

**DALÍ EXPERIENCE:
SALVADOR DALÍ AND MATHS**

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Abstract. Dalí experience is the title of an exhibition held in winter 2016/17 at Palazzo Belloni, a prestigious historic building in Bologna. The exhibition collected about 200 works, from the "The Dalí Universe" Collection, one of the richest documentations of Dalí's artistic history, exhibited in an interactive and multimedia path, with the aim of inviting the visitor to an engaging and participatory experience. A good fortune for lovers of ... maths!

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Mathematics Subject Classification: Primary 00A66; Secondary 00A06, 00A69

1 Introduction

Maths?!
Maths, yes.
(And art, of course!)

As people generally ignore, but Aplimat lovers know very well, art has a lot to do with maths. Consider for instance Salvador Dalí, one of the most revolutionary artists of his time. Just take a look at his mustache in one of the photographs in Figure 1: don't you think our genius shows some interest in the subject considered by many the most arid of the universe?

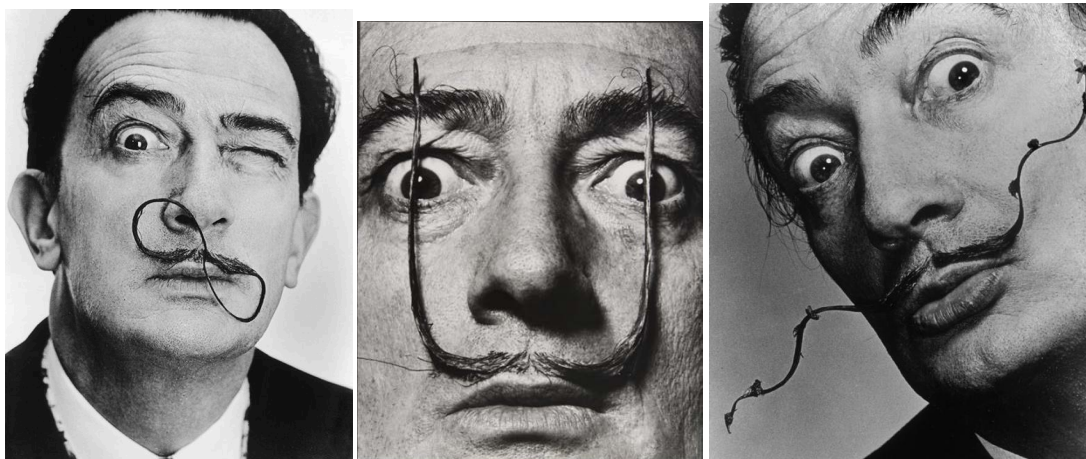


Fig. 1. Mathematical forms in the mustache of Salvador Dalí.

But Salvador Felipe Jacinto Dalí y Domènech (1904-89) goes a step further: analyzing his work is indeed a great way to support the thesis that mathematics can be, in addition to a good technical support for artists, also an exceptional creative stimulus. Starting from his statement, contained in his book *50 Secrets of Magic Craftsmanship*, according to which

«You must, especially as a young man, use geometry as a guide to symmetry in the composition of your works. I know that more or less romantic painters argue that these mathematical scaffolds kill the artist's inspiration, giving him too much to think and reflect. Do not hesitate for a moment to respond promptly that, on the contrary, it is just not to have to think and reflect on certain things that you use them».

Paraphrasing, Dalí suggests to the young artist a "recipe" for beauty: put close geometric constraints at the base of a picture, and then let your creativity flow, sure that the result will be aesthetically harmonic and nice to see. This recipe is made explicit by the preparatory sketches of Dalí, one among all that of the *Atomic Leda* (figure 2). Comparing the picture with its sketch, we realize that in the picture nothing is left to chance: the right foot of Gala-Leda ends in one of the five points of the Pythagorean star described by the diagonals of a pentagon inscribed in the circumference whose diameter delimits the width of the picture; the circumference is tangent to the bottom of the stool on which Leda is sitting, and the woman's head is entirely contained in the center point of the star. «Some days I have the impression that I will die of an overdose of satisfaction» - he used to say. He must have thought that while signing that picture: how to contradict him?



Fig. 2. Atomic Leda (1949 - left) and its preparatory study (right).

