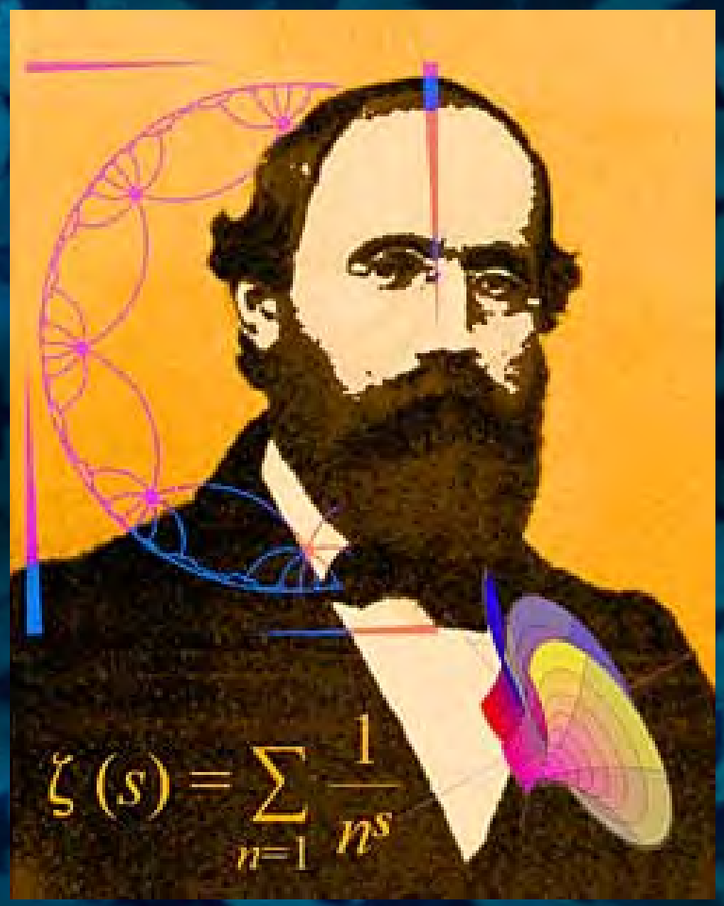

Teaching the Shakespeare of Mathematics

Marcus du Sautoy

Department for Education

Draft National Curriculum Programmes of Study

Department for Education

Draft National Curriculum Programmes of Study

English

to develop a student's love of literature through widespread reading for enjoyment. Students will get to read Shakespeare, romantic poetry, the great novels of the nineteenth century together with seminal works of world literature. Exposure to the great works of literature it is hoped will give students an appreciation of our rich and varied literary heritage.

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Science

by building on fundamental ideas and concepts the curriculum aims to foster in students an excitement and curiosity of natural phenomenon. Students will study the fundamental mechanics of the cell, learn about stem cells, photosynthesis and genomics; they will be exposed to radiation (in a theoretical sense) and the evidence for the Big Bang.

