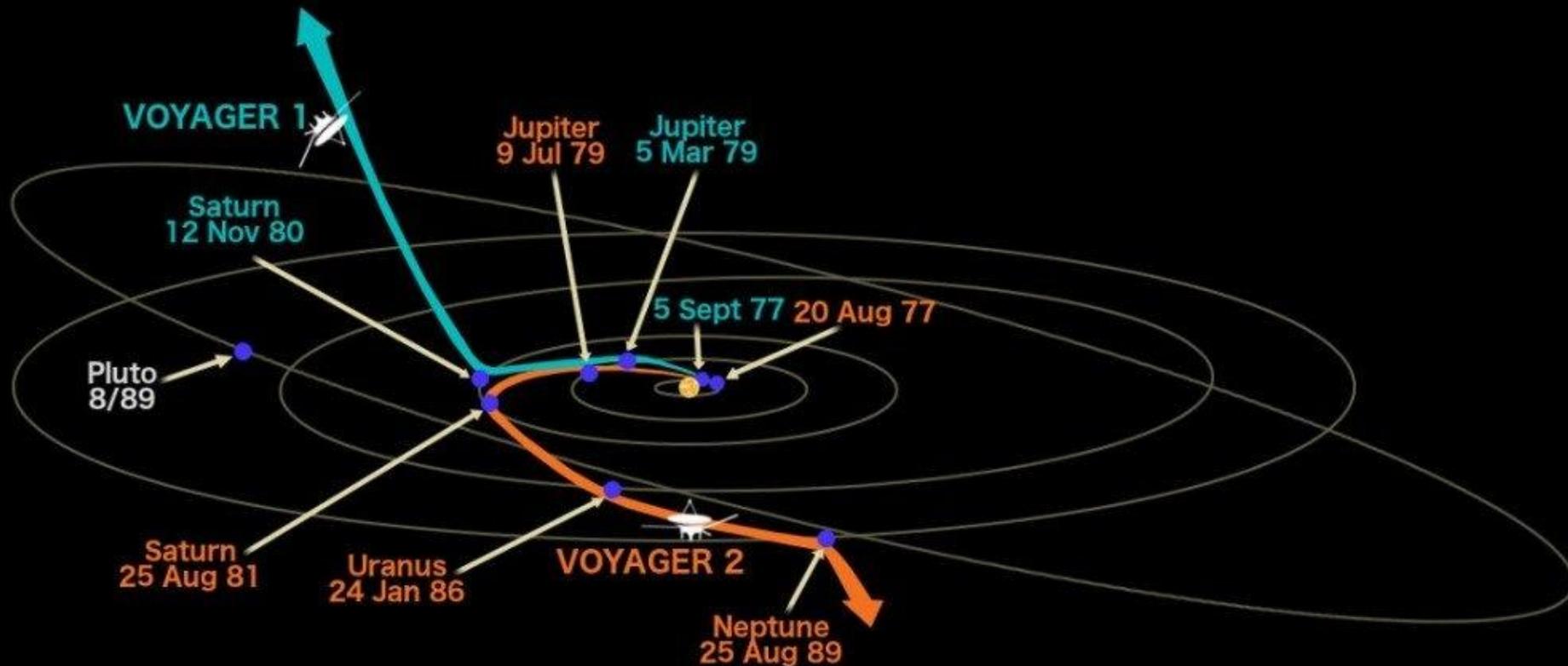
By the time NASA sent the Voyagers into space, NASA scientists had become more ambitious and had manufactured 2 phonograph records, created on 12-inch gold-plated copper disks called the “Golden Records”.

The Golden Records contain music from all around the world, along with 115 images encoded within the grooves.

These records on the Voyager satellites serve as humanity’s few possible forms of communication with extraterrestrial life.

# Objective:

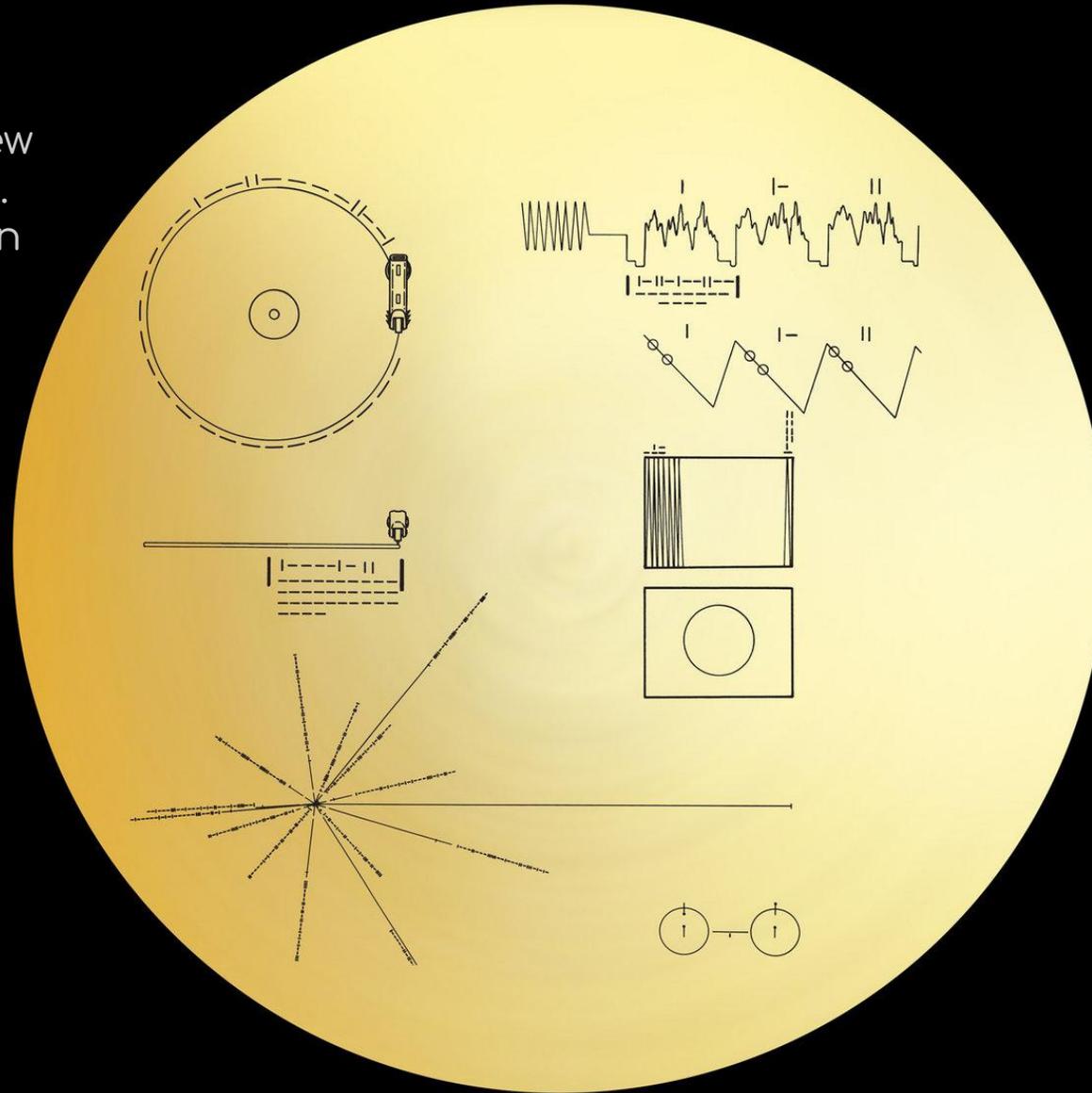
In this project, we will decode the images on the Golden Record, simulating how an extraterrestrial (with no prior knowledge of the record's manufacturing) would attempt to decipher the encoded message.



# How To Decode The Record

On the top left side of the cover, we see a bird's eye view of the record and the stylus. The rotation speed is written in binary (about 3.6 sec)

Below that we see a planar view of the record. It shows that the stylus will take around 1 hour (written in binary) to go from the outside to the inside.