2 Golden section

Leda is one of the examples of paintings based on the concept of *golden section*, which underlies the construction of the pentagon: in a regular pentagon, in fact, the relationship between each diagonal and the side is the same as this number, Φ , known in the centuries as *gold number*, *golden ratio*, *golden section*, *golden mean* (look here <https://www.youtube.com/watch?v=kkGeOWYOFoA> to learn more). All artists have been fascinated by this number, and Dalí is conformist in this respect: golden rectangles and related objects pervade his work even when it does not seem.

It is quite clear, for instance, that the golden rectangle governs the proportions of *The Last Supper* (figure 3): the table is positioned so as to divide the total height in two parts that are in aureus ratio; the disciples to the right and left of Christ divide the picture into two vertical

strips of amplitudes in the golden ratio one with the other. In the background we can see the dodecahedron, which with its twelve pentagonal faces is a living incarnation of Φ .



Fig. 3. Golden Section in *The Last Supper* (1955). The ratio between the blue and white segments, both vertical and horizontal, is the golden one.

Equally explicit is the presence of the number Φ in *Giant Flying Mocca Cup with an Inexplicable Five Metre Appendage* (1944 - figure 4), of which we particularly like the title, with reference to the appendage that only serves to adjust the dimensions of the picture.

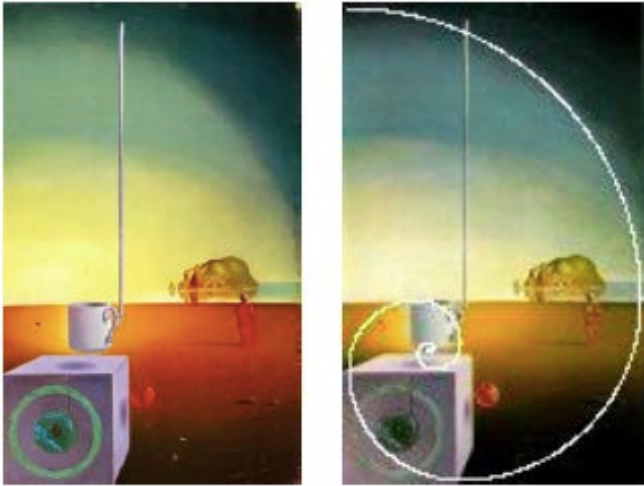


Fig. 4. Golden Spiral in *Giant Flying Mocca Cup with an Inexplicable Five Metres Appendage*. As shown in the figure on the right, the length of the pendant is given by the request that it ends at the intersection point between the vertical and the golden spiral centered in the cup and passing through the top left corner.

3 Topology

That of the golden section is a too popular maths for a poliedric artist such as Dalí, which in fact extends its interest in much more highbrow maths subjects.

In the Dalí Experience exposition in Bologna, for instance, one could appreciate the Dalínian soft watches, made famous by *The persistence of memory* (Fig. 6 - left). This is a representation of reality that we can define as a *topological* one, with reference to a relatively modern discipline, topology. This kind of geometry is a bit different from the one we study at school, where all objects have their own size, with rigid and crushproof contours. A topologist

thinks instead of objects as if they were made of pongo (or Didò, or plasticine, depending on his birth year): two objects are topologically equivalents if, thinking of them as made of plasticine, we can deform one into the other without cutting or gluing. A dish, for instance, is equivalent both to a bowl and a glass, while a cup with a handle is not the same as the previous objects, and a two-handled cup is not equivalent to either the first or the second. The cup with a handle, on the other hand, is equivalent to a lifebuoy, or to a donut (see https://commons.wikimedia.org/wiki/File:Mug_and_Torus_morph.gif)

Dalí's watches "trickle" as if they were made of plasticine, in a reality in which objects have changing contours, but their memory persists and remembers somehow the shape. Most of the works of Dalí's last period are topological even in the title: think about *Topological Contortion of a Female Figure* (1983, Figure 5 - left), and *Topological contortion of a female figure becoming a cello* (1983, fig. 5 - right)



Fig. 5. *Topological Contortion of a Female Figure* (left) and *Topological contortion of a female figure becoming a cello* (right).

It would be embarrassing, though mathematically significant, to get into the details of the topological genus of the female figure represented in these two paintings, and perhaps some reader would seek help from Freud. That is why we self-censor and take a step forward, from topology to quantum mechanics. This will lead us to leave Freud for Heisenberg, and the soft clocks for their disintegration: as Dalí writes in his *Manifesto antimaterico*, «during the surrealist period I wanted to create the iconography of the inner world and the wonderful world conceived by my father Freud. Today, however, the outer world and the physical world have surpassed that of psychology. Today my father is Dr. Heisenberg. » As a consequence, the *persistence* of 1931 *disintegrates* in 1954, decomposing into blocks who summarize the author's recognition of the new frontiers of science (see Fig. 6 - right).

