Python for non-coders : from physics to video games

David Louapre
Science étonnante & Ubisoft

« If you learn to code, and then become a professional programmer, you will be yet another coder among thousands.

But if you do anything else : psychology, physics, history, medecine, art… and know how to code, all your peers will think you’re a wizard. »

Definition 5 (Chain-mail invariant) *The chain-mail invariant is defined as the sum over representations labels (colors), of the evaluation of the colored link.*

$$CM(M,\Delta,T,T^*) = \left(\prod_{e\notin T}\sum_{j_e} d_{j_e}\right)\left(\prod_{e^*\notin T^*}\int_{H/W} d\theta_{e^*}\,\Delta^2(\theta_{e^*})\right)\ \mathrm{eval}[L_{\Delta,T,T^*}(\theta_{e^*},j_e)] \tag{25}$$

D. Main theorem

So far we did not prove that $CM(M,\Delta,T,T^*)$ is independent of all the ingredients and is actually an invariant of M. This is proved by the fact that it is equal to the Ponzano-Regge invariant. This is the main result of this paper which gives rise to the following theorem

Theorem 2 *The Ponzano-Regge amplitude we defined for a colored triangulation is equal to the Reshetikhin-Turaev evaluation of the colored chain-mail link*

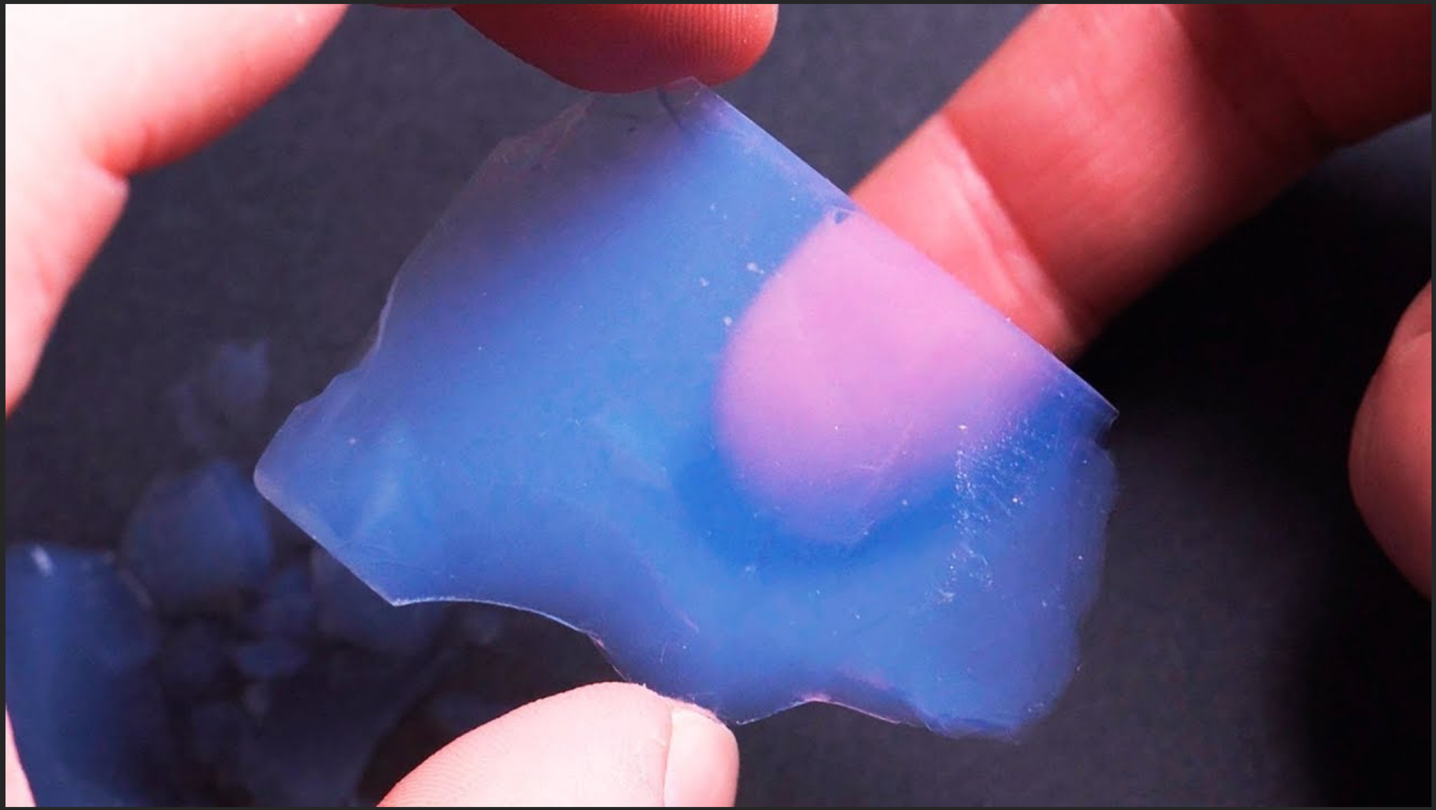
$$Z_{\Delta,T,T^*}(\{j_e\},\{\theta_{e^*}\}) = \mathrm{eval}(L_{\Delta,T,T^*}(\{j_e\},\{\theta_{e^*}\})) \tag{26}$$

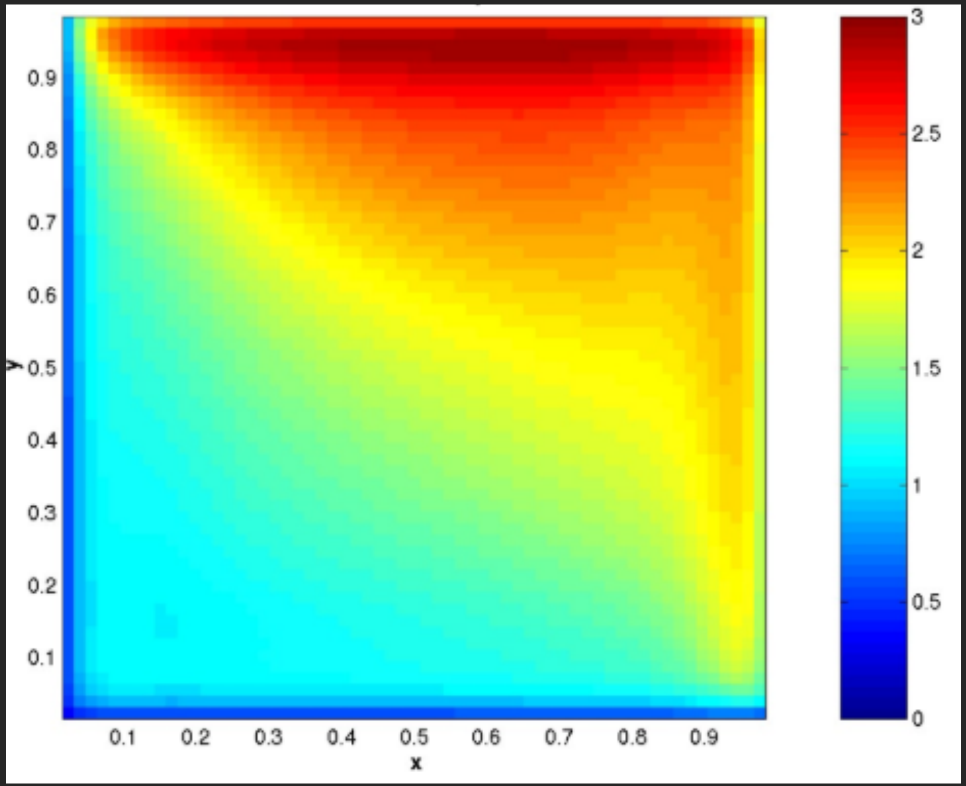
It then follows from (16) and (25) that

$$CM(M,\Delta,T,T^*) = PR(M_d). \tag{27}$$

$CM(M,\Delta,T,T^*)$ is thus an invariant of M that can be denoted $CM(M)$. It is equal to the gauge fixed Ponzano-Regge invariant.

SAINT-GOBAIN





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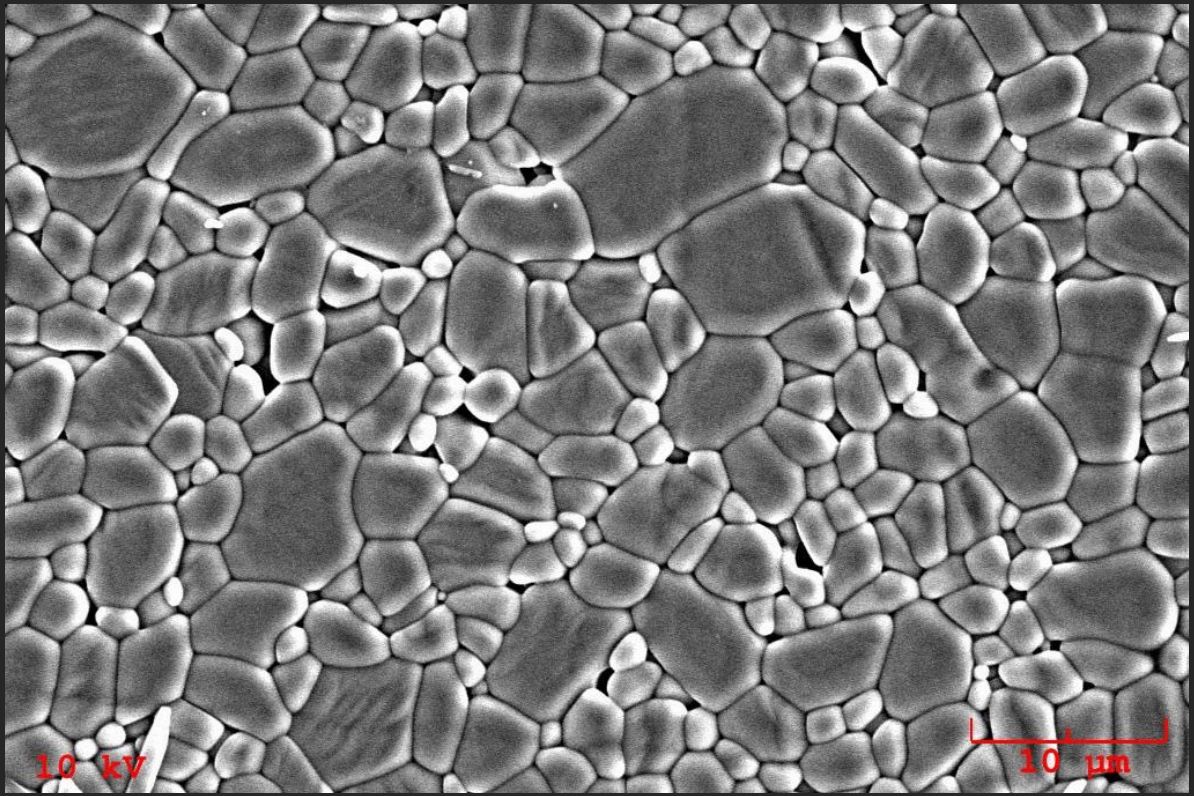
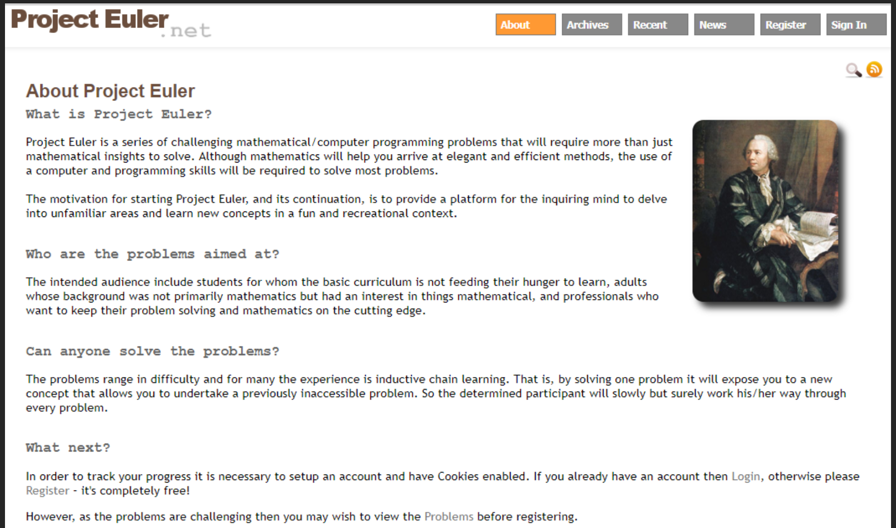
WinPython




Project Euler.net

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About Project Euler

What is Project Euler?