Audio wave with the numbers 1, 2, and 3 written in binary. Represents a very small portion of the audio wave which consists the images.

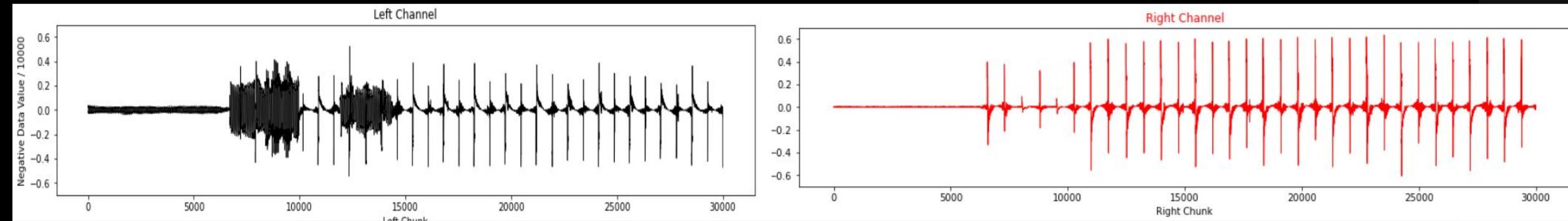
Below that, we see the same binary numbers alongside a different wave. This tells us to structure the information in the original wave as rows.

Below the second wave, we see a rectangle with the rows of decoded audio waves inside. Also, we see the number 512 written in binary. This tells us that there are 512 rows per image.

At the bottom, we see a circle within a rectangle. This is our calibration image; if we manage to get this image, we know our method is correct.

# Two Notable Assumptions:

1. As we do not have access to a physical copy of the Golden Record, we obtained the audio file online in the form of a .wav file. We are skipping the process of turning the grooves in the record into a digital audio wave.
2. We know that the audio is recorded in stereo, meaning there are two channels. Extraterrestrials will have to figure this out on their own, as there are no indications on the record or the record cover signifying two distinct channels.



# METHODS PART 1

## Initiation

- Importing the audio file into python: used a function **'wavfile'** imported from **'scipy.io'**.
- The data was then loaded in using **pandas**: store our **left** and **right** channels separately.
- Each picture: **precisely 734 pixels** in width
- Using the number **512** which was engraved on the Golden Record in **binary**: ran a function to append all the pixels to the image, essentially in the form of an array of 512 arrays with 734 values.
- We also used an **adjustment** value, which allowed us to minorly adjust the images' **orientation** and display them **properly**.
- Once we had all the values appended to the given image's array, we used **matplotlib** to plot the image necessary.
- This process had to be repeated for each image, and the initial value had to be **manually** found for each image.

This process had to be done for both the left and right channel.

# METHODS PART 2

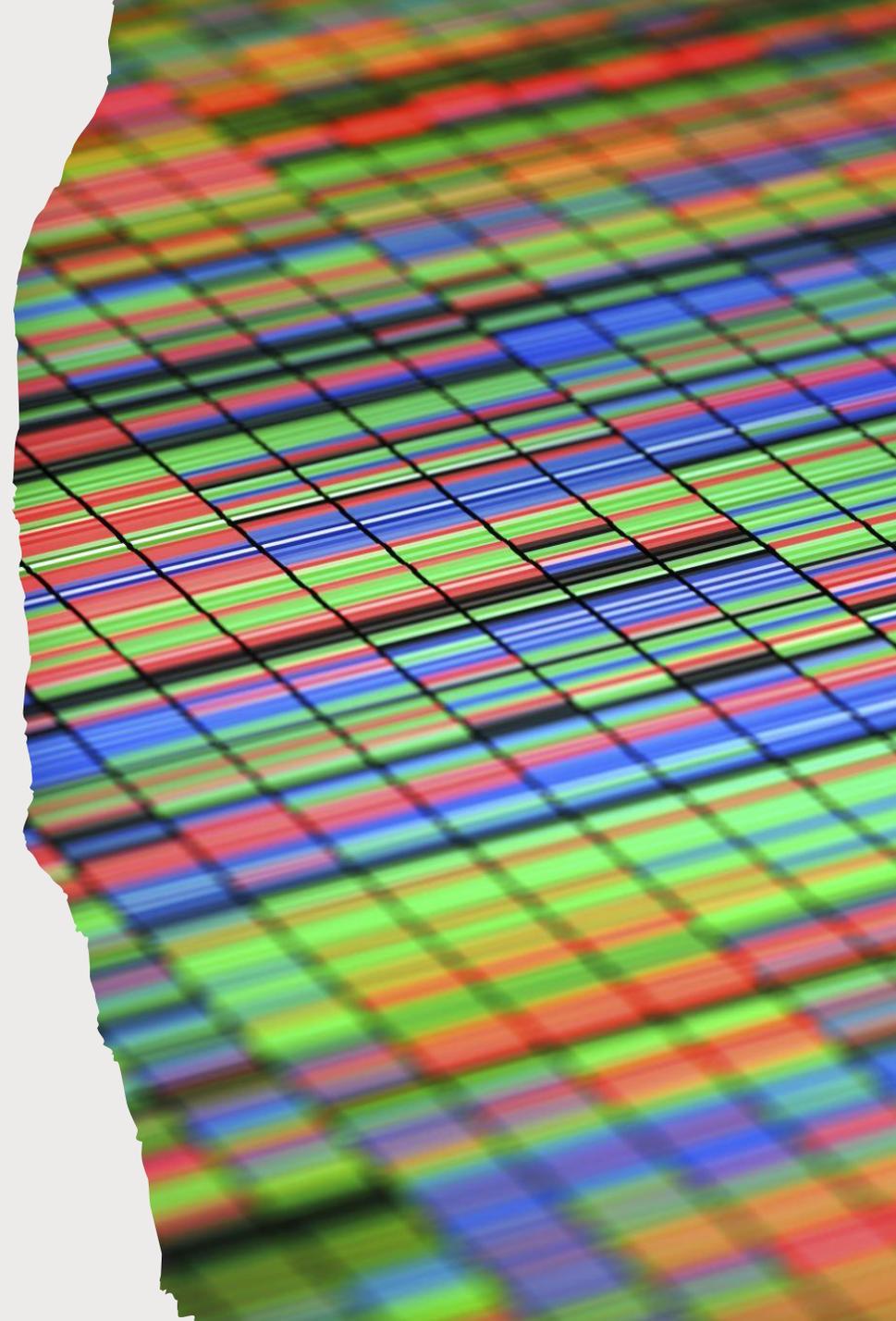
## RGB function

RGB image: **3 channels: red, green, blue**

On the Golden Record: some images **repeated 3 times** -> each of the color channels.