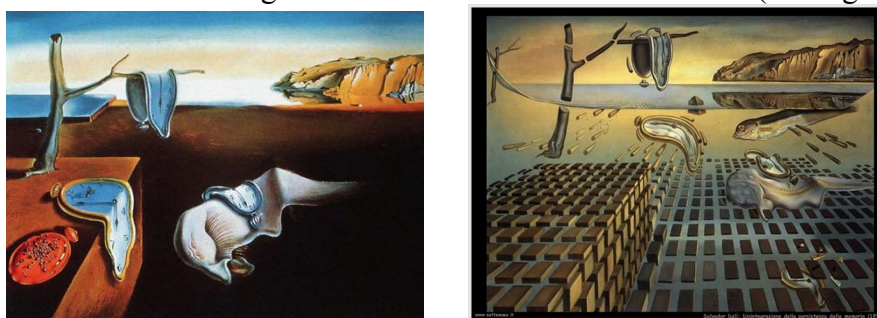


Fig. 6. *The Persistence of Memory* (l) vs *The Disintegration of The Persistence of Memory* (r).

Before leaving the concept of topology, if you have been so lucky to visit it, think about the Dalí experience exhibition and reflect on the modalities of the exhibition itself: we can define it in a certain sense "intrinsically topological" because it "trickles" on the city, in paths that pour out from Palazzo Belloni to inundate all Bologna, in a deliberately interactive experience

that softens boundaries, deforming and contaminating. Something that definitely Dalí would have liked a lot.

4 Fourth dimension

But let's go further: if you talk about Dalí's relationship with mathematics, you can not help but mention his passion for the fourth dimension, embodied in the beautiful representation of the hypercube that serves as a cross to the Christ of *Corpus Hypercubus* (1954). Just as the cross represents the planar development of a cube, the figure to which the dalinian Christ is crucified represents the three-dimensional development of its analogue in dimension 4, which mathematicians call *hypercube*: the artist uses this concept to communicate the idea of the transcendence of Christ, who lives in an higher dimension than the ones the human beings are able to conceive.

Let's explain something more: imagine a square. If we "cut" the two sides converging to one of its vertices, we can "open" the square up to extend it along a straight line, which occupies 4 consecutive segments: this figure represents the 1-dimensional development of a square. It lives in the plan, in 2 dimensions. Now let's take a cube, for instance a cubic box of cardboard. If we cut the box over three consecutive sides, and then carefully cut it along other sides (which ones?!), we can, as before with the square, open the cube and spread it on a table: the cross-shaped figure we get represents the 2-dimensional development of the cube, which lives in the 3-dimensional space instead. Finally, let's take an hypercube: none of us can imagine it (at least we think, with artists is better not to be too categorical), because such an object lives in 4 dimensions, where our perception does not arrive. However, we can think of doing the same as before with the square and then with the cube, that is "cutting" the hypercube ... along what? Think about that, and you will conclude that it is along a set of squares that bound cubes, which in turn bound the hypercube. If you cut correctly, you can "open" your hypercube and "spread it" in the ordinary space, that is in the 3-dimensional space, where we all can see it. What we will see is actually the 3-dimensional development of the hypercube, which lives in a 4-dimensional space, but is so kind to visit Dalí in a smaller dimension so that he can draw it!

See more, play and get much more references about maths popularization of the concept of fourth and higher dimensions at <http://www.loopmm.com/benvenuti/index.html> [20].

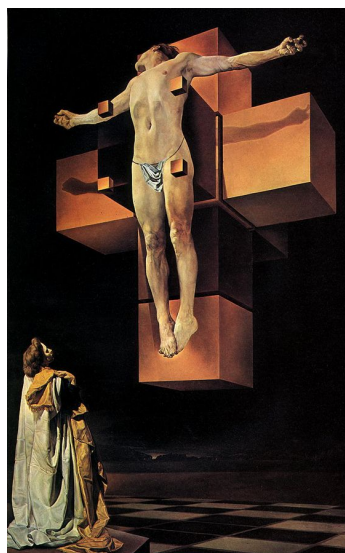


Fig. 7. Fourth Dimension in Dalí: Corpus hypercubus.