Project Euler is a series of challenging mathematical/computer programming problems that will require more than just mathematical insights to solve. Although mathematics will help you arrive at elegant and efficient methods, the use of a computer and programming skills will be required to solve most problems.

The motivation for starting Project Euler, and its continuation, is to provide a platform for the inquiring mind to delve into unfamiliar areas and learn new concepts in a fun and recreational context.

Who are the problems aimed at?

The intended audience include students for whom the basic curriculum is not feeding their hunger to learn, adults whose background was not primarily mathematics but had an interest in things mathematical, and professionals who want to keep their problem solving and mathematics on the cutting edge.

Can anyone solve the problems?

The problems range in difficulty and for many the experience is inductive chain learning. That is, by solving one problem it will expose you to a new concept that allows you to undertake a previously inaccessible problem. So the determined participant will slowly but surely work his/her way through every problem.

What next?

In order to track your progress it is necessary to setup an account and have Cookies enabled. If you already have an account then Login, otherwise please Register - it's completely free!

However, as the problems are challenging then you may wish to view the Problems before registering.

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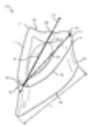
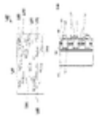
image processing in python

Abrasive article including shaped **abrasive** particles



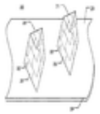
CA CN EP JP KR US WO • Application US20150000209A1 • David **Louapre** • Saint-Gobain Ceramics & Plastics, Inc.
Priority 2013-06-28 • Filing 2014-06-27 • Publication 2015-01-01
A shaped **abrasive** particle having a major surface-to-side surface **grinding** orientation percent difference (MSGPD) of not greater than about 35%.

Abrasive article including shaped **abrasive** particles



CA CN EP JP ~~KR~~ **US** WO • Application US20150291865A1 • Kristin BREDER • Saint-Gobain Ceramics & Plastics, Inc.
Priority 2014-04-14 • Filing 2015-04-14 • Publication 2015-10-15
15 . A shaped **abrasive** particle comprising: a body comprising a first major surface, a second major surface, and a side surface extending between the first major surface and the second major surface, wherein the body comprises an oblique, truncated shape. 16 . The shaped **abrasive** particle of claim 15

Shaped **abrasive** particles and methods of forming same



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Priority 2013-09-30 • Filing 2014-09-30 • Publication 2015-04-02
1 . A shaped **abrasive** particle comprising a body having at least one major surface having a self-similar feature. 2 . The shaped **abrasive** particle of claim 1 , wherein the body comprises a corner roundness of not greater than about not greater than about 100 microns. 3 . The shaped **abrasive** particle of

Abrasive article including shaped **abrasive** particles

CA CN EP **JP** ~~KR~~ US WO • Application US20150291866A1 • Christopher Arcona • Saint-Gobain Ceramics & Plastics, Inc.
Priority 2014-04-14 • Filing 2015-04-14 • Publication 2015-10-15
A shaped **abrasive** particle comprising a body comprising a first major surface, a second major surface, and a side surface extending between the first major surface and the second major surface, wherein a first portion of the side surface has a partially-concave shape. 11 . The shaped **abrasive** ...

Abrasive article including shaped **abrasive** particles

CA CN EP JP KR US WO • Application US20150291867A1 • Kristin BREDER • Saint-Gobain Ceramics & Plastics, Inc.
Priority 2014-04-14 • Filing 2015-04-14 • Publication 2015-10-15
A shaped **abrasive** particle including a body comprising a first major surface, a second major surface, and a side surface extending between the first major surface and the second major surface, the body having a Shape Index within a range between at least about 0.48 and not greater than about 0.52 ...

Abrasive article including shaped **abrasive** particles

CA CN EP JP KR US WO • Application WO2014210568A1 • David **Louapre** • Saint-Gobain Ceramics & Plastics, Inc.
Priority 2013-06-28 • Filing 2014-06-27 • Publication 2014-12-31
A shaped **abrasive** particle having a major surface-to-side surface **grinding** orientation percent difference (MSGPD) of at least about 40%.


SCIENCE ÉTONNANTE
Le blog de David Louapre
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MON LIVRE
COSMOLOGIE 3 : LA CONSTANTE COSMOLOGIQUE
6 JUILLET 2015 / DAVID / MODIFIER
Cela fait un moment que je vous dois le troisième (et probablement dernier) épisode de ma série consacrée aux bases théoriques de la cosmologie. Nous allons donc parler de la constante cosmologique, c'est-à-dire de l'expansion accélérée de l'Univers et de la fameuse « énergie noire » : un thème que j'avais déjà abordé dans une vidéo il y a quelques semaines. Mais comme par écrit je peux me permettre de prendre mon temps, je vais en profiter pour apporter pas mal de détails et quelques nuances.
Commençons donc par faire un rapide résumé des épisodes précédents. Si ça n'est pas déjà fait, je vous invite à aller les relire ici (partie 1 : le Big-Bang) et là (partie 2 : forme et destin de l'Univers). Mais comme je sais que vous n'allez pas le faire, je vais y aller tranquillement pour rappeler les bases !
PREVIOUSLY, DANS COSMOLOGY…
Pour faire de la cosmologie sans trop se compliquer la vie, on fait l'hypothèse que l'Univers est homogène et isotrope, c'est-à-dire identique en tout point de l'espace et dans toutes les directions. Pour décrire un tel Univers à un instant donné, il n'y a que deux choses qu'il faut préciser :
• sa courbure (ou son rayon de courbure) qui est forcément la même en tout point de l'espace puisque ce dernier est supposé homogène;
• la densité de matière/énergie qu'il contient, elle aussi identique en tout point pour la même raison.
RECHERCHER…
RECHERCHER
MON LIVRE
David Louapre
INSOLUBLE MAIS VRAI !
CES ÉNIGMES ET CASSE-TÊTE QUI RÉSISTENT ENCORE À LA SCIENCE
FACEBOOK
Science …
38 K mentions J'a…
J'aime déjà
Vous et 80 autres amis aimez ça
TWITTER
J'ai quand même la vague impression qu'avec du reinforcement learning, on devrait pouvoir entrainer un algorithme p… twitter.com/i/web/status/1… 4 hours ago
Suivre @dlouapre
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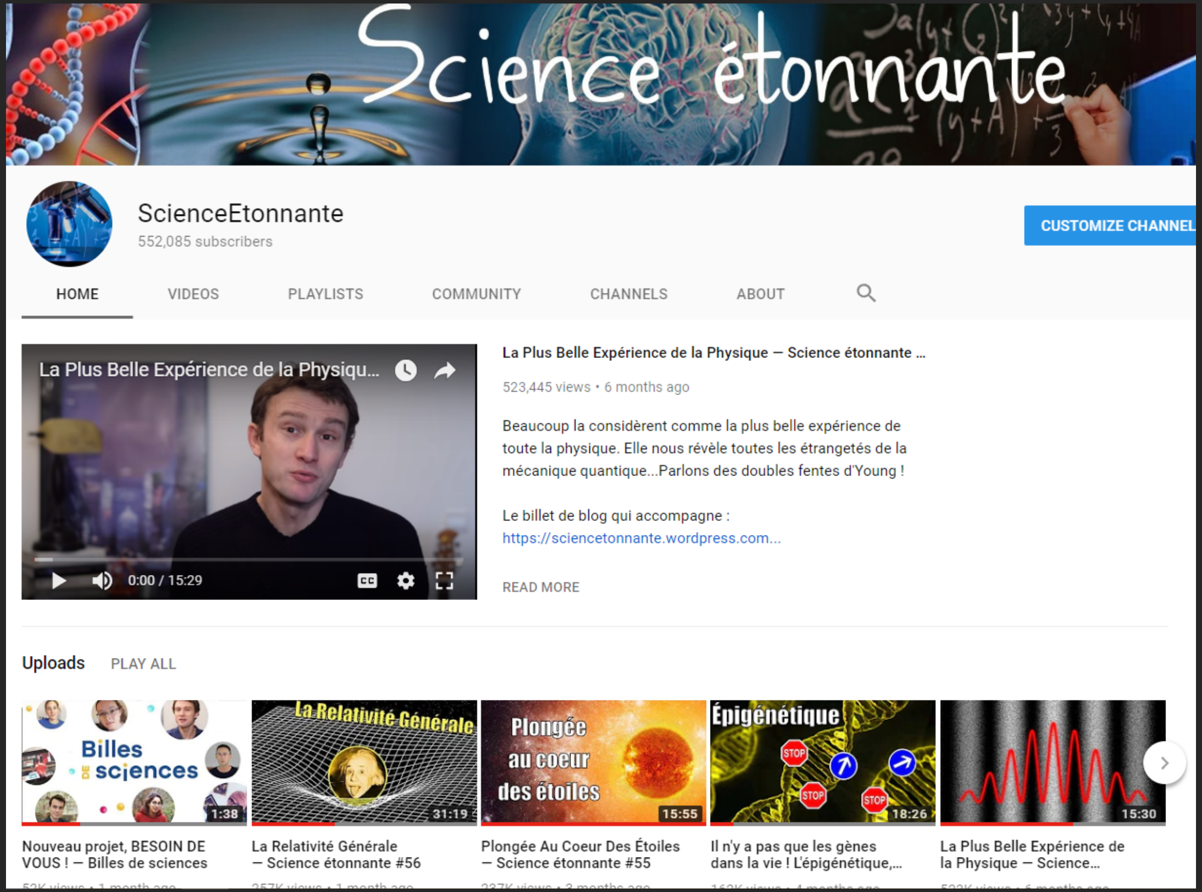
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523,445 views • 6 months ago
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La Relativité Générale
31:19
Plongée au coeur des étoiles
15:55
Épigénétique
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Nouveau projet, BESOIN DE VOUS ! — Billes de sciences
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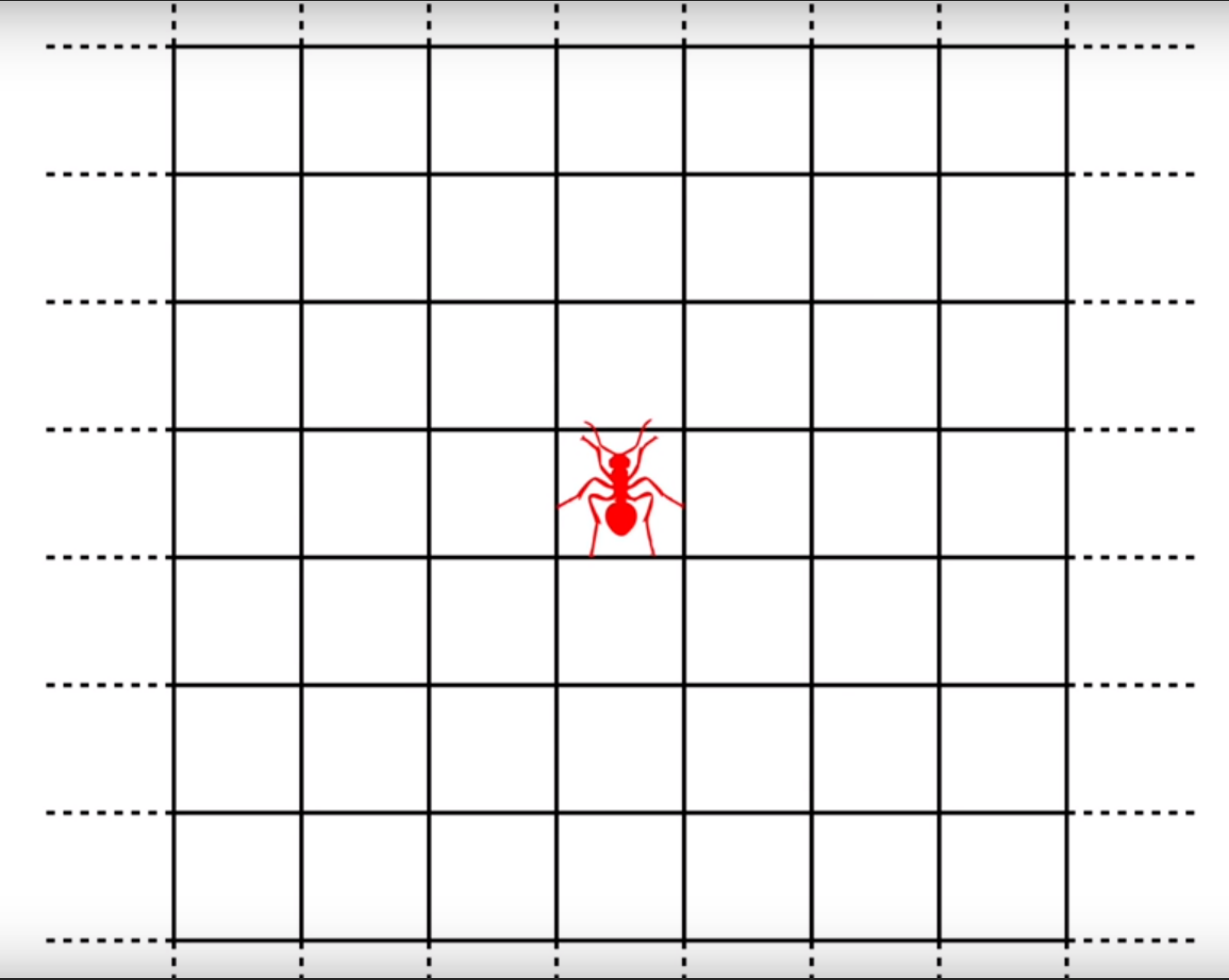
Il n'y a pas que les gènes dans la vie ! L'épigénétique,…
La Plus Belle Expérience de la Physique — Science…