To display the image in matplotlib, we created a numpy array of shape **512 \* 734 \* 3** with zeros (**np.zeros**)

Then, we input the array: red (item 0), green (item 1), blue (item 2)



# METHODS PART 2

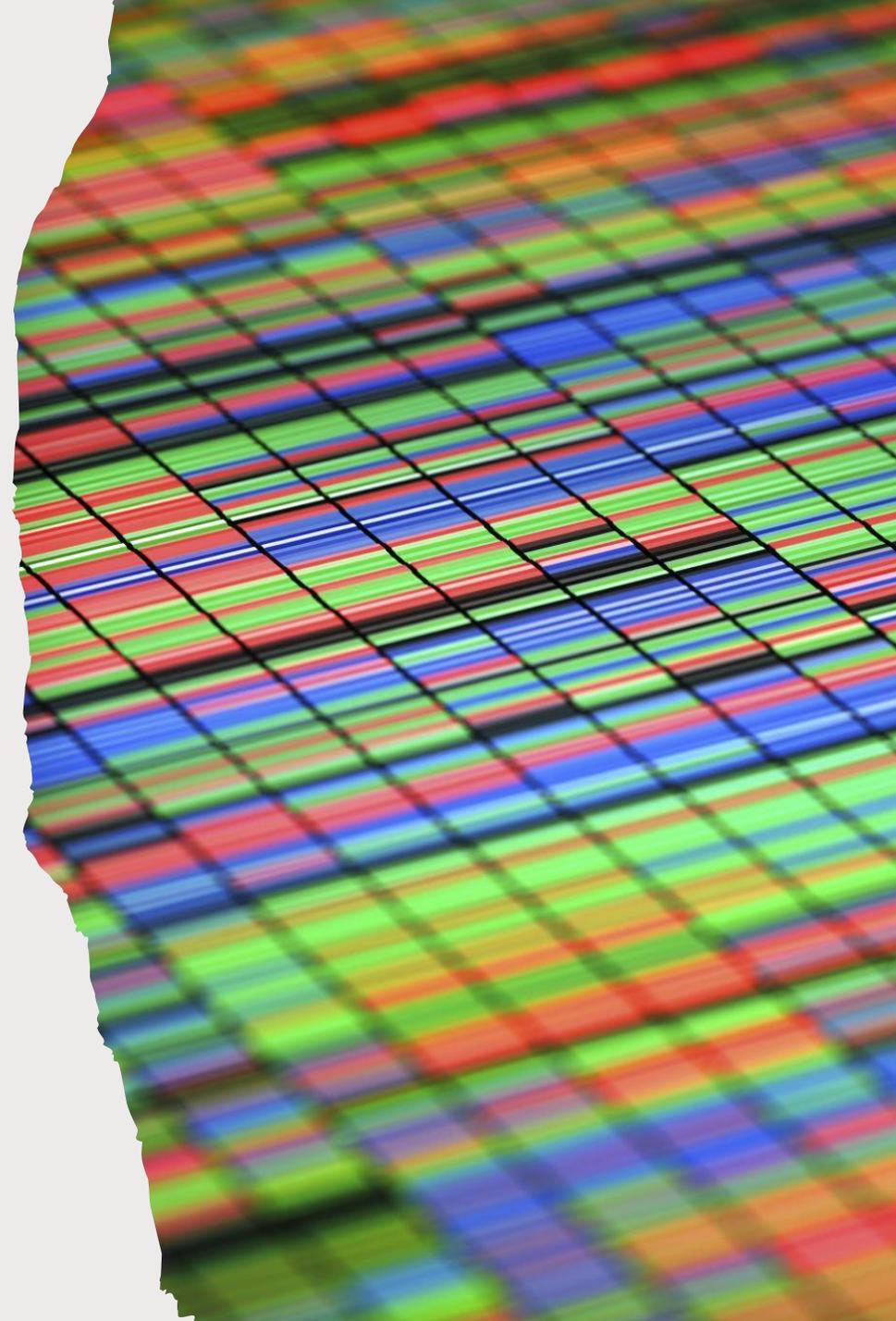
## ANIMATION

Using **FFMpegWriter** and *for* loops:

created animations where each layer of r, g, and b slowly add on each other

This revealed the mechanism of how matplotlib show color (as well as softwares in general):  
**values** in each channel correspond to the **intensity** of that color

**Adding** them will successfully give a **full-color** representation of the image



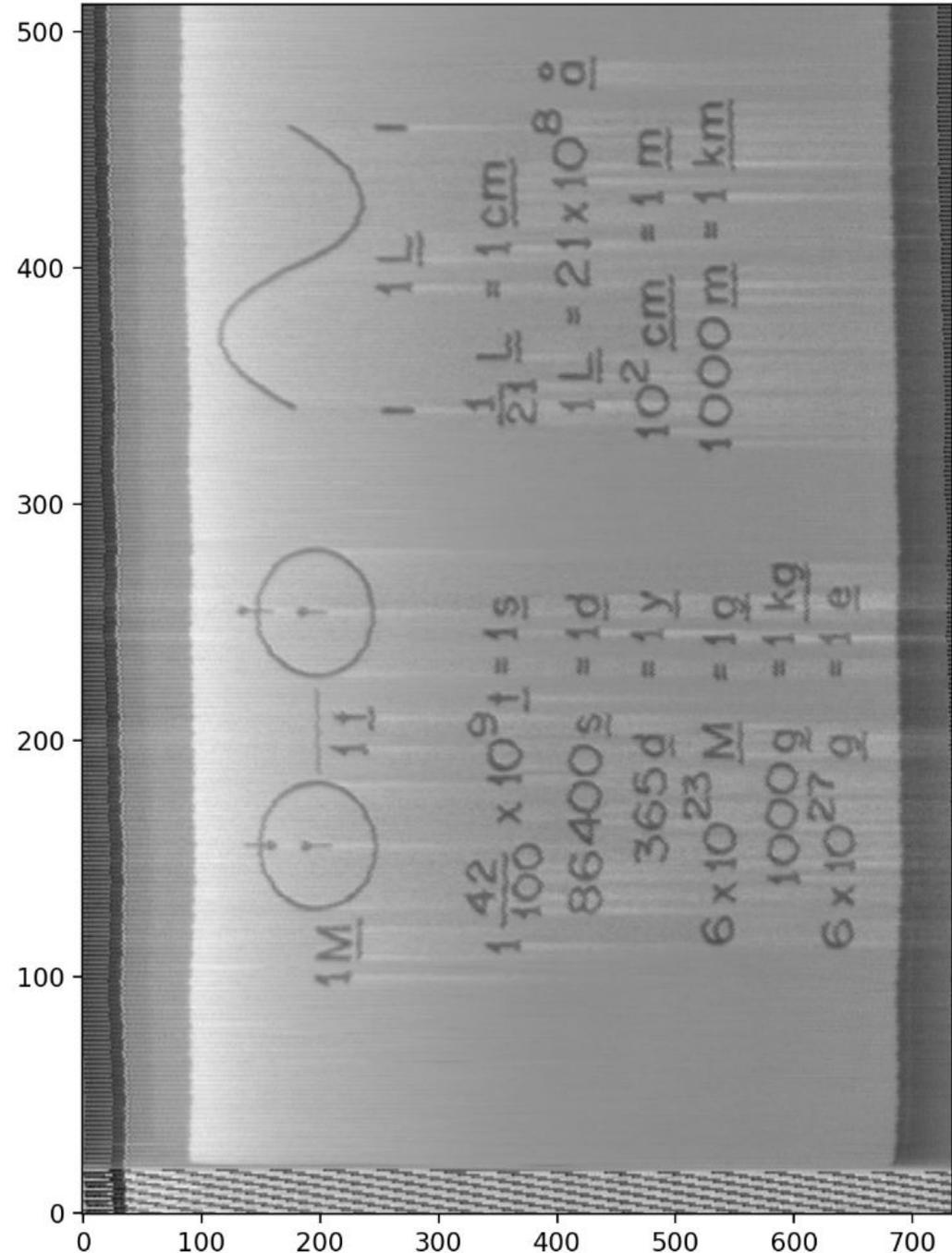
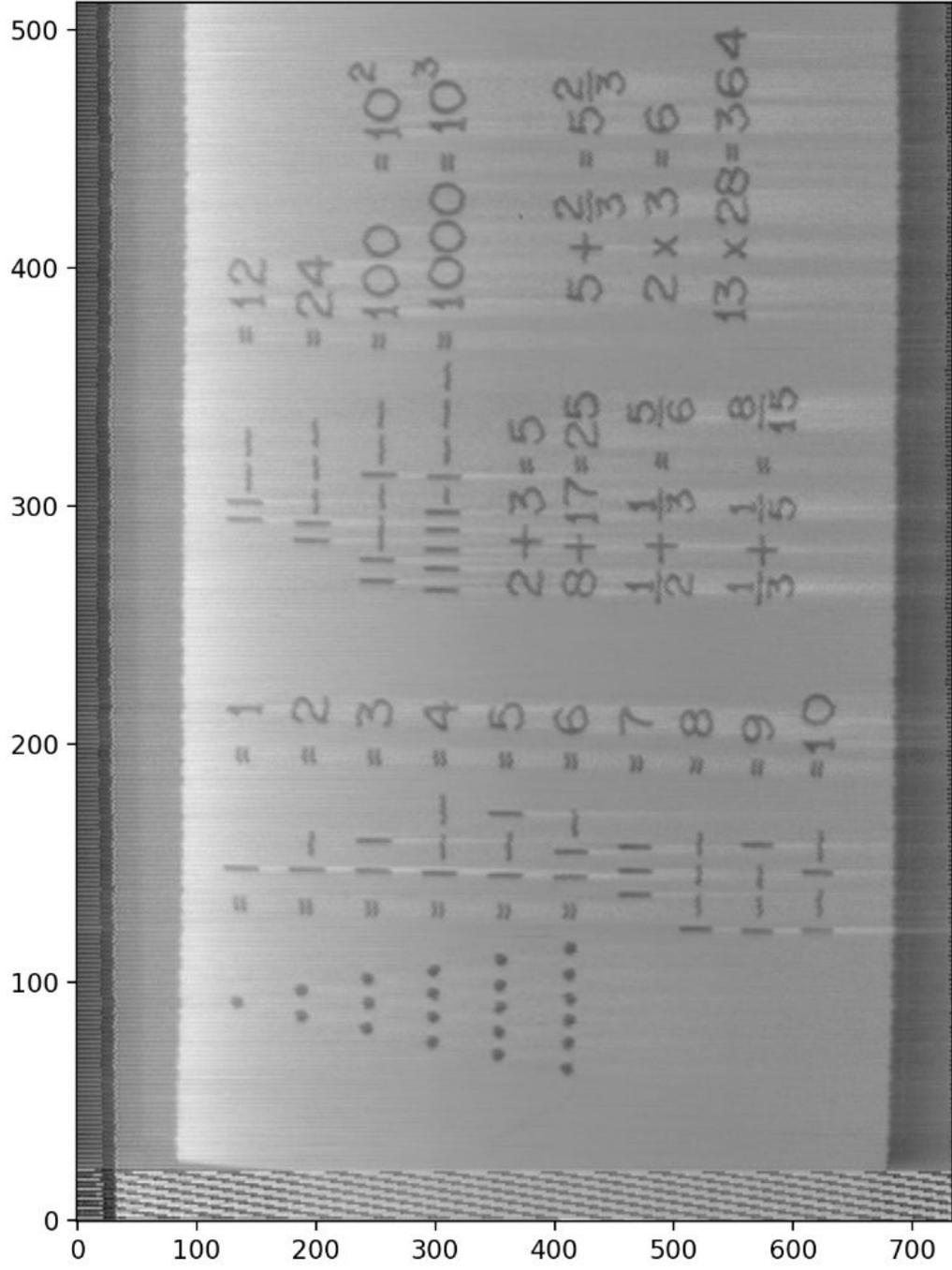
# FINDINGS AND RESULTS – PART 1