5 Catastrophe theory

But let's go further: while visiting the Bologna exhibition, you will surely dream to rest a second on the object that looks so good in one of the central rooms (see fig. 8). Definitely, it is a sofa. But certainly not a usual one, with that color, vivid red, and with that peculiar shape.



Fig. 8. Mae West sofa (1935?).

As Salvador Dalí himself designed it, it cannot be a trivial object. In your living room it would be perfect, next to the window door, though no placement can match the one our man conceived in his Figueres home-museum, to draw a smile in the serious face of the actress Mae West. But the most surprising thing is that this object, with its comfortable sensuality, is not inspired (perhaps) by the fleshy lips of Gala or those of Mae West itself, but rather by the cryptic sensuality of ... a mathematical concept. Concept, besides, which is not at all a trivial one: that of "singularity", or "bifurcation", or "catastrophe". Dalí heard about that probably through the mathematician René Thom, his friend and Fields medal winner, author of the book *Structural Stability and Morphogenesis*, the Bible of Catastrophes.

Let us consider a mathematical object, for example the curve in Figure 9a, described by an equation containing one or more parameters. By making them change gradually, the parameters can be used as "knobs" to adjust the position and shape of the curve: sometimes small variations cause small changes, as can be seen from the situation in fig. 9a to that of Fig. 9b; in other cases, minimal variations cause the transition between two qualitatively different situations, such as in the passage from the curve made by a single piece of figure 9b to the one composed of two pieces shown in figure 9d. We then say that a bifurcation, or a catastrophe, occurred. Specifically, the catastrophe curve is that of figure 9c, from which any minimal variation in the parameter leads to the two qualitatively different situations depicted in the adjacent figures. Thom, in his book, lists a finite number of "elementary catastrophes", with evocative names such as swallowtail, butterfly, fold, cusp, etc, which generate all the others, including the lips we met above.

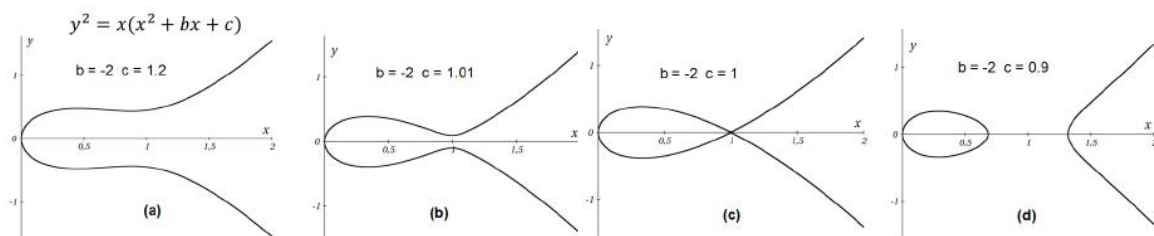


Fig. 9

Well: if Thom's book stays on Dalí's night table starting from 1984, while Mae West's sofa is designed in 1935, it's really difficult for the latter to be really inspired by the former - although, being Dalí a visionary man, nobody knows. Imagine, however, Dalí's satisfaction in seeing his sofa emerging from Thom's original pages as a «section of the continuous surface

of two cusps contained in the image of a swallowtail catastrophe». It looks like a tongue-twister, in fact. But figure 10 explains it better.

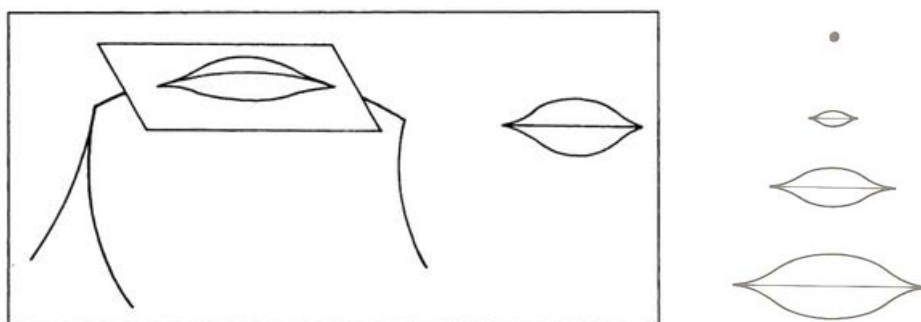


Fig. 10. Formation of the lips singularity (Tito Tonietti - left); same singularity in the book of Thom (right).