La fourmi de Langton



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Move forward
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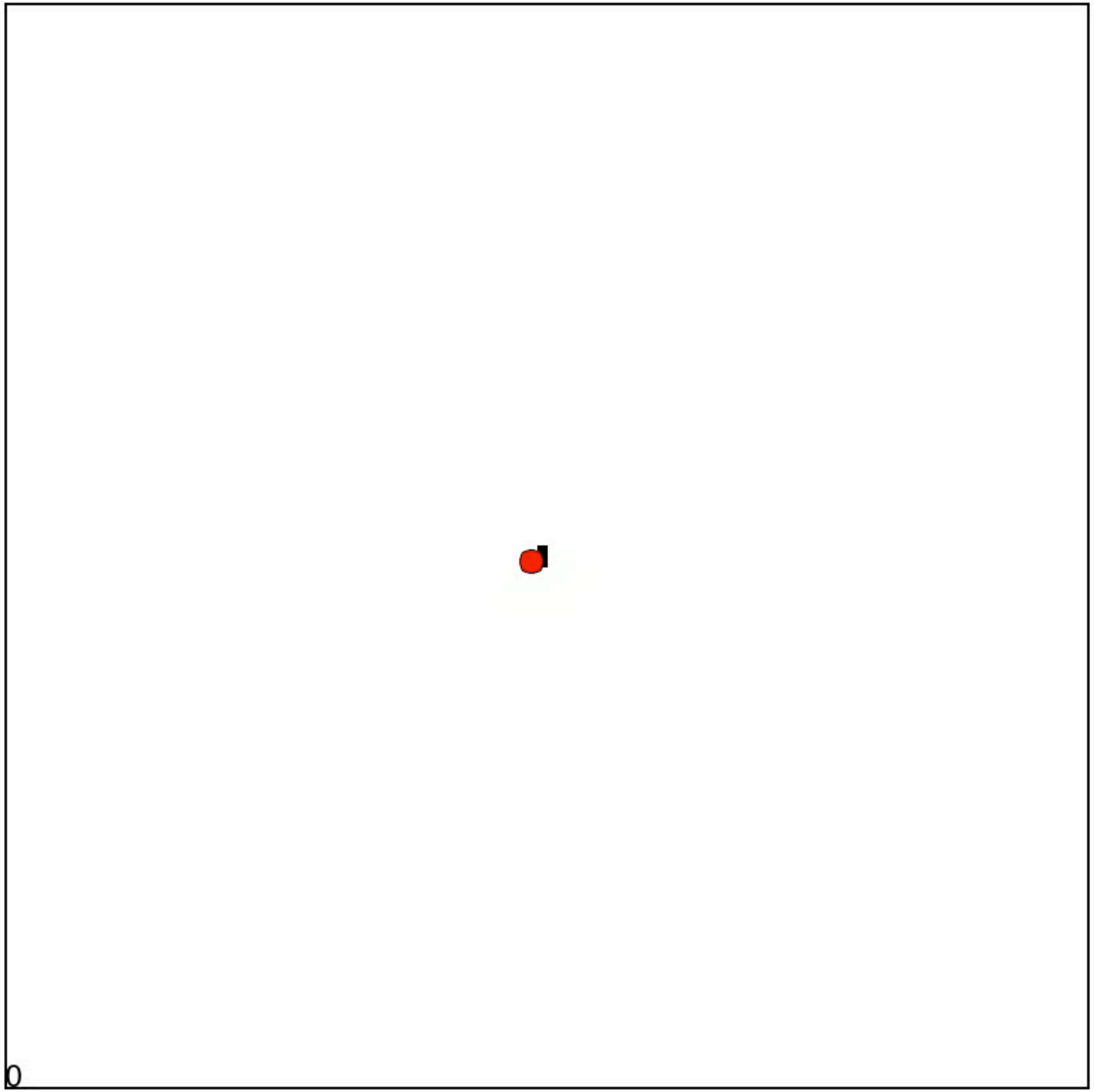