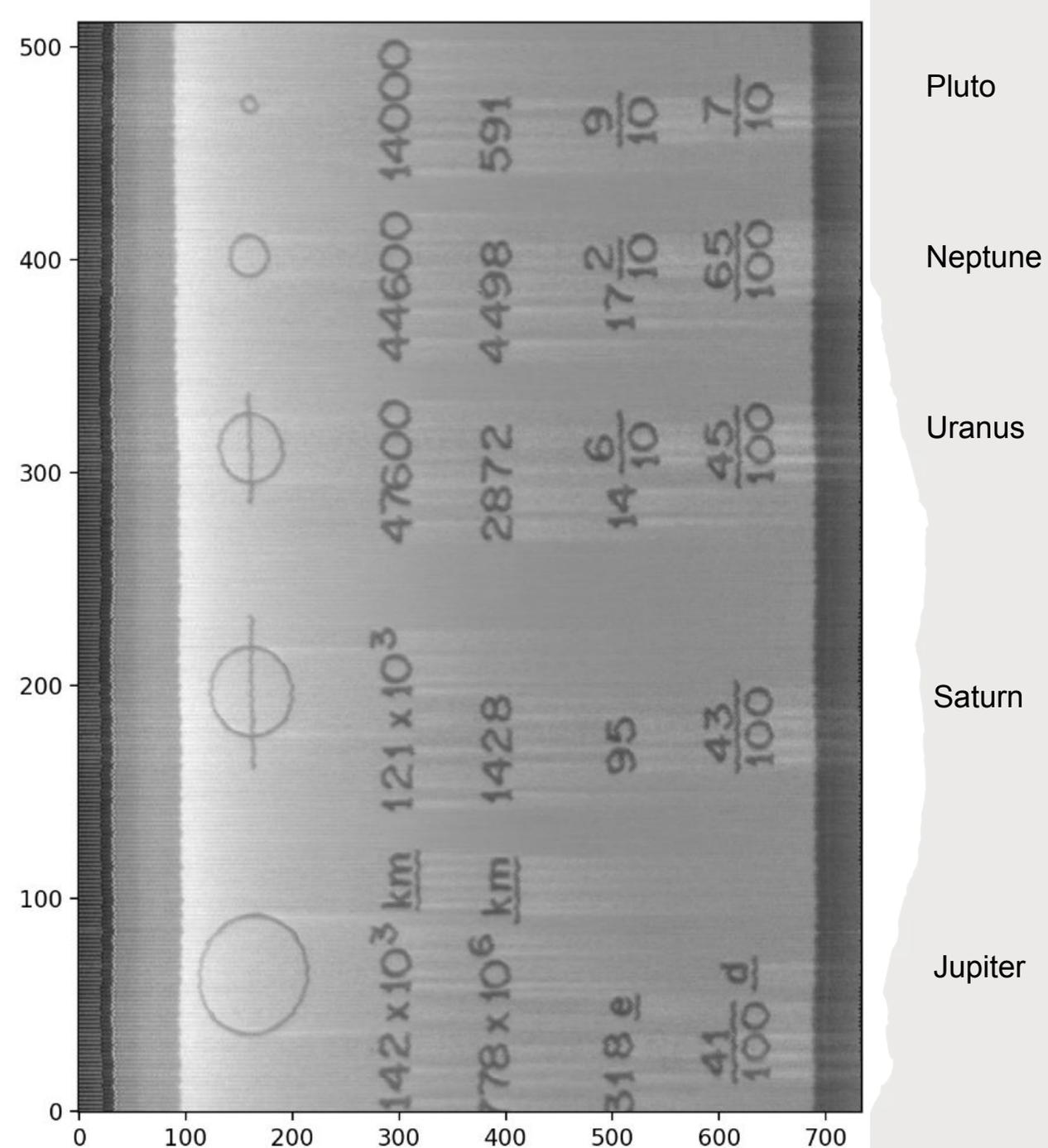
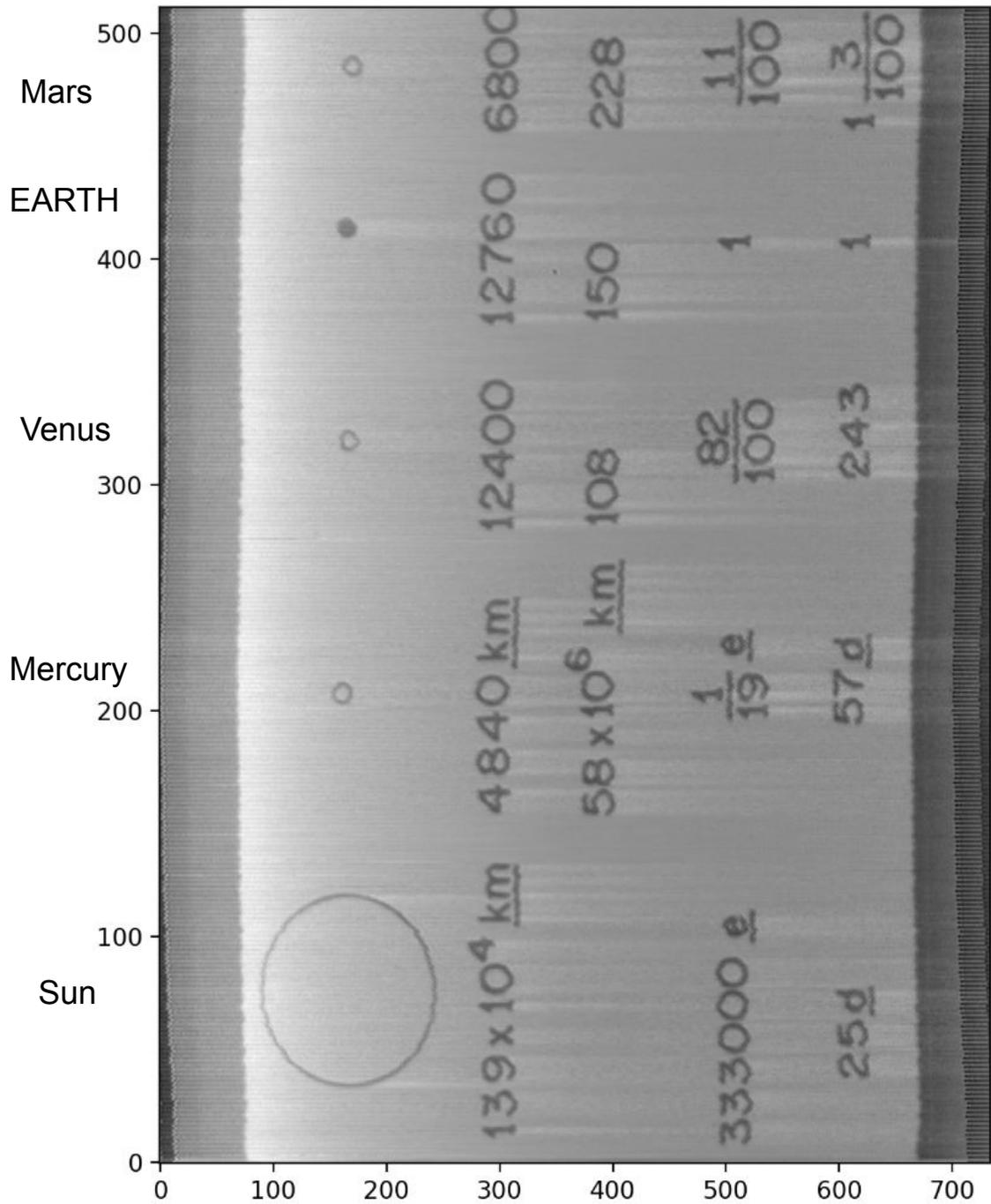
- We learned about this **cool** technique of **encoding images in sounds**, done by NASA a few decades ago!!
- **115** images decoded: each individual image had to be coded separately as the starting values were **not** exactly in an arithmetic sequence.
- The **adjustment values** differ for each image too
- High amount of **noise**: led to the increase in variability of the starting points of each image.
- **Depreciation in image quality** in some places: could be due to noise/**corruption of audio file/ phonograph**: not very accurate way of recording sound - **mechanical loss** of quality