If that of the lips singularity is an *a posteriori* interpretation, there is no doubt that Dalí explicitly relies on Thom's theory in his last works: the catastrophe known as the swallowtail, for instance, is the main character of both his last picture, *Swallowtail and cello* (1983 - fig. 11, left) and of *Topological abduction of Europe. Tribute to René Thom* (1983 - fig. 11, right).

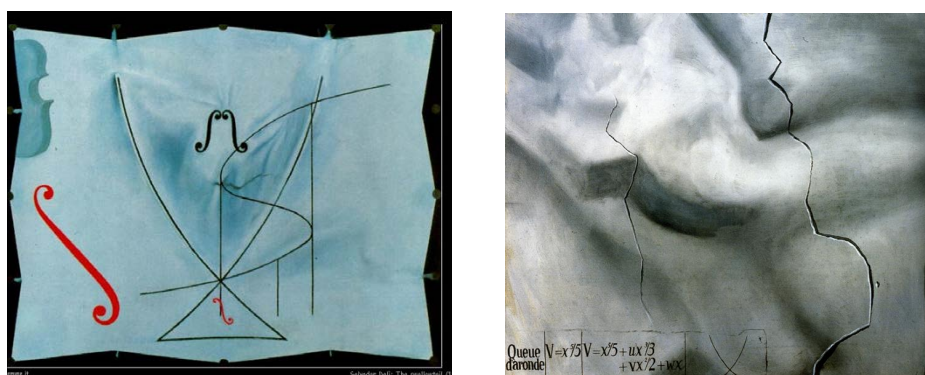


Fig. 11. *Swallowtail and cello* (left) and *Topological abduction of Europe*. (right).

After all, the artist defined the Catastrophe Theory as «the most beautiful aesthetic theory in the world». And it is not a matter of a senile dementia: as we are proving, Dalí has been deeply fascinated by maths throughout all his life, and his works deeply reflect its passion.

6 But there's a lot more...

But there is a lot more: Salvador Dalí not only understands the importance of mathematics, so much to use it deliberately in his paintings; moreover, he studied it a lot, thanks also to his friendship with important mathematicians like René Thom, Matila Ghyka, Thomas Banchoff, Martin Gardner. He was also irresistibly attracted by many other sciences: he personally knew Einstein, studied theory of relativity and quantum physics, his home-museum is full of representations of the model of the hydrogen atom; his library contained hundreds of science books, with its annotations on the margin to witness fervent reading; he was until his death subscribed to many scientific journals; he did not even miss one of the six major lectures, of important physicists, mathematicians, astrophysics and chemists, of the symposium *Cultura y ciencia: determinismo e libertad*, celebrated in 1985 in his museum; one of his paintings, in

tribute to Crick and Watson, is titled *Galacidalacidesoxiribonucleicacid ...* do you need other evidence of his fascination for ANY science?

One mention would be due to a thousand other mathematical themes, including anamorphisms, stereoscopy, optical illusions and holograms. But the range of math arguments touched by Dalí is so vast that it is unavoidable to operate a selection, democratically carried out according to the preferences of the writer.

Hence, let me conclude with a topic perhaps more neglected, but that you have noticed for sure: the ubiquity of the egg. The eggs in Dalí can be found everywhere: the wall of his house in Figueres (fig. 14) have monumental spherical and ovoidal decorations; eggs appear in many of his paintings and sculptures; egg-shaped are the faces of many of his statues. Dalí apparently considered the egg to be so fundamental to use them as a cabin for his *Ovocipede*, a peculiar means of locomotion that in his times was perhaps not properly appreciated, but constitutes today the joy of thousands of children (including the author's) and the despair of thousands of moms (including myself) when we meet it in the playgrounds (Figure 12). Both the dalinian and the modern ovocipede have a propulsion system based on the driver's movement: essentially the driver runs like a hamster making it roll, and then releasing sweaty and soaking wet, but extremely happy (at least until he is 8 years old ...).



Fig. 12. Dalinian (left) and modern (right) ovocipede.