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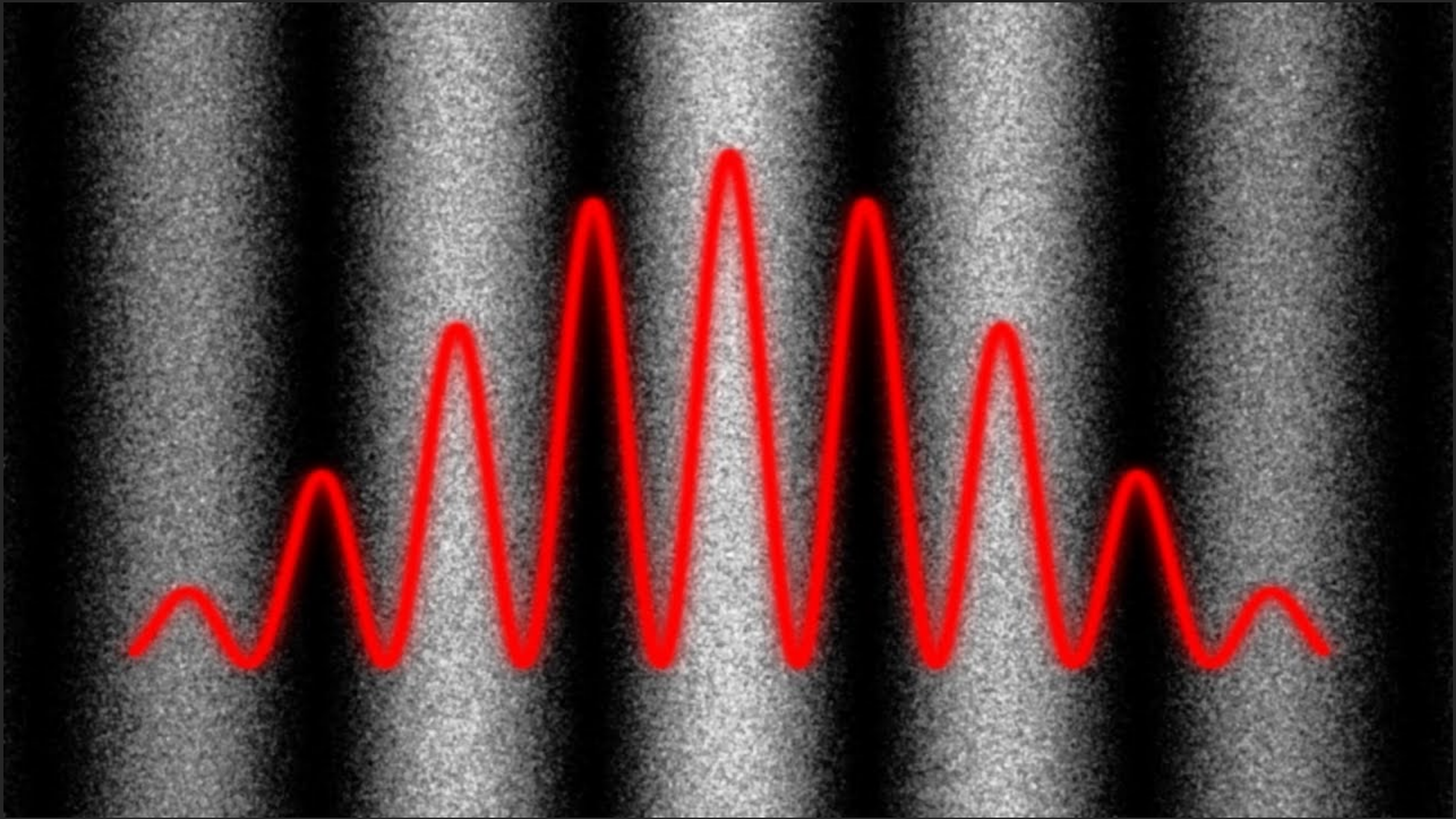
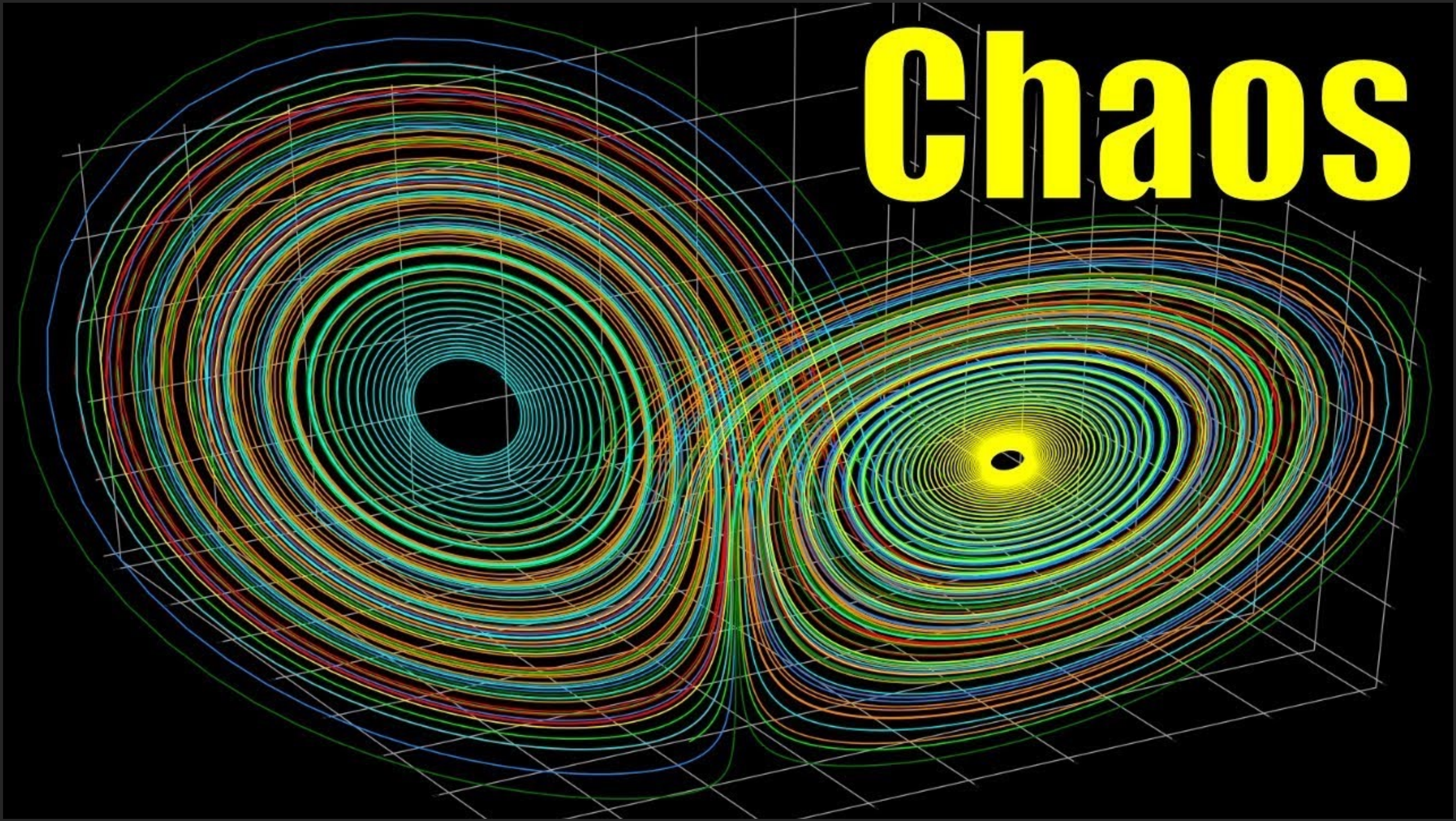
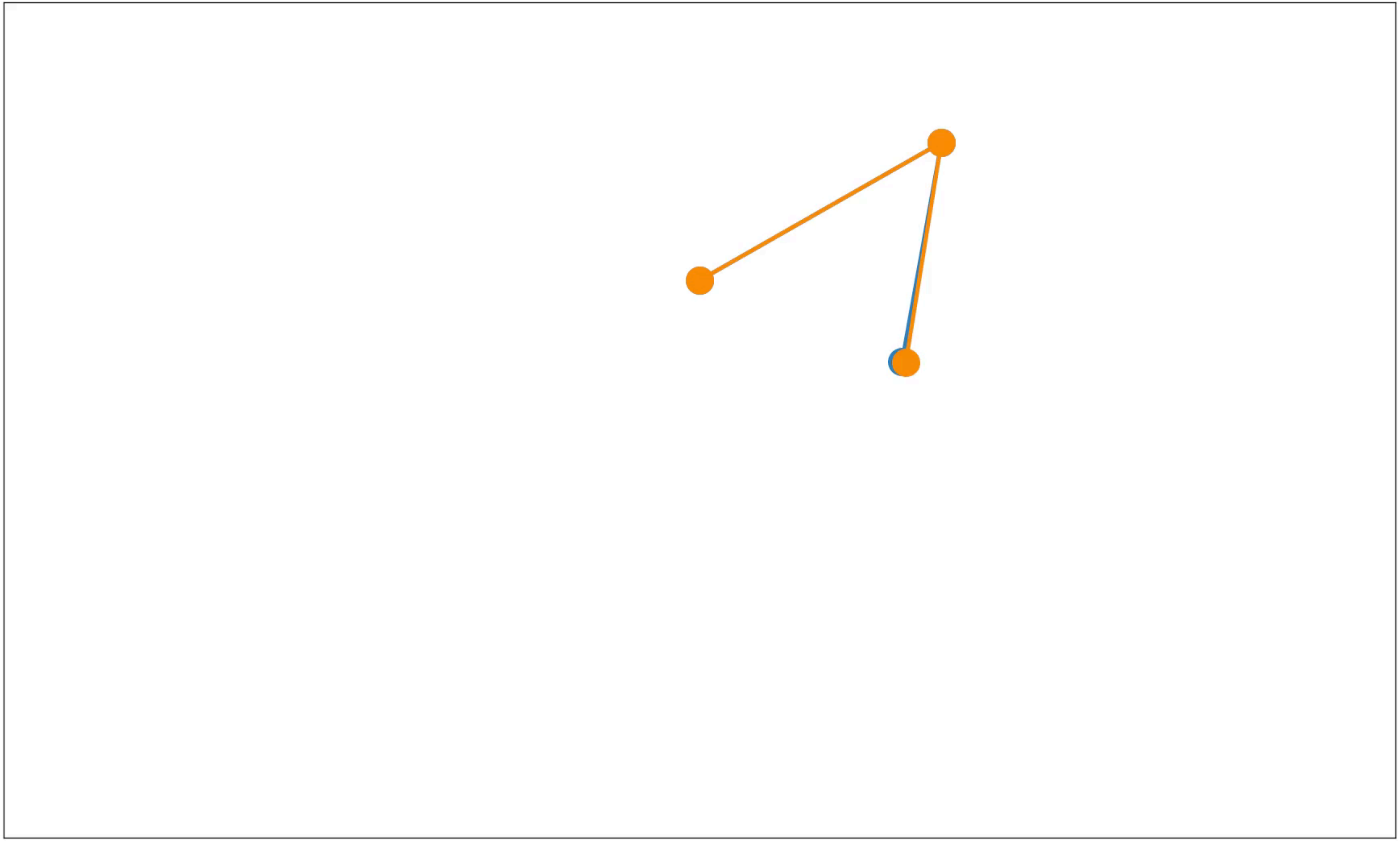
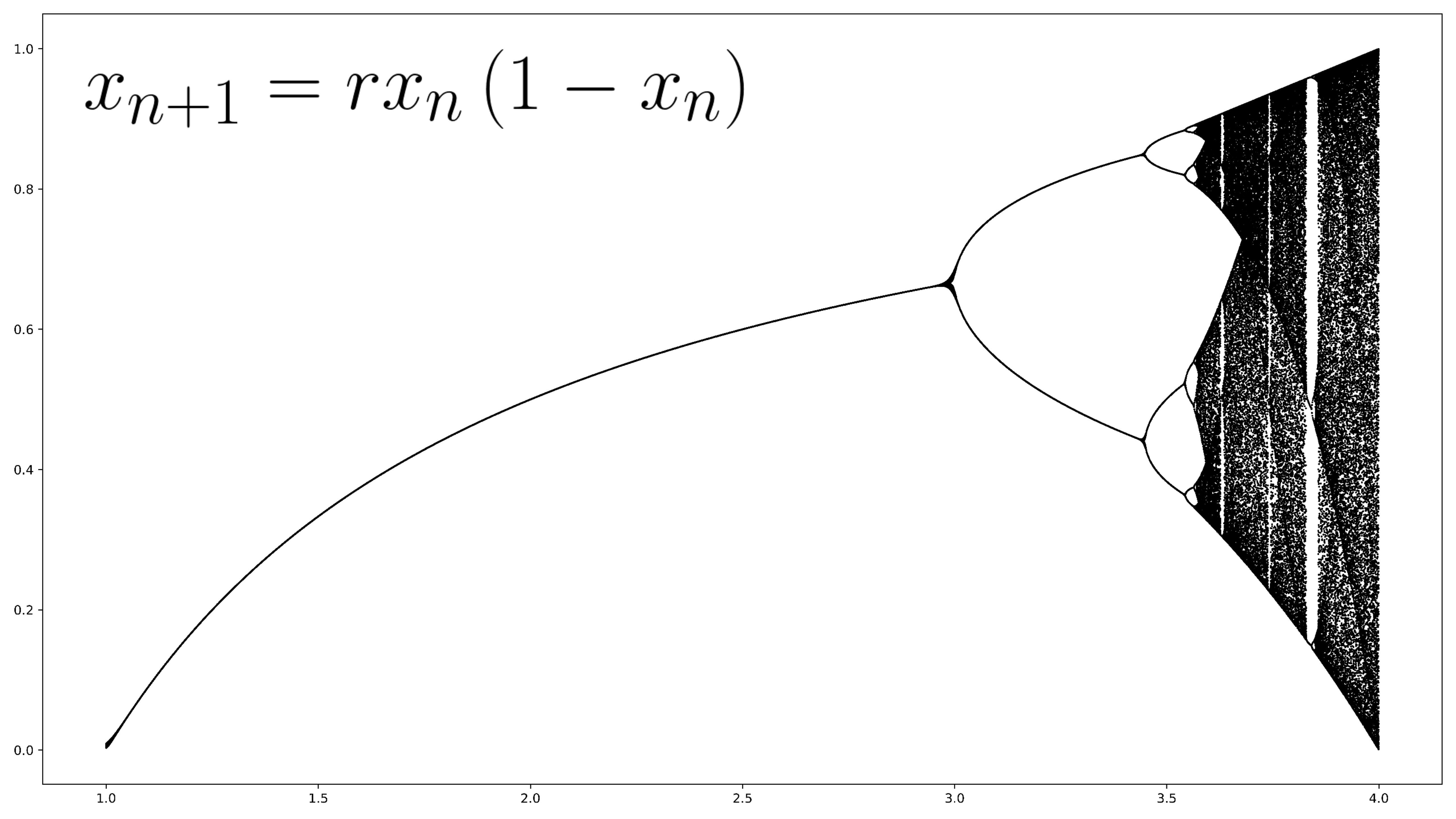