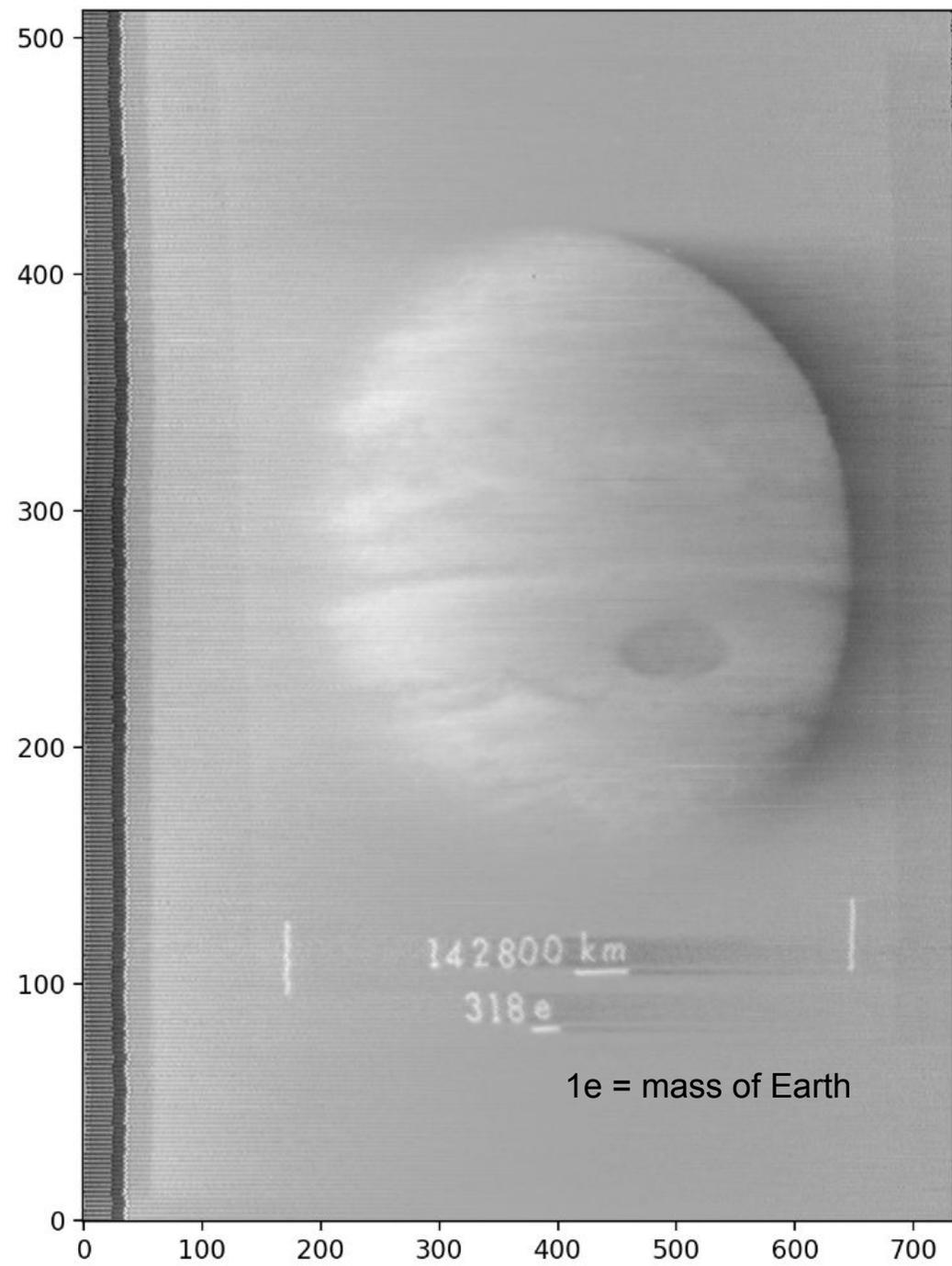
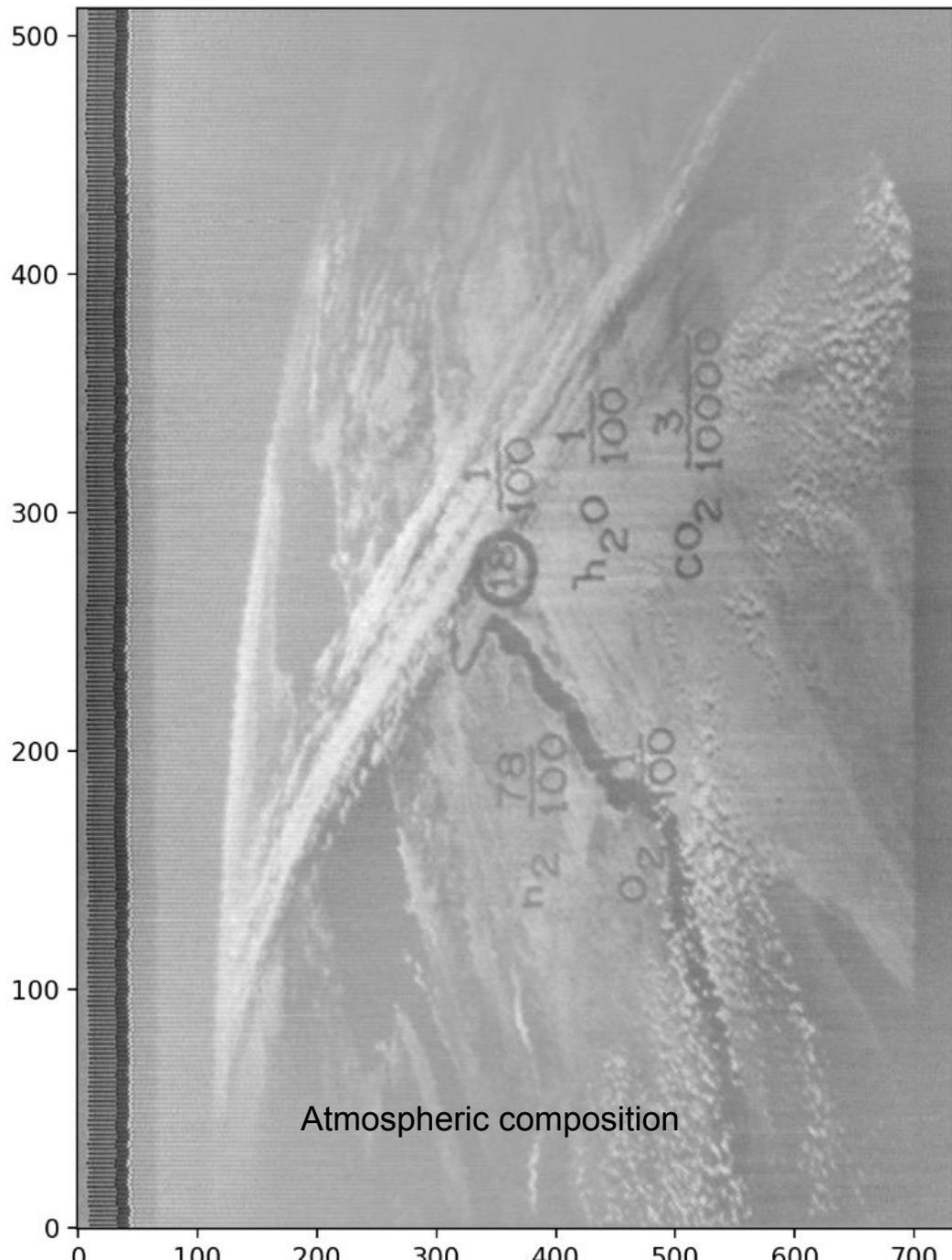
## FINDINGS AND RESULTS – PART 2

