UNIVERSITÀ DELLA CALABRIA DIPARTIMENTO DI FISICA

A Basic Study of Dimensionality

A Quantitative Approach

Scientific Data Acquisition and Processing

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Abstract

A brief summary of the experiment.

Keywords

List of relevant keywords

Contents

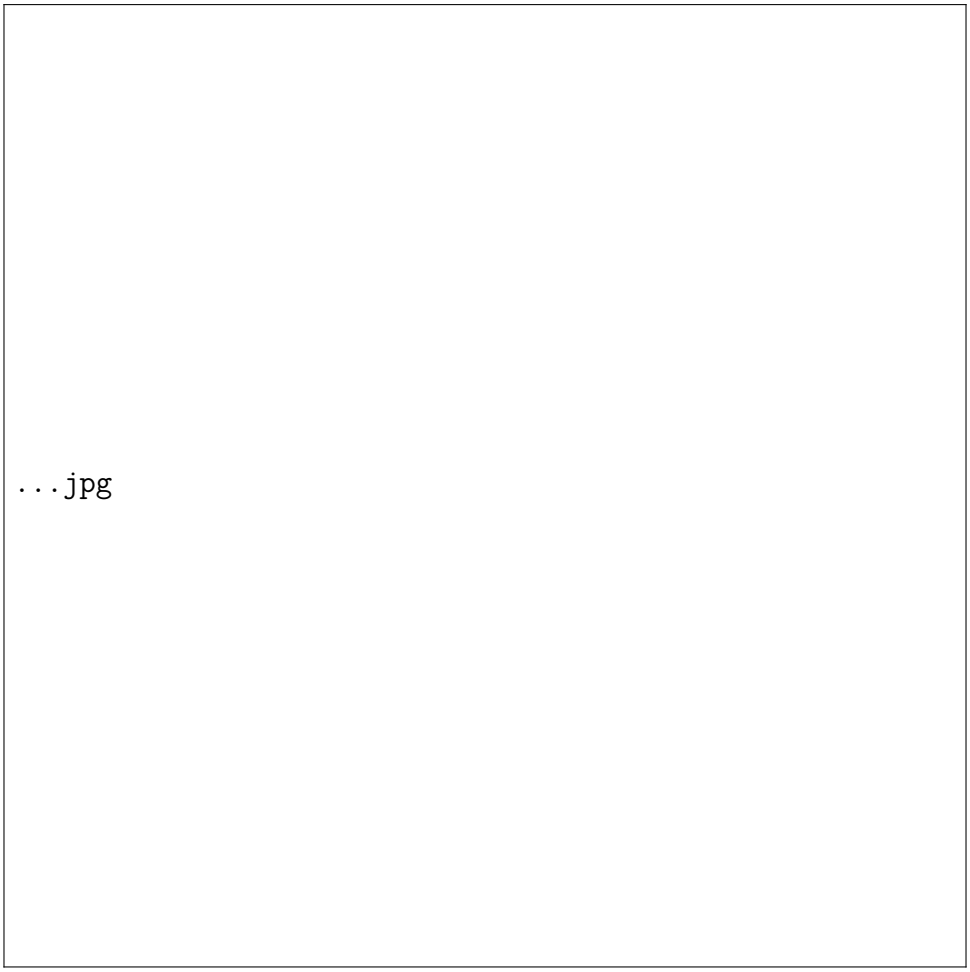

Figure 1: An example of cauliflower seen from far away (left) and from up close (right)

1 Introduction

In the following experiment our aim is to demonstrate the fractal nature of a very simple physical object: a small tin foil ball.

Fractal objects are objects which are characterised of the self-similarity property, in simpler words, they look the same when observed at different scales. One of the most famous fractal object is the Mandelbrot set, but we can find these objects also in nature, such as in the structure of a Romanesco Caullflower, or from a physical point of view, polymers can be regarded as fractals as well.