Chaos




$x_{n+1} = rx_n(1 - x_n)$
1.0
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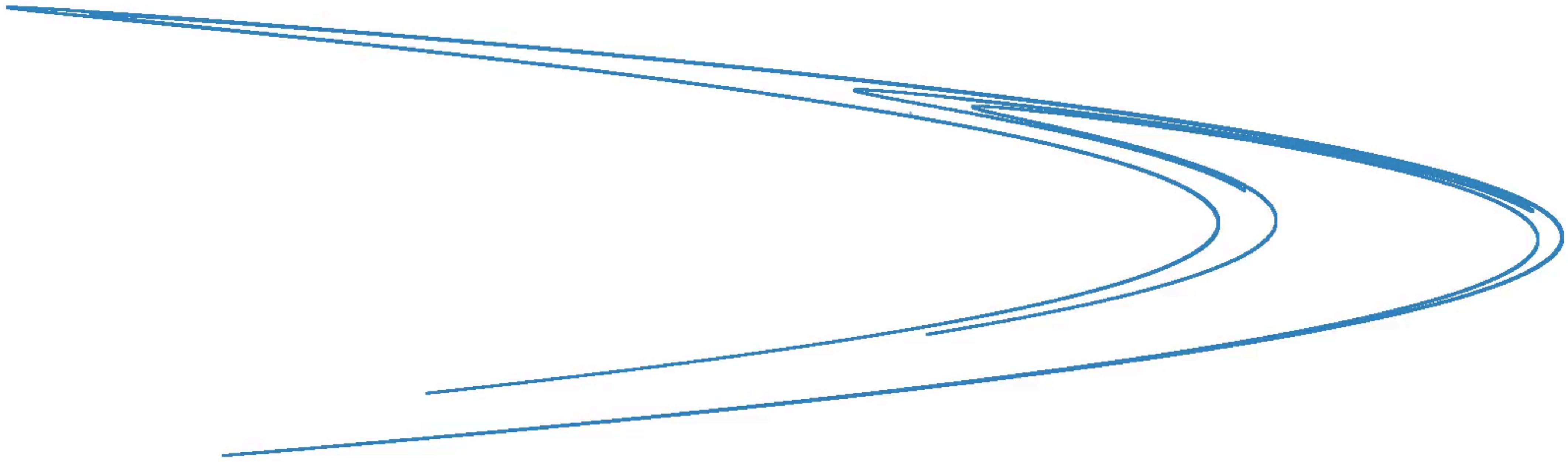
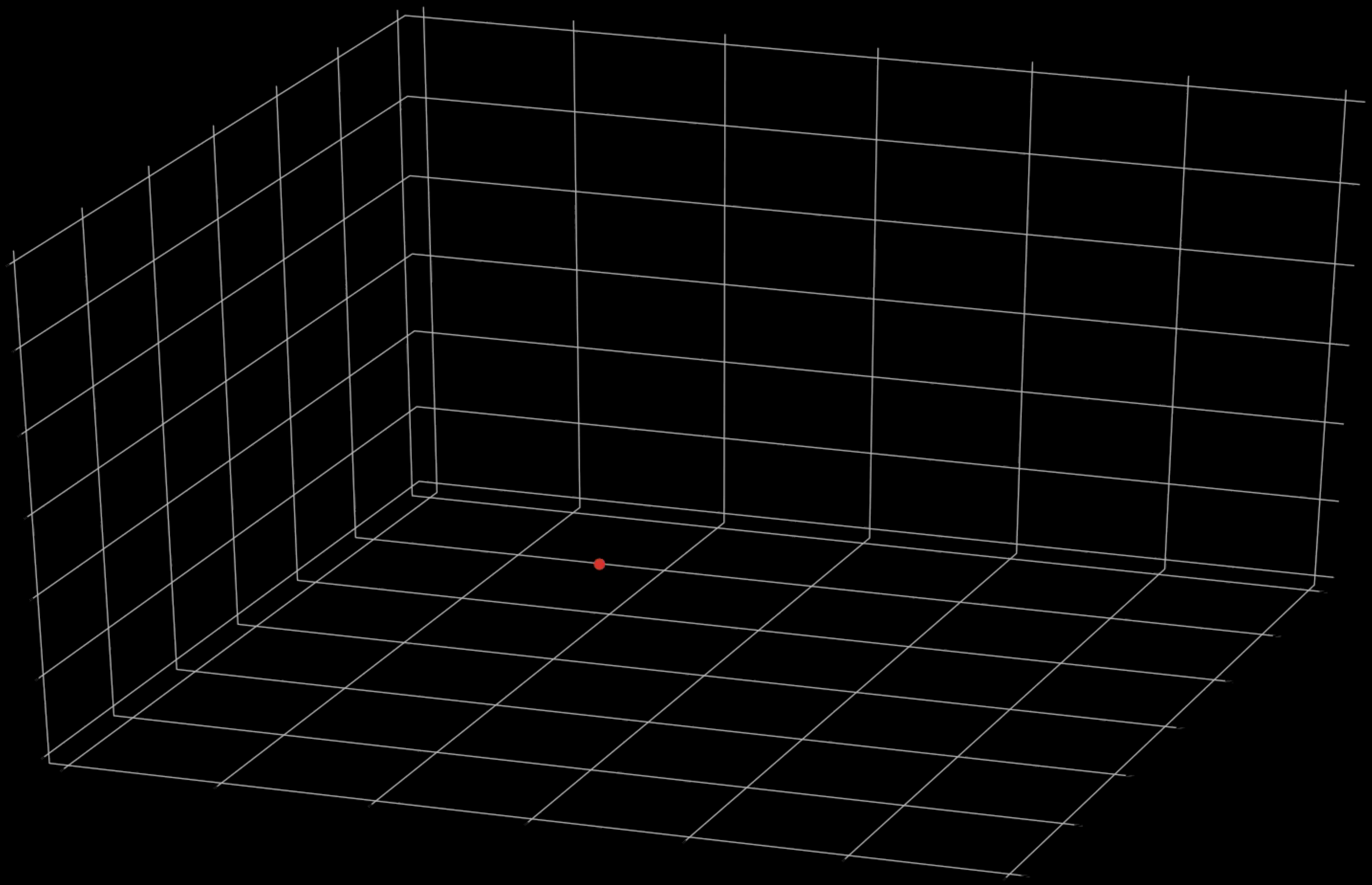
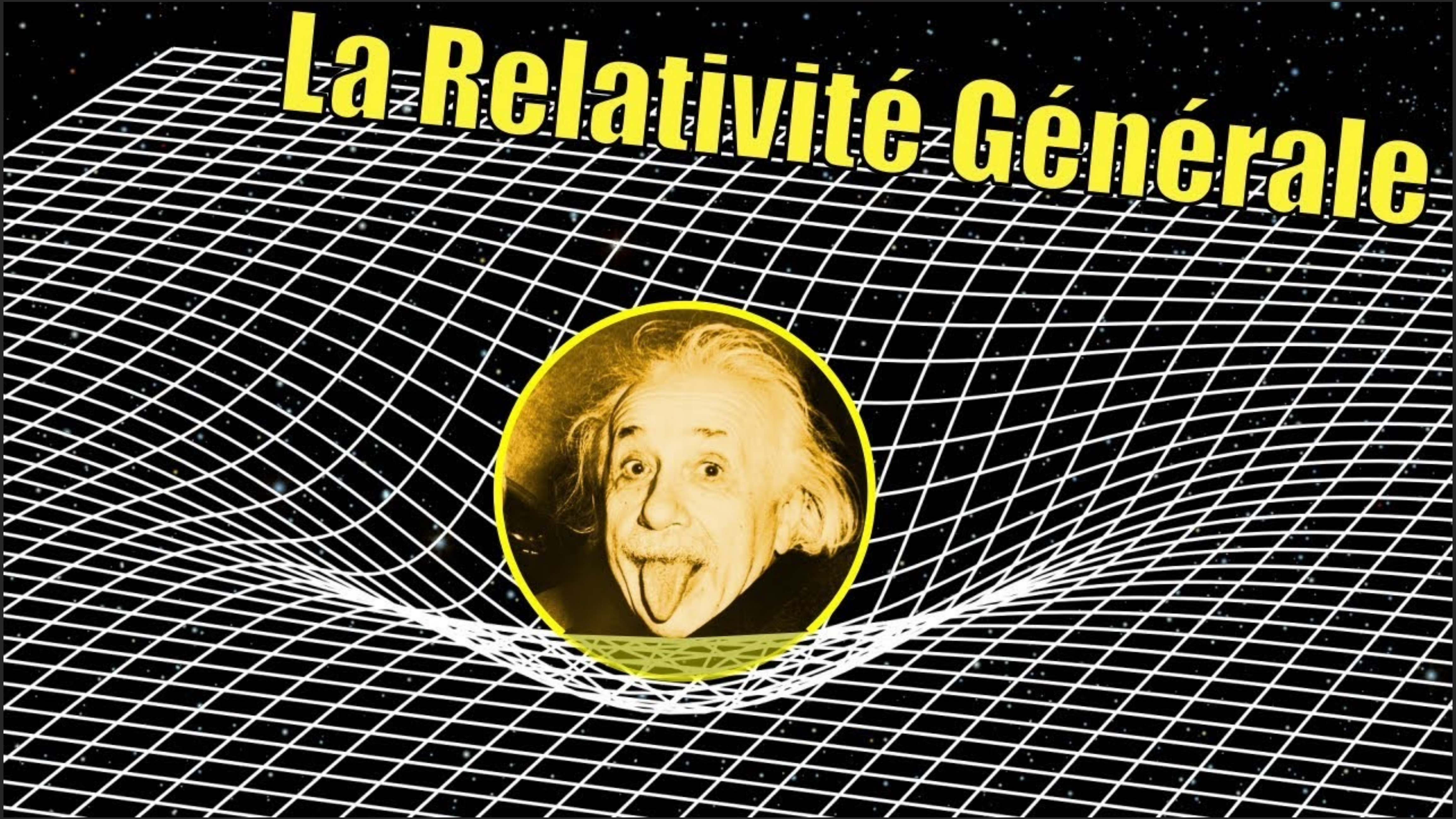
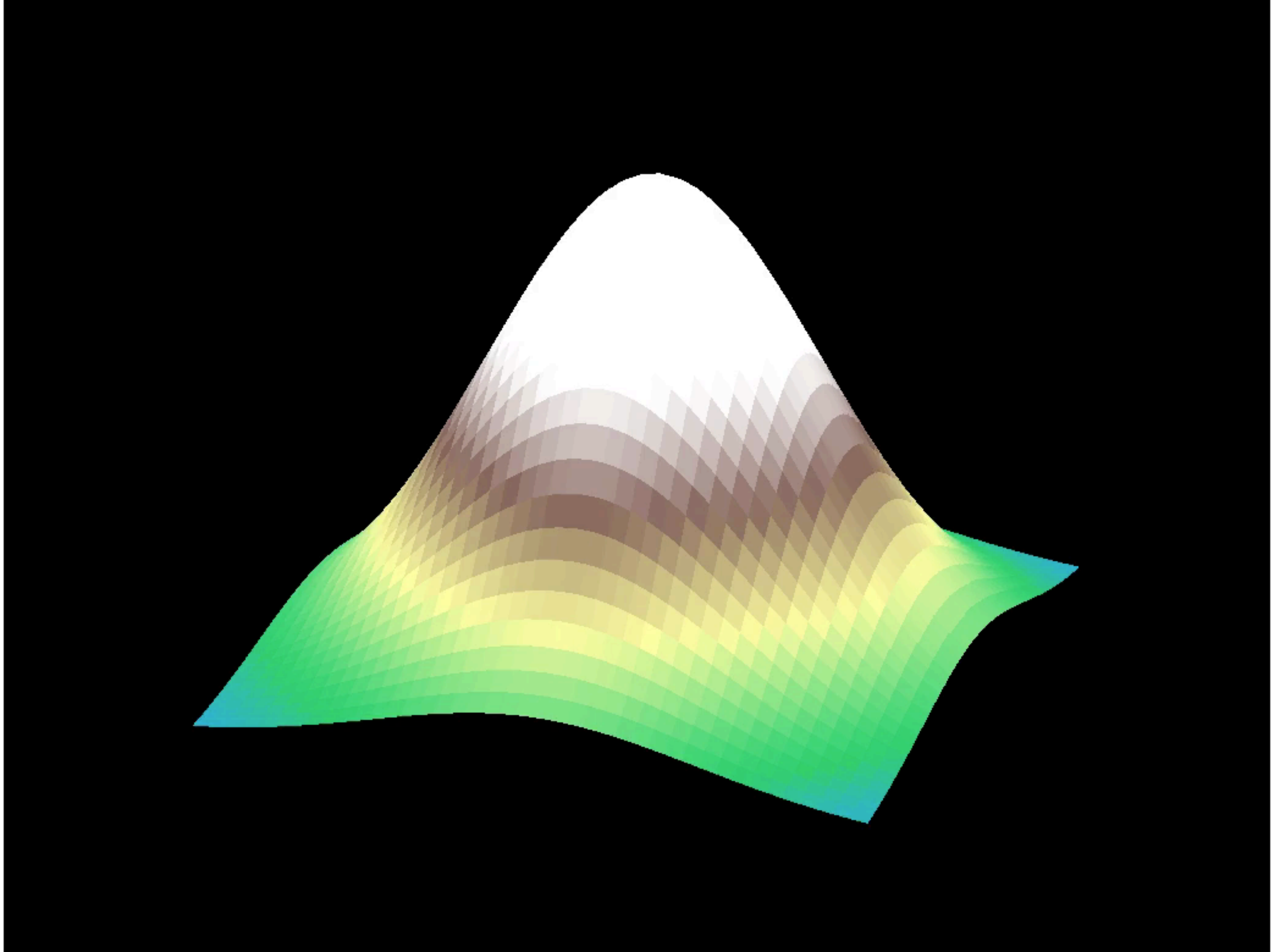
0.6
0.4
0.2
0.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0

