What is so special about π?

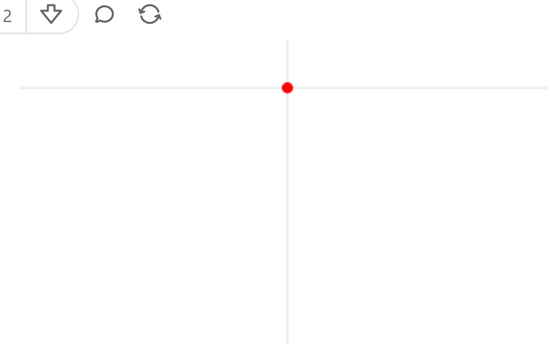
Michael Brenner
Studied Mechanical Engineering & Comparative Linguistics at Vienna University of Technology · Dec 26

There is nothing special about the number 3.14159265.... , and therefore all the hype around it is a myth. Or in other words: 3.141592.... is as "special" as 1.5707963... or 0.78539.... or 6.283185..... you can choose any of them, give it a catchy name and make it a hyped number with exactly the same numerical results in every relevant applications. The questions is: is the choice of π a smart one, a relevant one, or is it clumsy and irrational as the number itself?

The number 3.141... is arrived at by dividing the circumference of a circle by its diameter, its width, where the diameter is unit. That is already clumsy and irrational because how do we arrive at a circle? via diameter? no, there are infinite shapes with constant widths but only a circle is produced via constant radius: tie a rope to a pole and walk with the stretched rope through 360˚ and you have walked a circle, you have produced a circle - or rather the rope has produced the circle and the rope is radius and not diameter, the radius is the "doer" whereas the diameter of a circle is as much a "result" of the "doer" as the circumference, so putting results in relation like C/d does not make any deeper sense, we could also put other results in relation like Circumference and Area C/A and call that a special number.

What would make deeper sense though would be putting "result" and "doer" in relation and that is Circumference and Radius: τ=C/r=6.28315.... now that would be a special relation and would produce cleaner and more sensible equations. If π is unit as claimed, then why is it appearing in most important equations as 2π? .... because π is half-unit, π=τ/2, and therefore you need two to express unit.

That the radius is the relevant part of a circle and not the diameter becomes clear in the definition of radians [θ=s/r]. Here, the distance walked around the circumference [s] is set in relation to the radius [r] and that gives you the angular displacement, which is 360˚ or τrad for a full turn. In the below animation we see how irrational it is to take the half circle as unit, instead of the full circle.



We see 2π in many equations where it makes it seem that nature operates in double units instead of unit, which is of course a dead give away that something is amiss:

.......Normal Distribution:

$$\frac{1}{\sqrt{2\pi}\sigma}e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

......Fourier transform:

$$f(x) = \int_{-\infty}^{\infty} F(k)e^{2\pi ikx}\,\mathrm{d}k$$

$$F(k) = \int_{-\infty}^{\infty} f(x)e^{-2\pi ikx}\,\mathrm{d}x$$

......Cauchy’s integral formula:

$$f(a) = \frac{1}{2\pi i}\oint_{\gamma}\frac{f(z)}{z-a}\,\mathrm{d}z$$

.....Riemann Zeta function :

$$\zeta(2n) = \sum_{k=1}^{\infty} \frac{1}{k^{2n}} = \frac{|B_{2n}|}{2(2n)!}(2\pi)^{2n}$$

..... nth root of unity:

$$z^n = 1 \implies z = e^{2\pi i/n}$$

..... and it goes on and on with 2π because of course the full circle is unity not the half circle.