- The pictures we found showed many beautiful things on earth:
  1. fundamental mathematical operations: e.g. **fractions, addition, subtraction** etc.
  2. The **solar system**
  3. **Molecular** structure, **DNA** double helix, **cells**

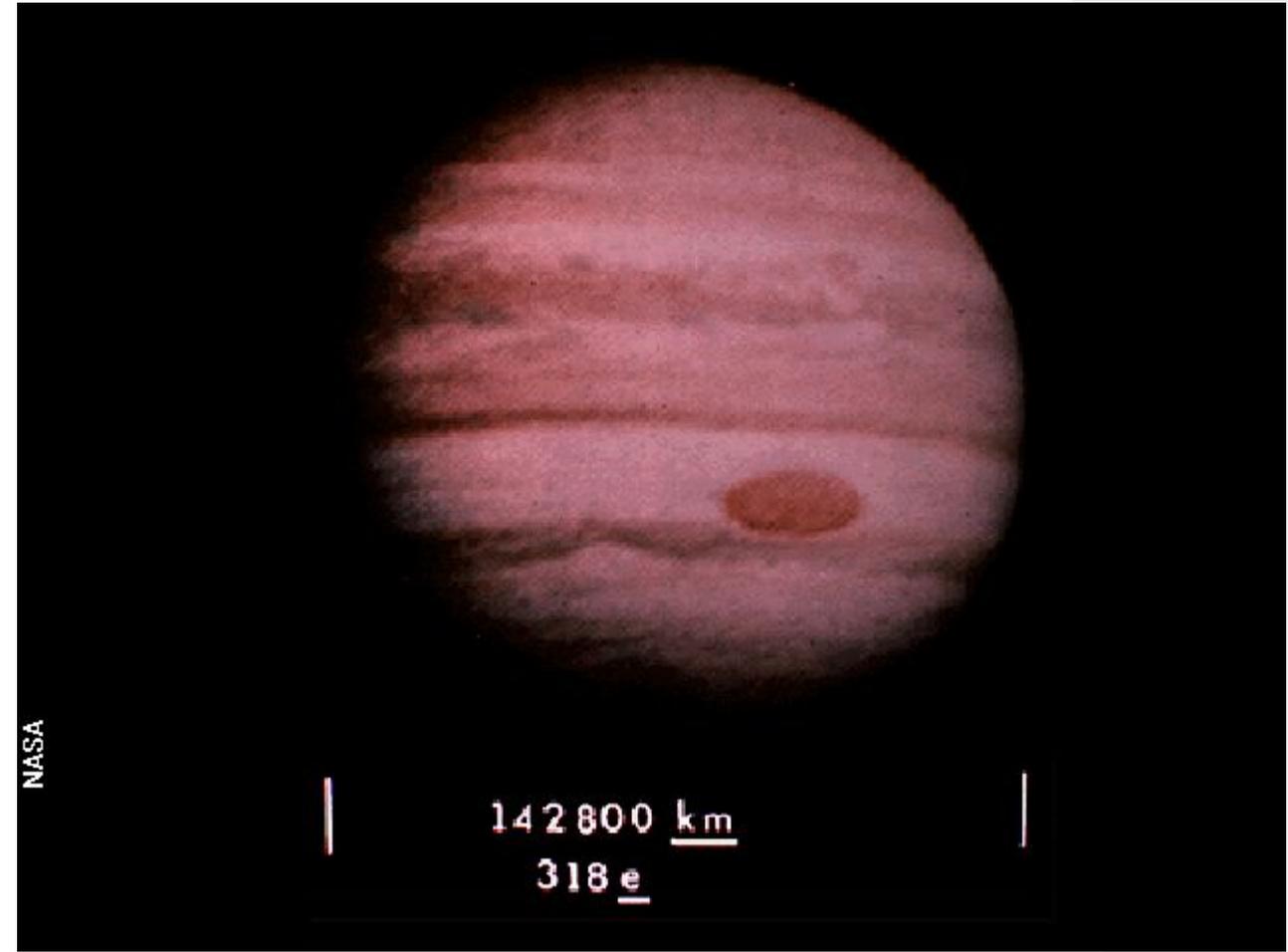
Let's be the aliens together for a while, and visualize the album Earth just dropped...