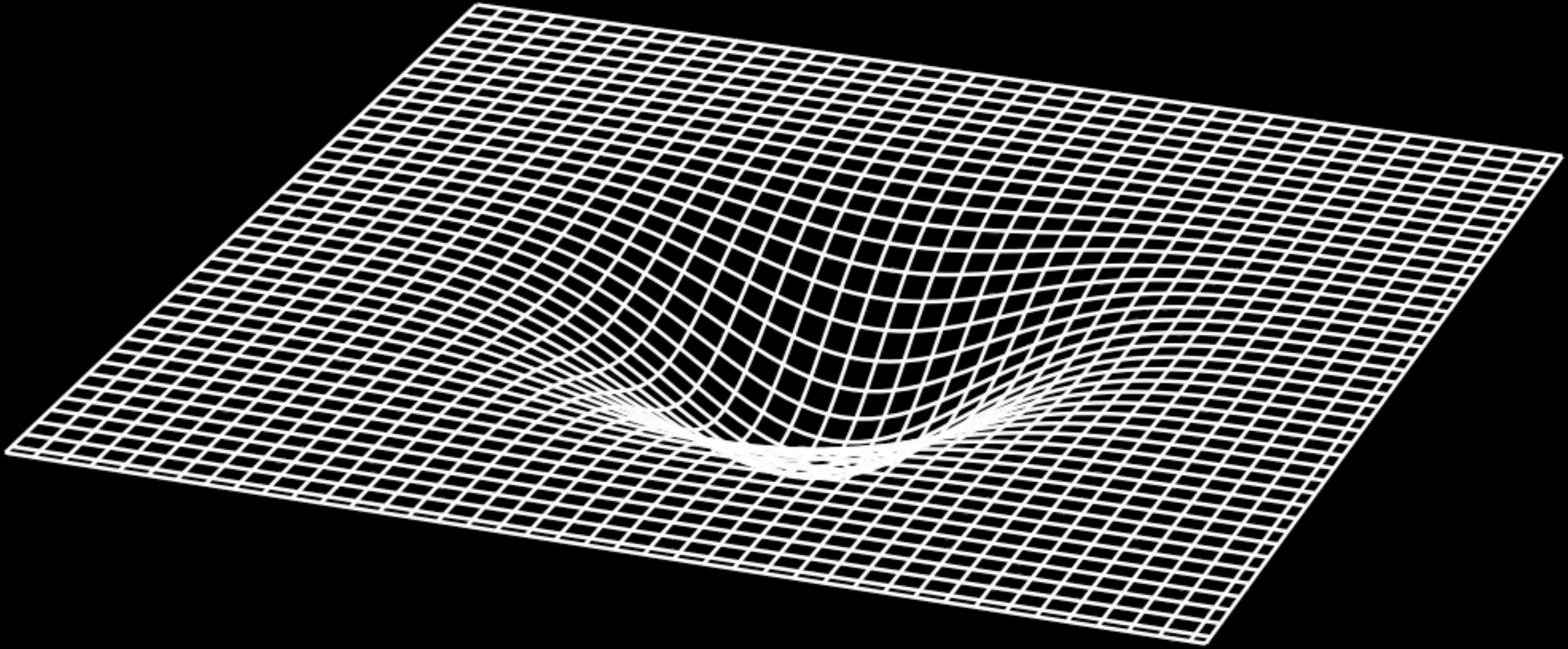
$$\begin{cases} x_{n+1} = 1 - ax_n^2 + y_n \\ y_{n+1} = bx_n. \end{cases}$$






La Relativité Générale





Deriving the geodesic equation via an action [edit]

We can (and this is the most common technique) derive the geodesic equation via the action principle. Consider the case of trying to find a geodesic between tw

Let the action be

$$S = \int ds$$

where $ds = \sqrt{-g_{\mu\nu}(x)dx^\mu dx^\nu}$ is the line element. There is a negative sign inside the square root because the curve must be timelike. To get the geodesic e

$$S = \int \sqrt{-g_{\mu\nu}\frac{dx^\mu}{d\lambda}\frac{dx^\nu}{d\lambda}}d\lambda$$

We can now go ahead and vary this action with respect to the curve x^μ. By the principle of least action we get:

$$0 = \delta S = \int \delta\left(\sqrt{-g_{\mu\nu}\frac{dx^\mu}{d\lambda}\frac{dx^\nu}{d\lambda}}\right)d\lambda = \int \frac{\delta\left(-g_{\mu\nu}\frac{dx^\mu}{d\lambda}\frac{dx^\nu}{d\lambda}\right)}{2\sqrt{-g_{\mu\nu}\frac{dx^\mu}{d\lambda}\frac{dx^\nu}{d\lambda}}}d\lambda$$

Using the product rule we get:

$$0 = \int \left(\frac{dx^\mu}{d\lambda}\frac{dx^\nu}{d\tau}\delta g_{\mu\nu} + g_{\mu\nu}\frac{d\delta x^\mu}{d\lambda}\frac{dx^\nu}{d\tau} + g_{\mu\nu}\frac{dx^\mu}{d\tau}\frac{d\delta x^\nu}{d\lambda}\right)d\lambda = \int \left(\frac{dx^\mu}{d\lambda}\frac{dx^\nu}{d\tau}\partial_\alpha g_{\mu\nu}\delta x^\alpha + 2g_{\mu\nu}\frac{d\delta x^\mu}{d\lambda}\frac{dx^\nu}{d\tau}\right)d\lambda$$

Integrating by-parts the last term and dropping the total derivative (which equals to zero at the boundaries) we get that:

$$0 = \int \left(\frac{dx^\mu}{d\tau}\frac{dx^\nu}{d\tau}\partial_\alpha g_{\mu\nu}\delta x^\alpha - 2\delta x^\mu \frac{d}{d\tau}\left(g_{\mu\nu}\frac{dx^\nu}{d\tau}\right)\right)d\tau = \int \left(\frac{dx^\mu}{d\tau}\frac{dx^\nu}{d\tau}\partial_\alpha g_{\mu\nu}\delta x^\alpha - 2\delta x^\mu \partial_\alpha g_{\mu\nu}\frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau} - 2\delta x^\mu g_{\mu\nu}\frac{d^2x^\nu}{d\tau^2}\right)d\tau$$

Simplifying a bit we see that:

$$0 = \int \left(-2g_{\mu\nu}\frac{d^2x^\nu}{d\tau^2} + \frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau}\partial_\mu g_{\alpha\nu} - 2\frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau}\partial_\alpha g_{\mu\nu}\right)\delta x^\mu d\tau$$

so,

$$0 = \int \left(-2g_{\mu\nu}\frac{d^2x^\nu}{d\tau^2} + \frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau}\partial_\mu g_{\alpha\nu} - \frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau}\partial_\alpha g_{\mu\nu} - \frac{dx^\nu}{d\tau}\frac{dx^\alpha}{d\tau}\partial_\nu g_{\mu\alpha}\right)\delta x^\mu d\tau$$

multiplying this equation by $-\frac{1}{2}$ we get:

$$0 = \int \left(g_{\mu\nu}\frac{d^2x^\nu}{d\tau^2} + \frac{1}{2}\frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau}\left(\partial_\alpha g_{\mu\nu} + \partial_\nu g_{\mu\alpha} - \partial_\mu g_{\alpha\nu}\right)\right)\delta x^\mu d\tau$$

So by Hamilton's principle we find that the Euler–Lagrange equation is

$$g_{\mu\nu}\frac{d^2x^\nu}{d\tau^2} + \frac{1}{2}\frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau}\left(\partial_\alpha g_{\mu\nu} + \partial_\nu g_{\mu\alpha} - \partial_\mu g_{\alpha\nu}\right) = 0$$