For a topologist, an egg is completely indistinguishable from a sphere (and also from a cube, or a dodecahedron); moreover, an ostrich egg is topologically equivalent to one of quail, as well as any intermediate egg size. If, however, we forget the topology and consider the objects in accordance with their metric properties, then everything changes: the egg and the sphere are distinct objects, and the ostrich egg is metrically different from the hen one. What, however, combines eggs of different shapes is that all of them are obtained by turning a flat curve around its axis: if we want to get a sphere we will rotate a circle, if we need an ellipsoid we will use an ellipse, if we really want an egg ... well, it gets a bit more complicated. Go to the fridge and take any egg: you will notice that while the sections made with planes perpendicular to the axis are all circumferences of different sizes (which tells us that the egg it is a rotation surface), those obtained by cutting with planes containing the vertical axis are neither circumferences nor ellipses, but strange curves in which a half is more paunchy than the other. Obviously, a mathematician can not cook an egg while ignoring the equation of the curve that generates it by rotation: hence here come the ovals of Cassini, Descartes and

Kepler, as well as the egg of Granville, that of Hügelschäffer and that of Moss, to end up with the double egg.

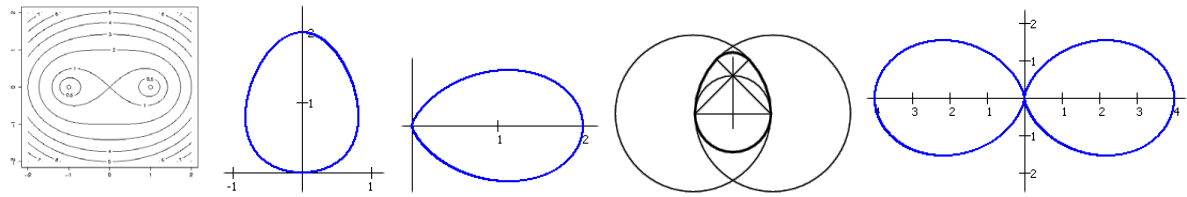


Fig. 13. Mathematical Eggs: Cassini, Granville, Keplero, Moss, Double Eggs.

As we said, the egg is ubiquitous in Dalí: he draws and sculpts it in all the possible shapes and sizes, and it comes spontaneously to wonder why. One possible explanation is that the egg is in fact also present in many classical paintings as a symbol of resurrection, as it is intrinsically linked to the birth of a new life: we find it for example in the famous *Pala di Montefeltro*, also called *Madonna of the Egg*, by Piero della Francesca, that Dalí loved so much to reproduce it in his peculiar way in the famous *Madonna of Port Lligat* (1950). It is well-known that Dalí had a deep fascination for classics, who he reinterpreted in unsuspected ways, for example by making a surrealist landscape on Michelangelo's Giuliano dei Medici's cheek, or strategically perforating his pictorial reproduction of the Pietà (see <http://www.mostradalipisa.it>).

«Begin by drawing and painting like the ancient masters», he used to say with regard to that. «After that you can do what you want: everyone will respect you».

A second reason for the persistence of the egg in Dalí's work is probably his "intrauterine egg theory": he was convinced to remember perfectly of his life in the maternal uterus, which he transforms into a kind of gourmet paradise where *huevos fritos* dominate.

In a more prosaic way we can also see in that ubiquity a manifestation of its Catalan spirit: in Barcelona and the surrounding area, in fact, the *ou* is eaten in all restaurants, from the greasy spoon to the starred restaurant, *ferrat* and accompanied by potatoes and *pernil de gla* in its working class' version, or "cooked at low temperature on potato parmentier and black butifarra foam" from 4 stars up. Besides, it is certain that Dalí wanted to pay homage to his land by immortalizing some of its culinary excellence: just think of the Empordà loaf with which he rakes the walls of his museum (fig. 14), that with the *ou ferrat* is absolutely delightful.



Fig. 14. Eggs and loaves in the walls of the Teatro Museo di Figueres.

Moreover, for Dalí, who at six years wanted to become a (female) chef, cooking is a fundamental pleasure, so much as to push him to write and illustrate even a recipes book, entitled of course *Gala Recipes*, not precisely dietetic ones: «If you are a follower of these calorie weighters who transform the joys of a meal into a punishment, close the book», he writes in the preface. At this point it is impossible, even if blasphemous, to resist the

temptation of demystifying our genius by imagining it in slippers in front of a half-finished canvas, while Gala with the apron mess about at the stove and, when the eggs are cooked, calls him: "Cariiiiinyo, lunch is ready when you aaaaareeeee, run that it gets coooold!"

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