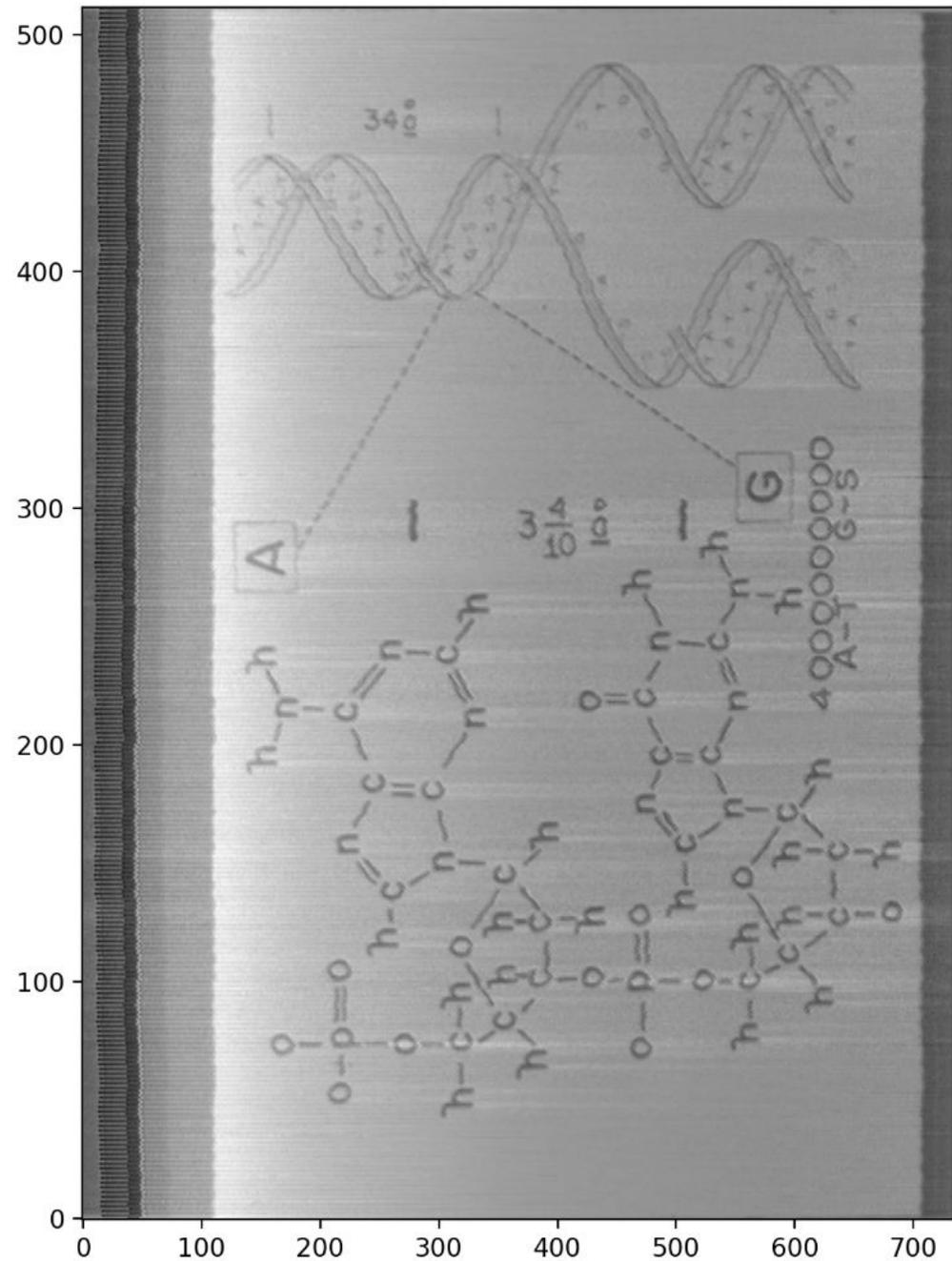
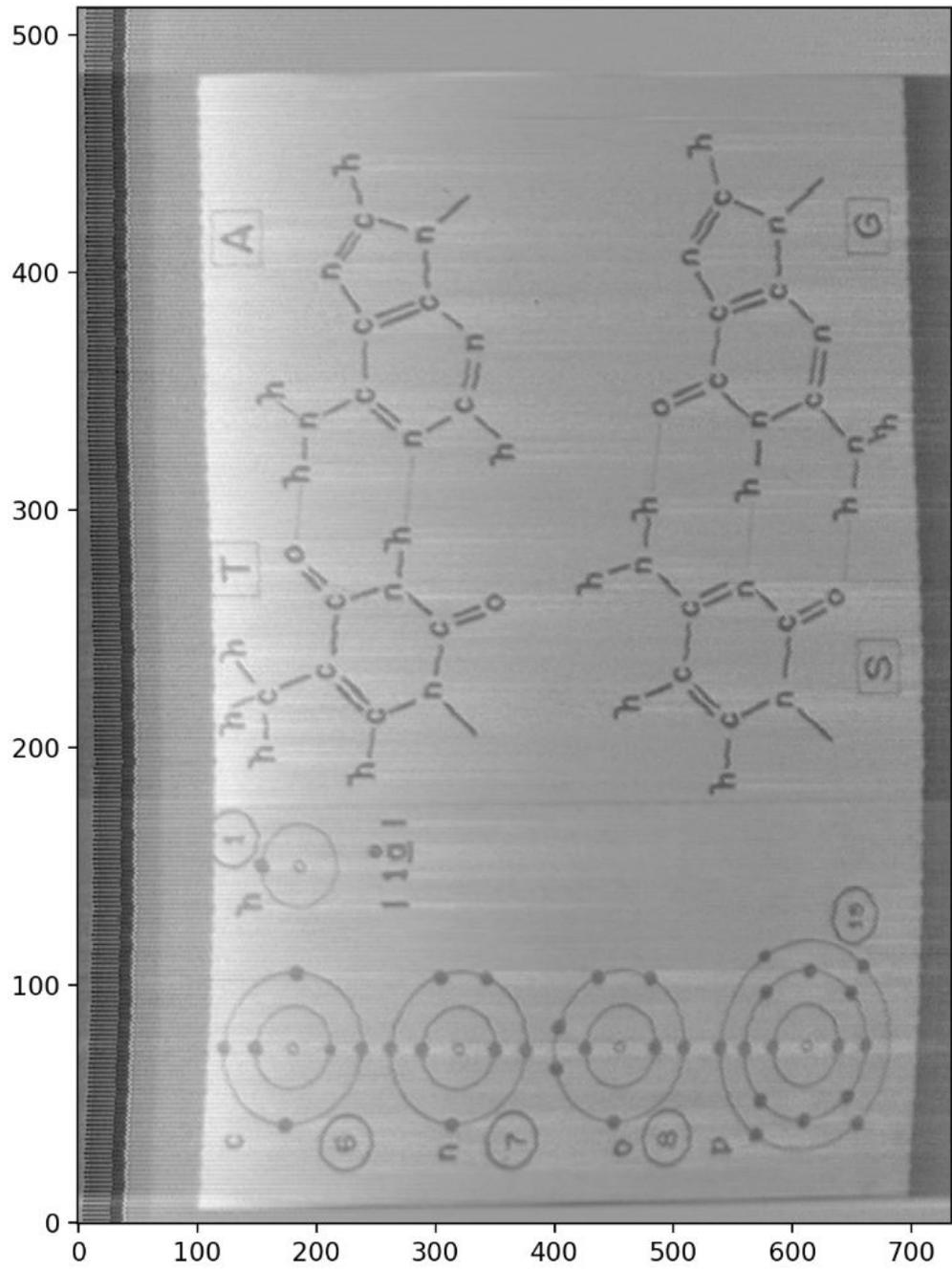