Multiplying by the inverse metric tensor $g^{\mu\beta}$ we get that

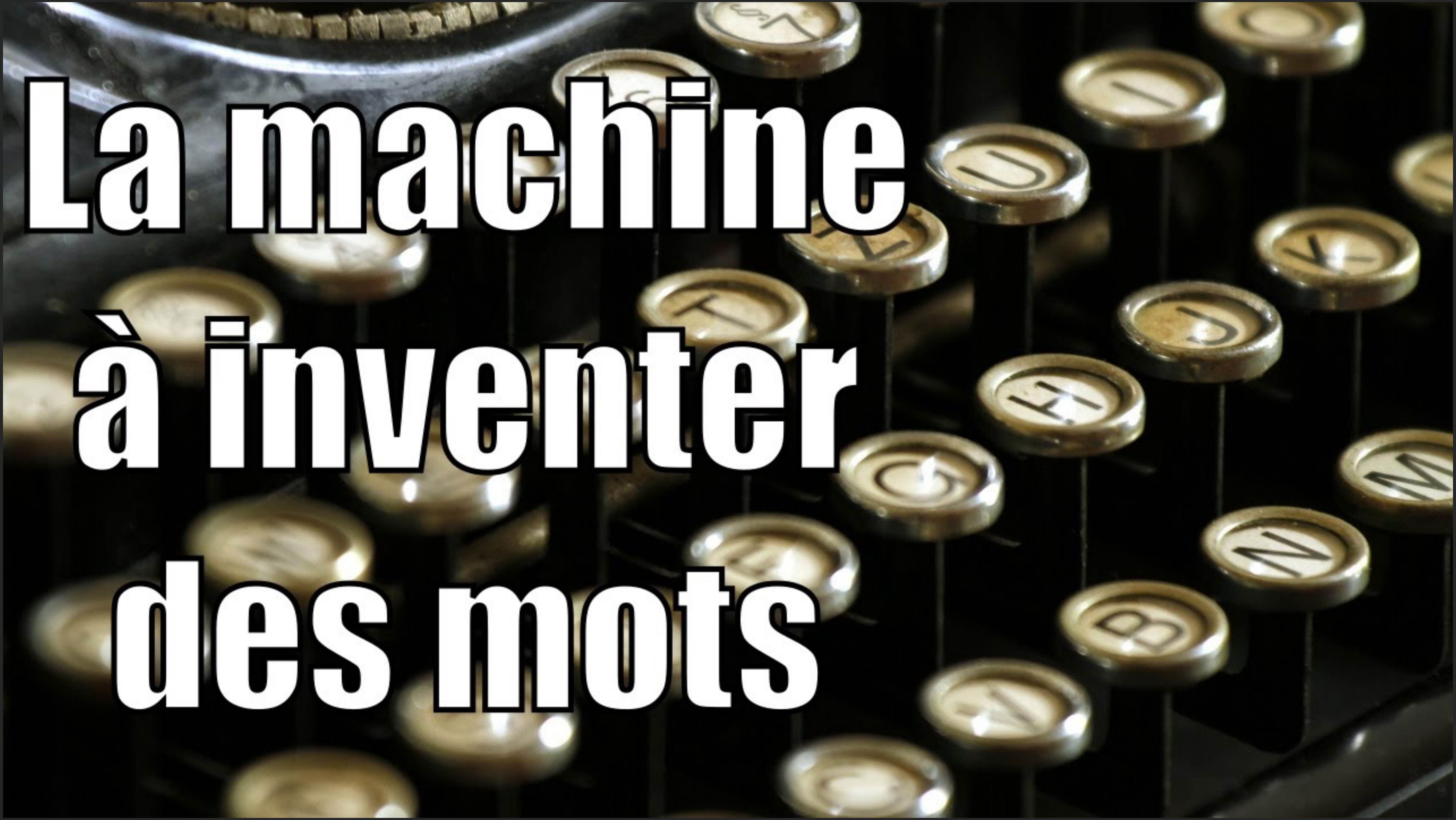
$$\frac{d^2x^\beta}{d\tau^2} + \frac{1}{2}g^{\mu\beta}\left(\partial_\alpha g_{\mu\nu} + \partial_\nu g_{\mu\alpha} - \partial_\mu g_{\alpha\nu}\right)\frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau} = 0$$

Thus we get the geodesic equation:

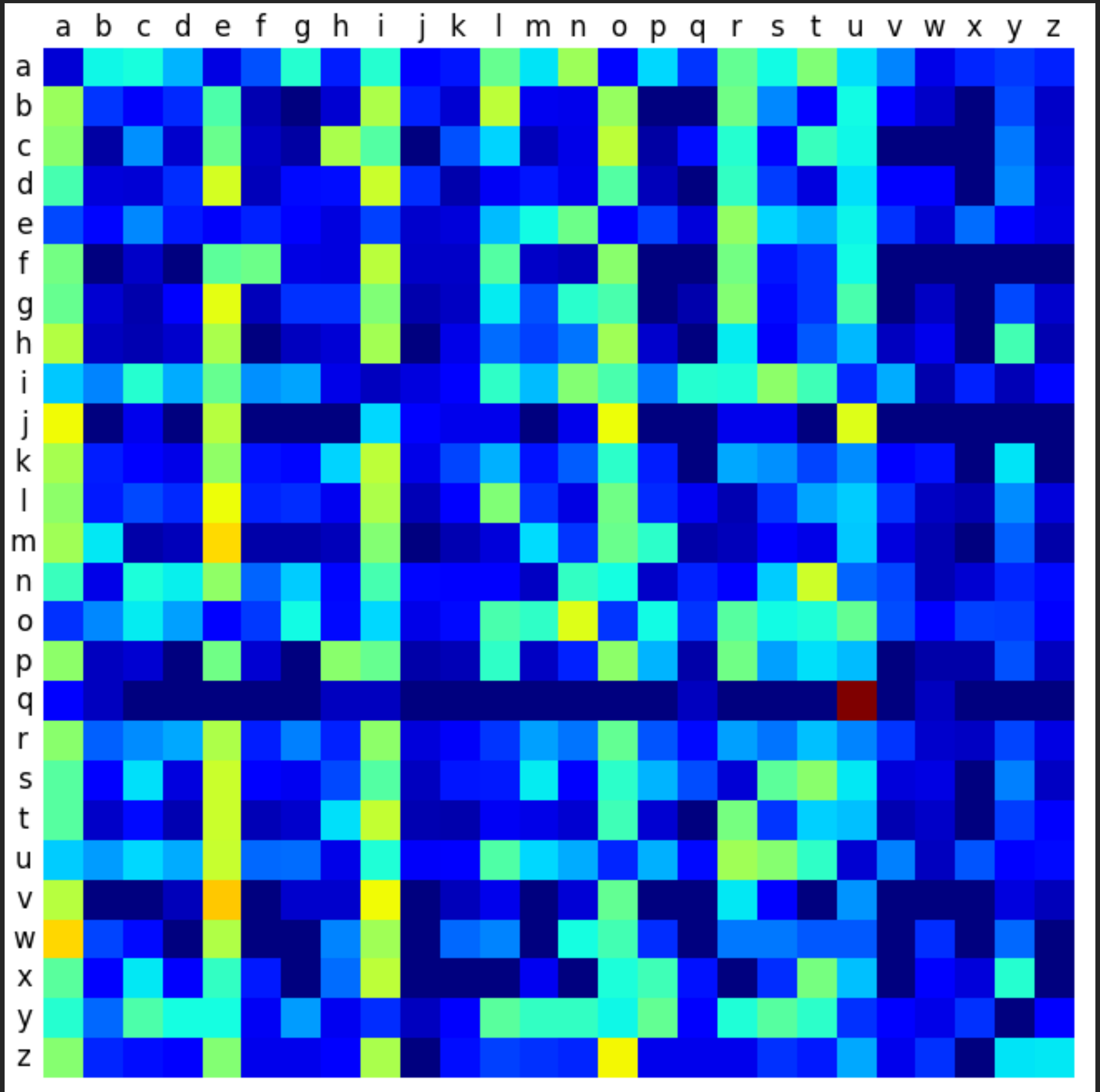
$$\frac{d^2x^\beta}{d\tau^2} + \Gamma^\beta{}_{\alpha\nu}\frac{dx^\alpha}{d\tau}\frac{dx^\nu}{d\tau} = 0$$

with the Christoffel symbol defined in terms of the metric tensor as

$$\Gamma^\beta{}_{\alpha\nu} = \frac{1}{2}g^{\mu\beta}\left(\partial_\alpha g_{\mu\nu} + \partial_\nu g_{\mu\alpha} - \partial_\mu g_{\alpha\nu}\right)$$


La machine
à inventer
des mots

AJBAWXEWQ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fulasselavit	prééteradait	lattestivent	trialispédes
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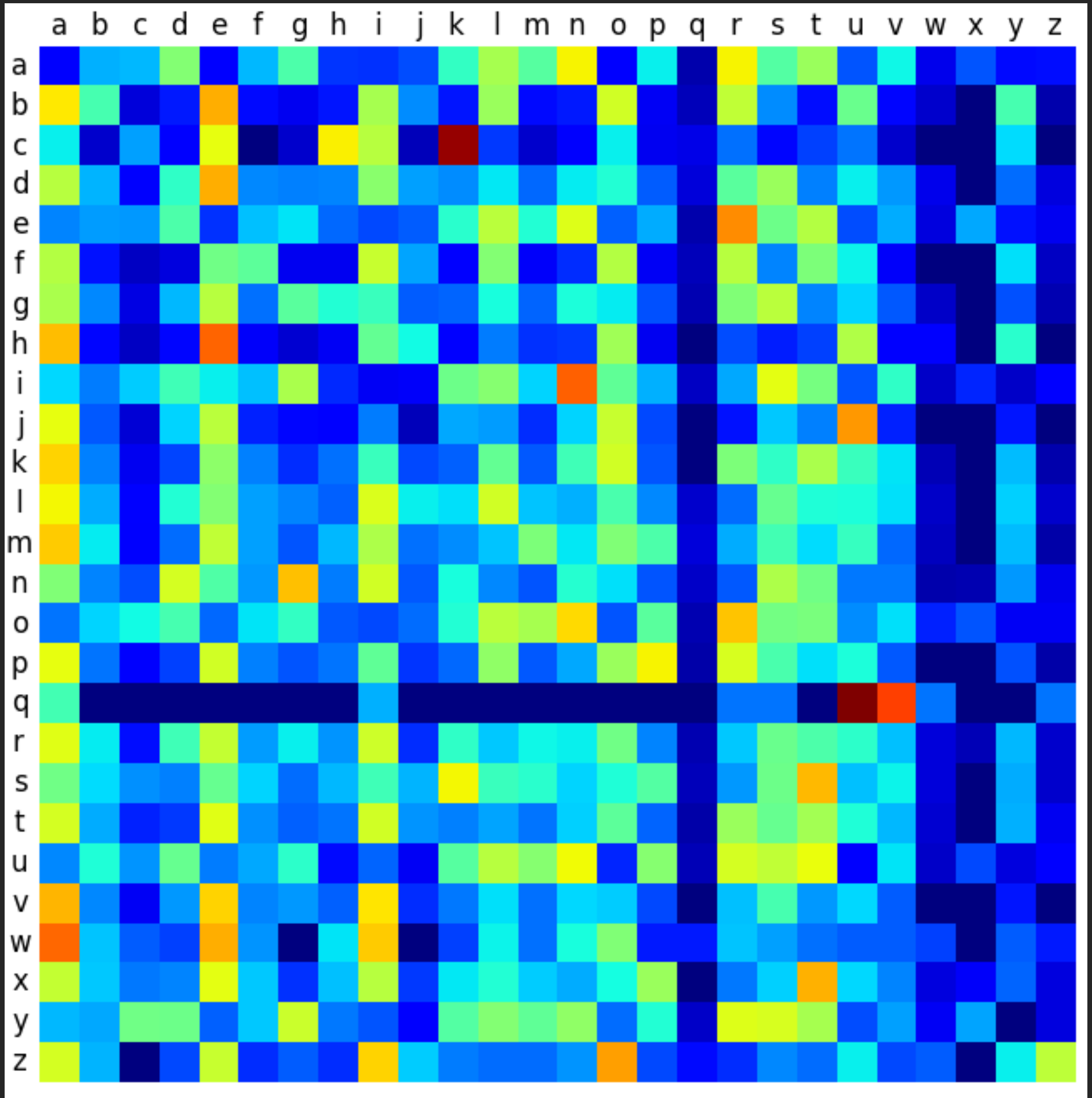