We can observe the same level of complexity of the images as seen from far away and up close in Fig **??** and Fig **??** above.

From the mathematical point of view, we have to define a fractal from its changes in

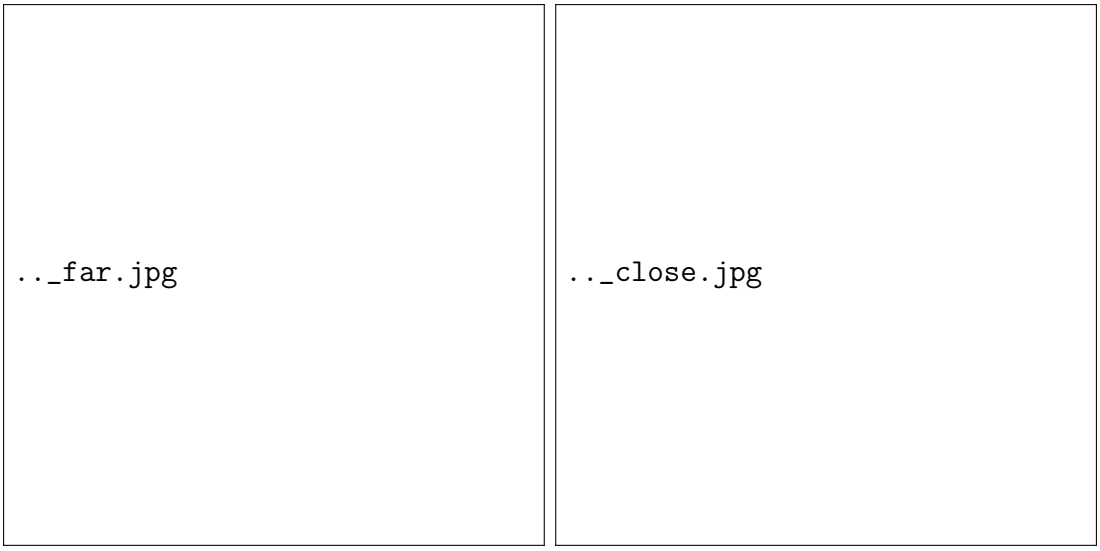

Figure 2: The Mandelbrot set seen from far away (left) and from up close (right)

terms of mass and volume. We start from an object that we know: a square sheet of paper. In this case we will have the mass distributed following the area of the sheet, furthermore the mass grows as the square of the typical lenght of the sheet (the side of the square which we will call r). The formula will be the following

$$M = Cr^2$$

where C is the surface density of the material of the sheet.

We can repat the same reasoning with a metal cube, obtaining ultimately the formula

$$M = Dr^3$$

where D is the volume density of the metal used.

Now let's apply this method to our experiment. Since the physical data which we will obtain will be the mass and the linear dimension of the system (the tin foil ball) the parameters will be the general density k and the exponent α in the formula

$$M_{\text{exp}} = kr_{\text{exp}}^{\alpha} \tag{1}$$

To sum up, in the following experiment we will see that also a rolled up ball of tin foil can be considered as a fractal.

2 Materials and Methods

2.1 Equipment and Tools

- Precision balance
- Caliber
- Micrometer
- Drawing rule and / or square
- Scissors
- Aluminum foil

2.2 Experimental Procedure

Detail the step-by-step process followed during the experiment, including any setup instructions, procedures, and configurations.

3 Results

Present all data collected, including graphs, tables, or charts. Explain the trends and observations found during the experiment.

4 Discussion and Analysis

Interpret the results, compare them with expected outcomes, and discuss any deviations or unexpected findings. Address possible sources of error and suggest improvements.

5 Conclusion

Summarize the main findings, confirm or refute the hypothesis, and suggest future research directions or practical applications.

6 Appendix

Include supplementary information such as raw data, calculations, or additional graphs that are too detailed for the main report but are still relevant.