$$C = 2\pi r$$

$$V_n = \frac{(2\pi)^{n/2}}{n!!}$$

$$e^{2\pi i} = 1$$

$$\ln z = \ln r + (\theta + 2\pi n)i$$

$$\sin(x + 2\pi) = \sin(x)$$

$$\left(\frac{2\pi}{T}\right)^2 a^3 = \omega^2 a^3 = G(M + m)$$

$$L = g\frac{A^2}{(2\pi)^2}$$

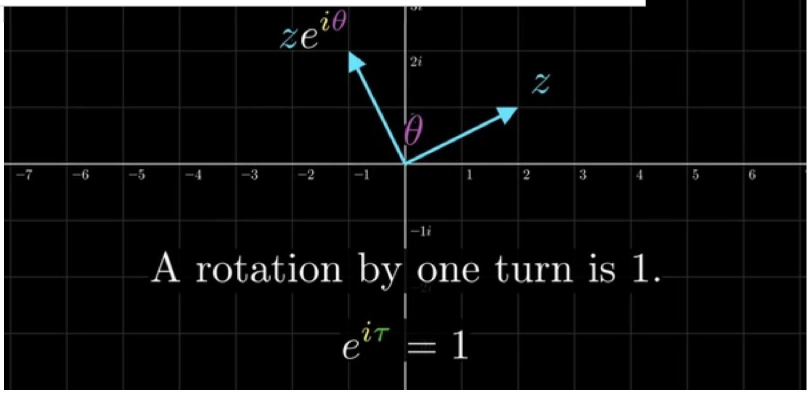
$$\hbar = \frac{h}{2\pi}$$

$$n! \approx \sqrt{2\pi n}\, n^n e^{-n}$$

That goes to show that habits and convention is driving math and not a mystical property of nature. Nature doesn't know numbers, she only knows proportions and these proportions are then arbitrarily projected onto a number grid - or projected onto an arbitrary number grid - and then there's a lot of oohing and aahing about the beautiful marriage of math and nature.

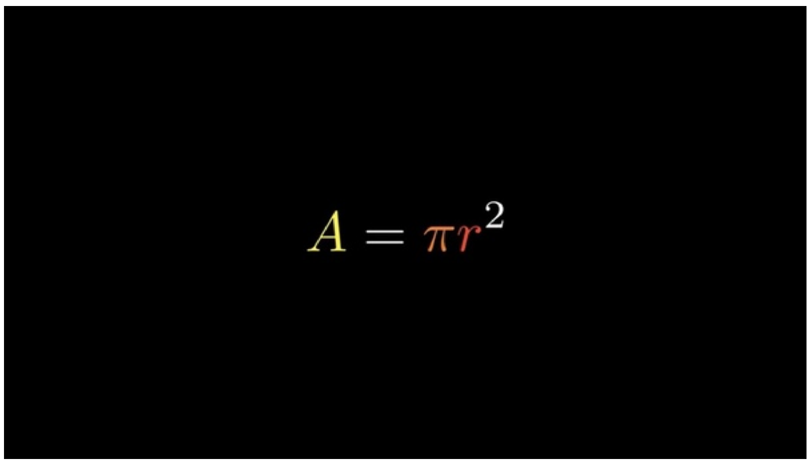
The same goes for the Fibonacci numbers btw. which are also worshipped as a quasi mystical property of nature, when in fact they are only a representation of proportionality, for instance density, as in ideal density of seed arrangements in sun flowers for instance.

Nothing demonstrates the natural character of the ratio τ=C/r=6.283185... better than Euler's identity:

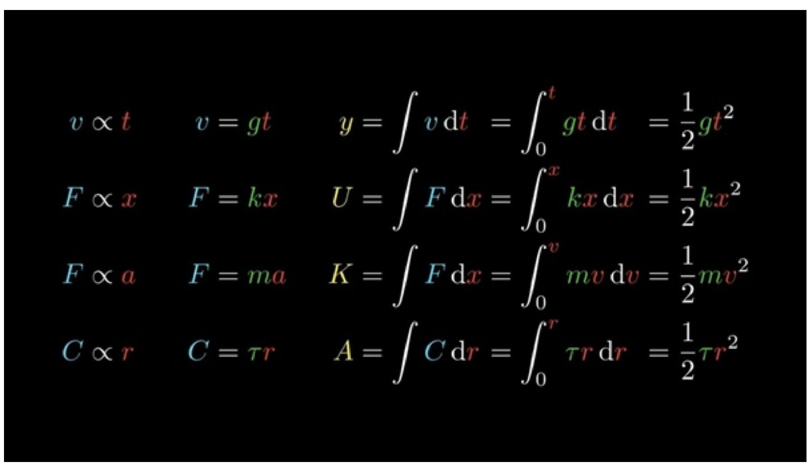


Here we see first, that complex numbers are just a transformation of linear measurements into rotational measurements, and secondly, that a rotation by one turn is 1.