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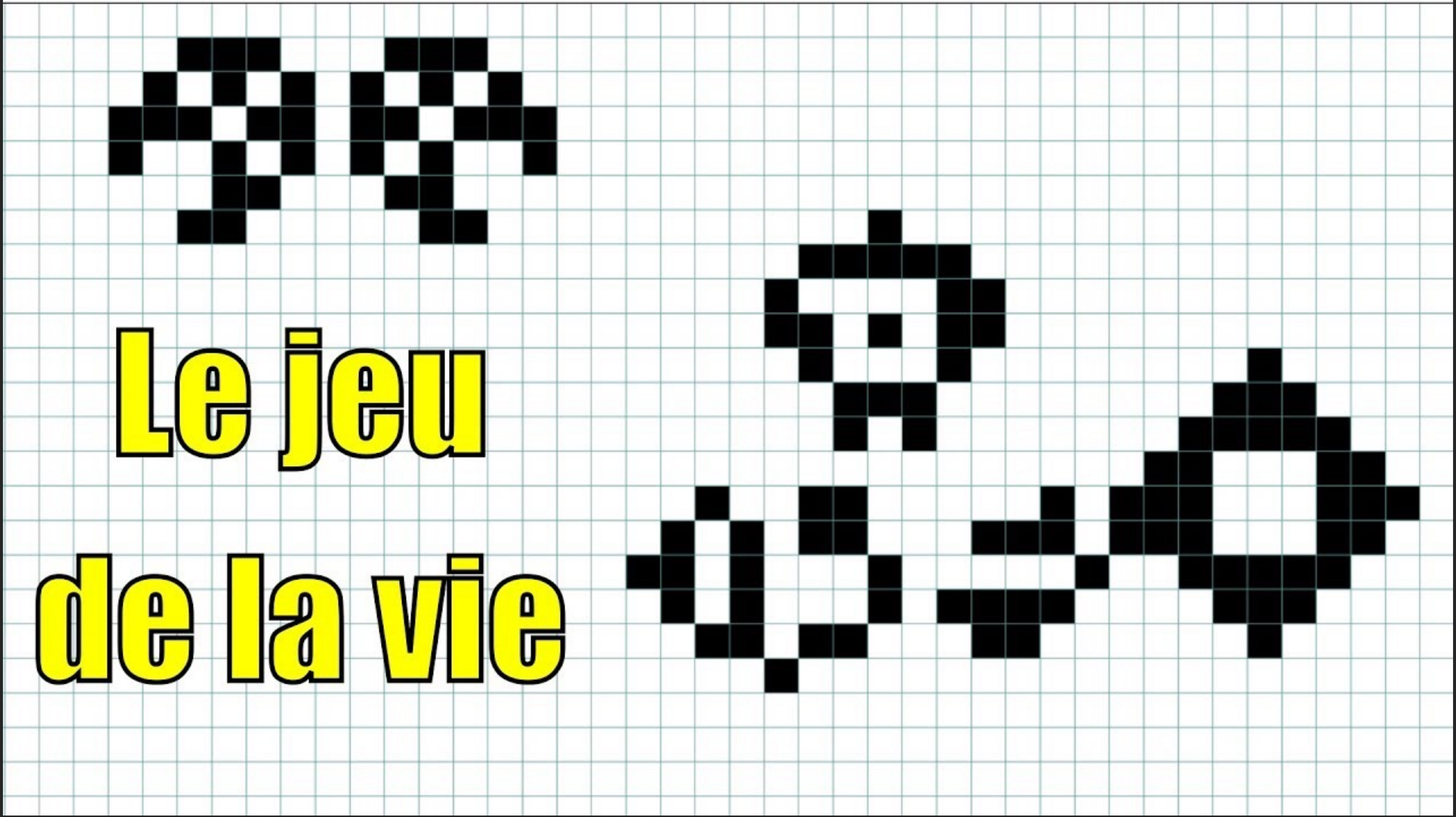
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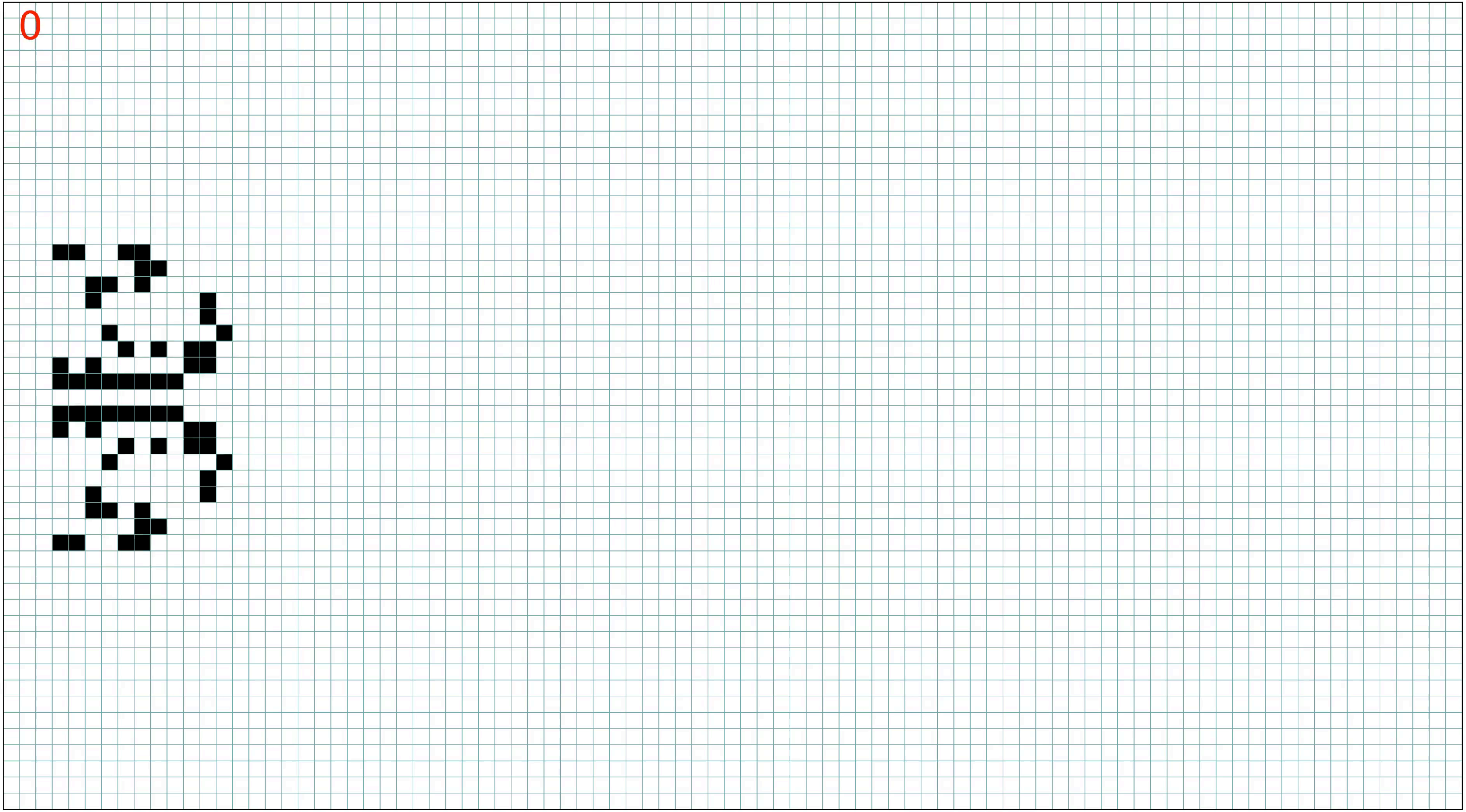
de la vie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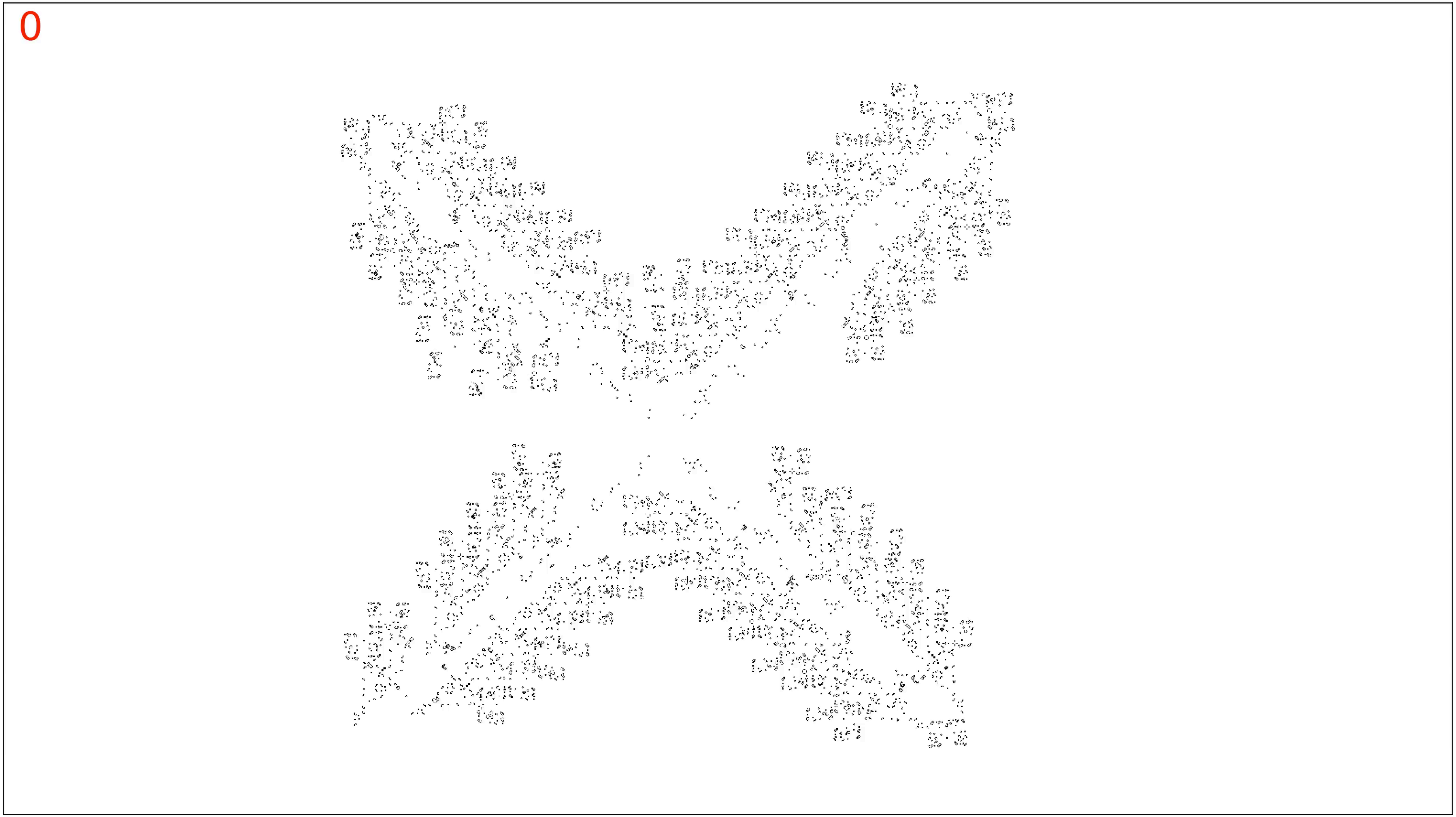
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Python for non-coders : from physics to video games

David Louapre
Science étonnante & Ubisoft