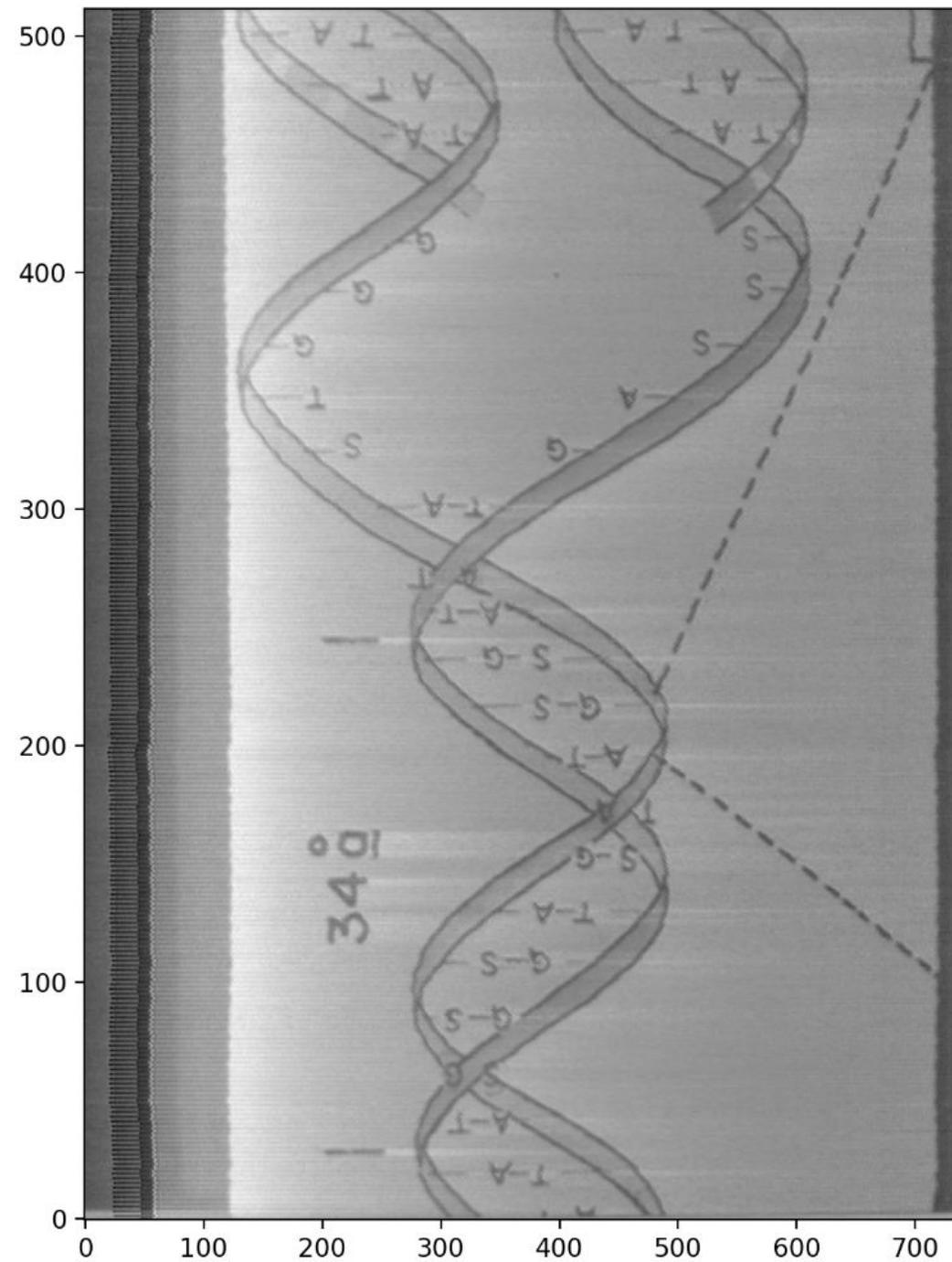
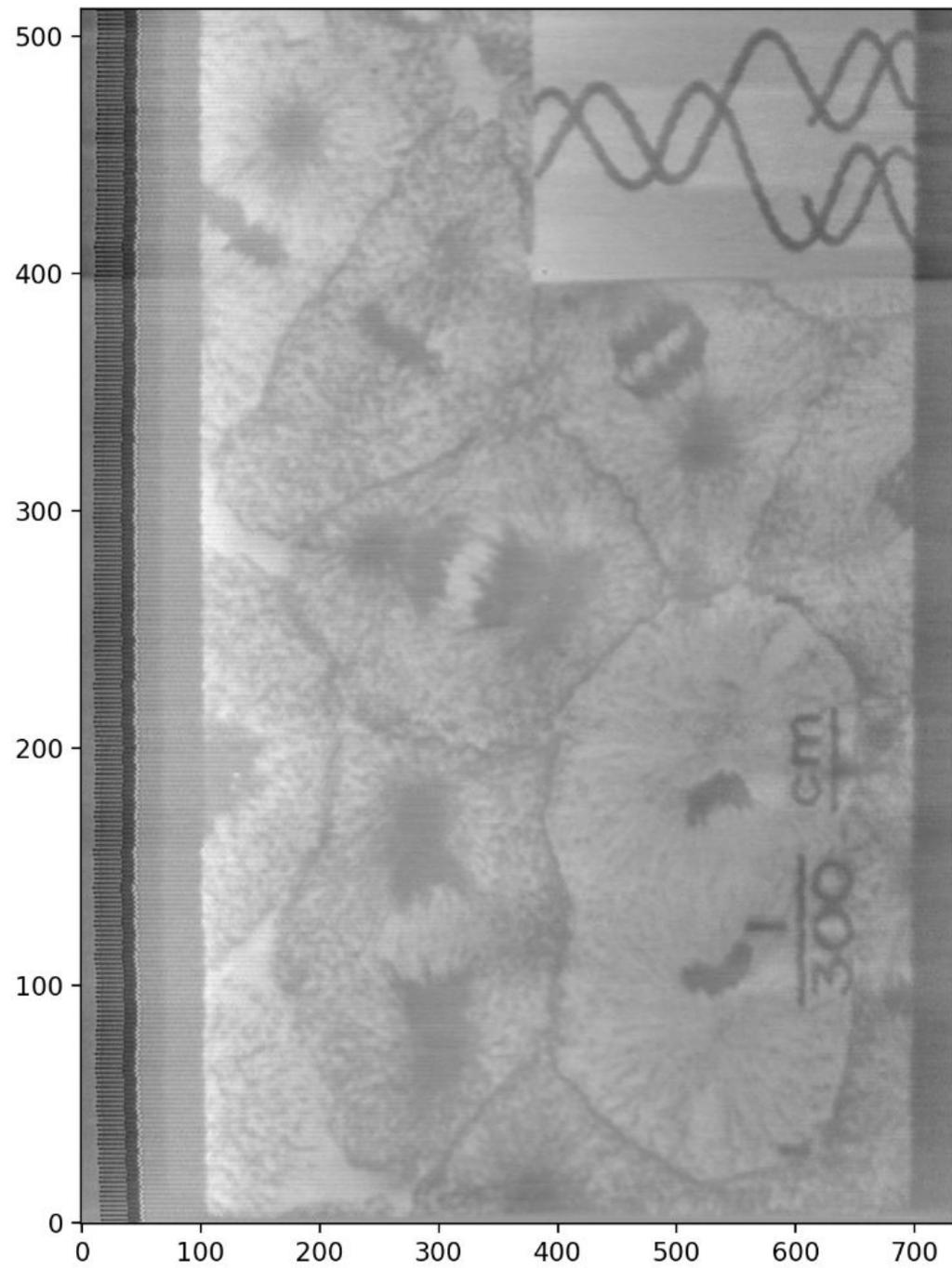




Comparison - Not bad right?! (Only black and white is encoded in the audio file)







# FINDINGS AND RESULTS - PART 3

RGB animation: stacking each image layer on top of the other.

Now the countryside!

## REFERENCES

- *Adler, Doug. "Will Aliens Understand Voyager's Golden Record?" Discover Magazine, Discover Magazine, 18 Apr. 2020, <https://www.discovermagazine.com/the-sciences/will-aliens-understand-voyagers-golden-record>. - This source gave us some information on how the aliens may be able to interpret and use the golden record.*
- *"Voyager - the Golden Record." NASA, NASA, <https://voyager.jpl.nasa.gov/golden-record/>. - From JPL's official page, information about the record and the voyager and pioneer projects in general.*
- *"Voyager - What's on the Golden Record." NASA, NASA, <https://voyager.jpl.nasa.gov/golden-record/whats-on-the-record/>. – From JPL's website, gave us some information on what was actually on the record.*