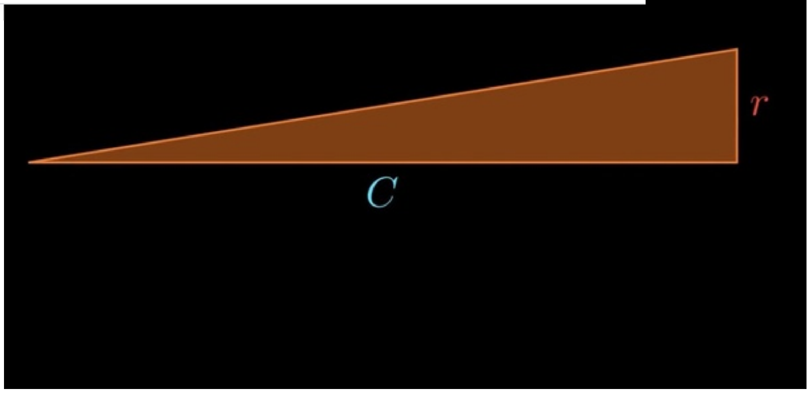
The area formula of a circle has been held as an example of beauty:

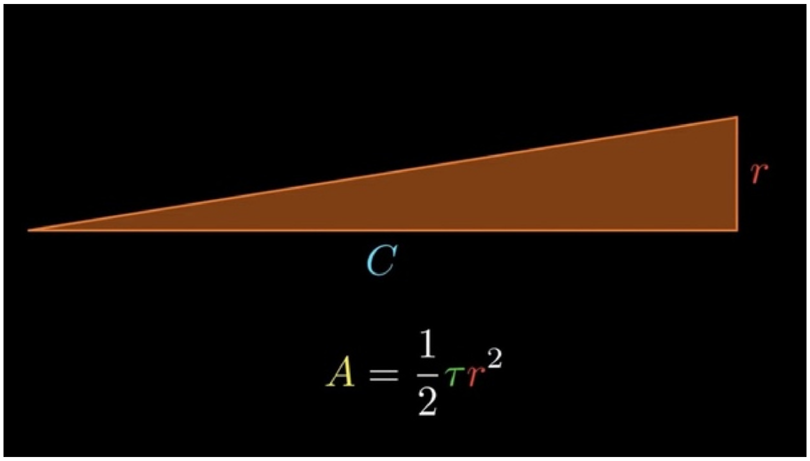


… but to a mathematician there's something amiss, because quadratic expressions look differently: they all come out as "half proportionality factor times argument"

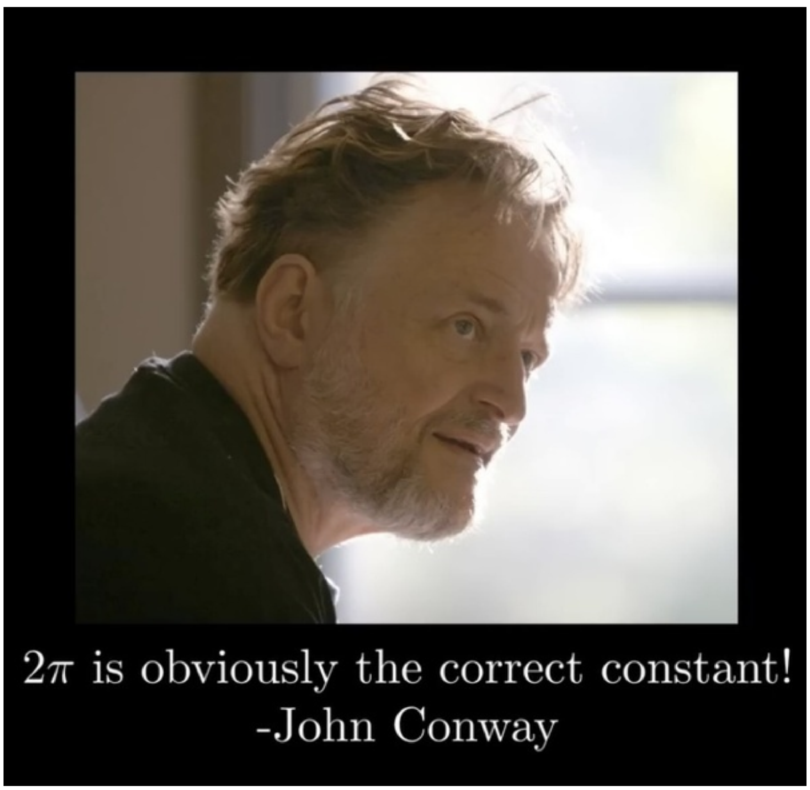


And btw. Archimedes described the area of a circle as a right triangle with height [r]





So from the beginning [C] and [r] are the defining factors of a circle, not [d], which means that



There has been a lot of discussion about tau vs pi since Bob Palais suggested rethinking π in 2001, but the essence of the problem has not really been brought to the fore: that projecting nature onto a mathematical plane is arbitrary and assigning numbers to nature is an anthropocentric habit.

About the Author

Michael Brenner

Studied Mechanical Engineering & Comparative Linguistics at Vienna University of Technology

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