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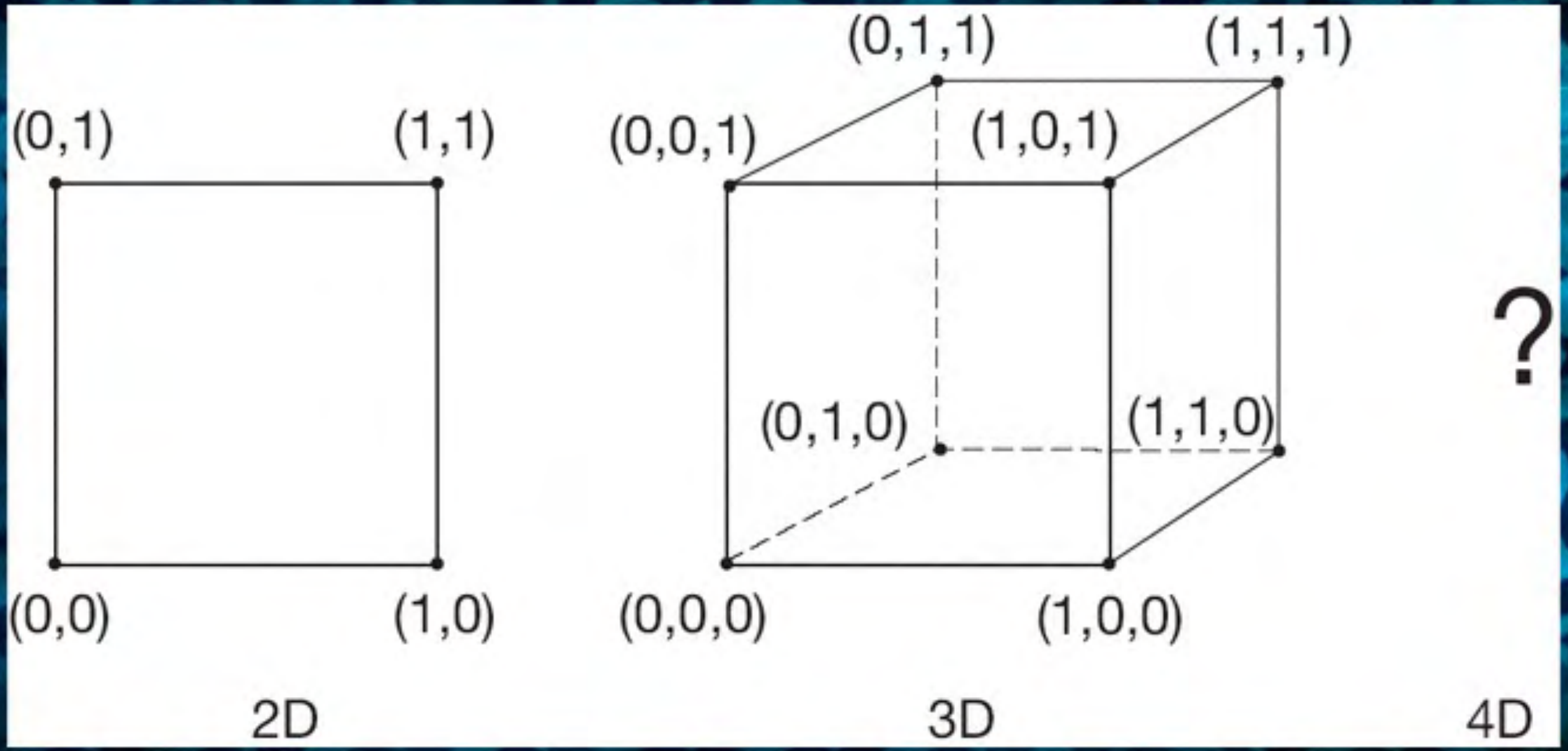
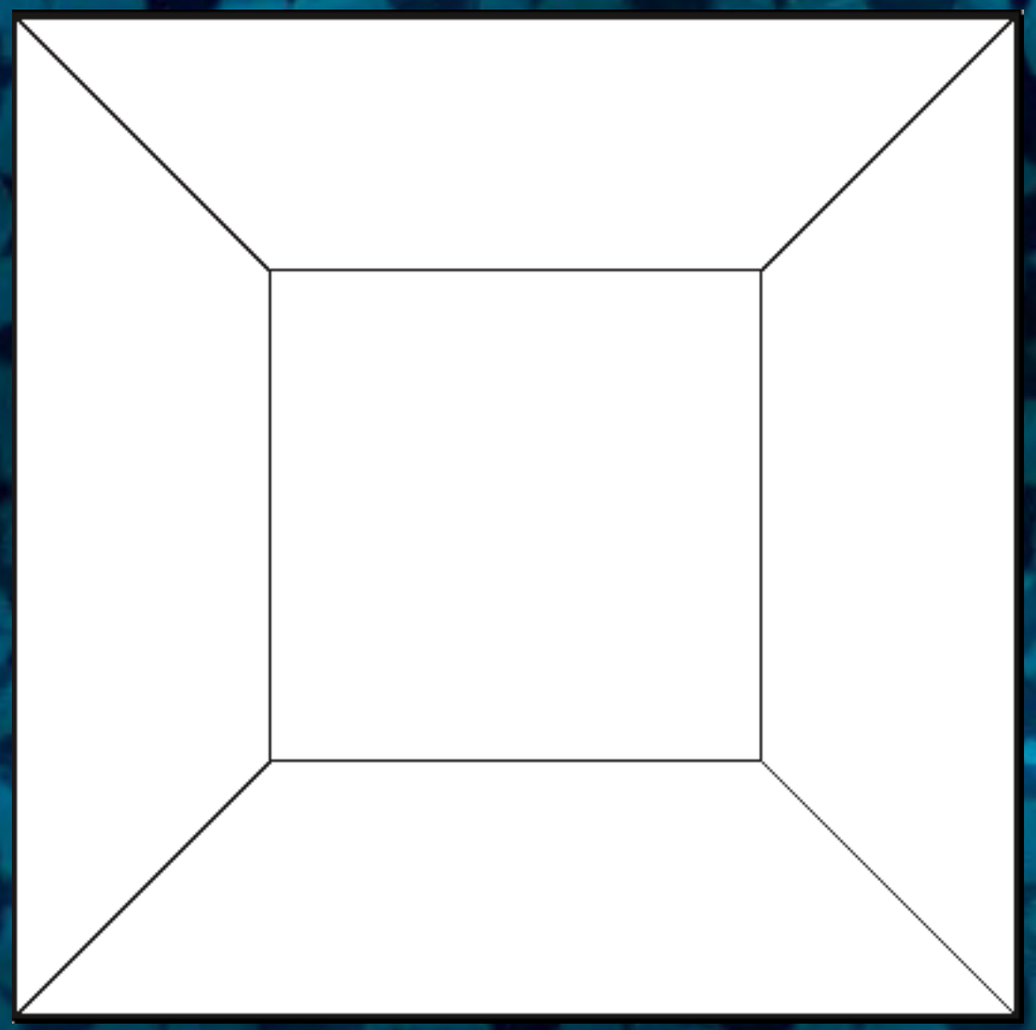
Mathematics

Mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. A high-quality mathematics education therefore provides a foundation for understanding the world, the ability to reason mathematically, and a sense of enjoyment and curiosity about the subject.

4 dimensional space

(12.392167, 41.824825)


(0,1)
(1,1)
(0,0)
(1,0)
2D
(0,1,1)
(1,1,1)
(0,0,1)
(1,0,1)
(0,1,0)
(1,1,0)
(0,0,0)
(1,0,0)
3D
?
4D



L'Arche at La Defense in Paris,
a shadow of a 4D cube

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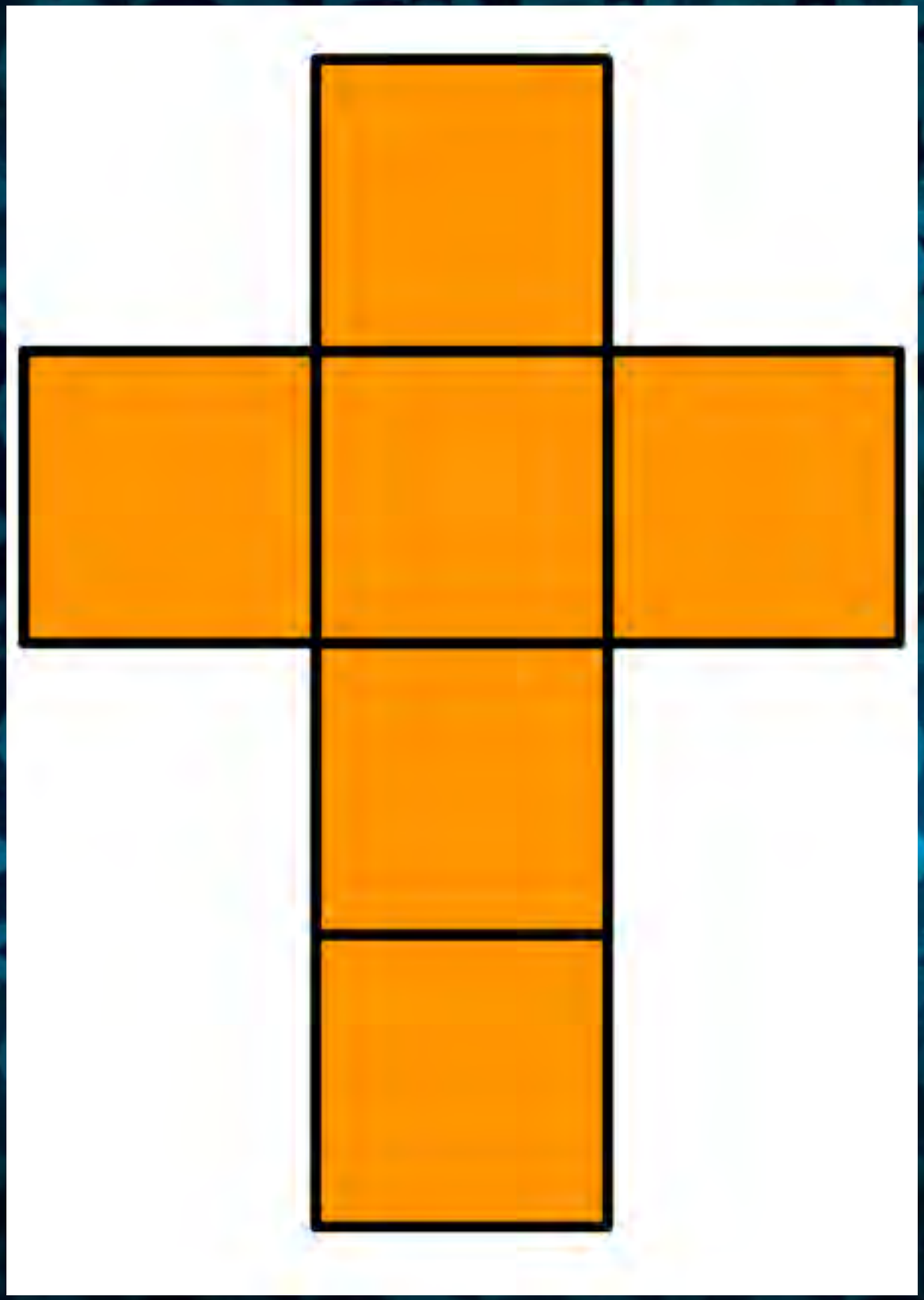
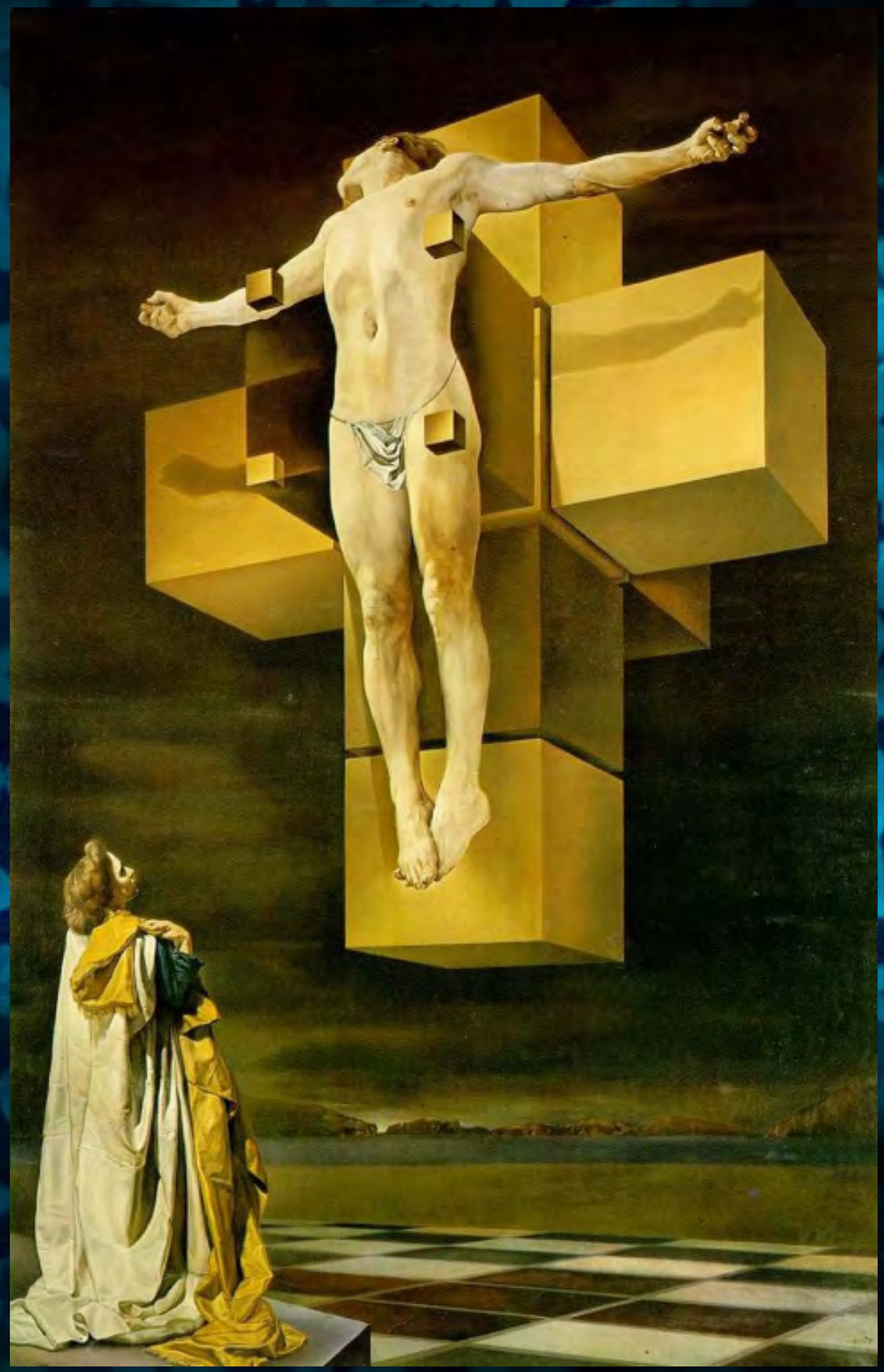


Salvadore Dali's
Corpus Hypercubus.
Crucifixion on a tesseract,
a four-dimensional cube
unwrapped in 3
dimensions

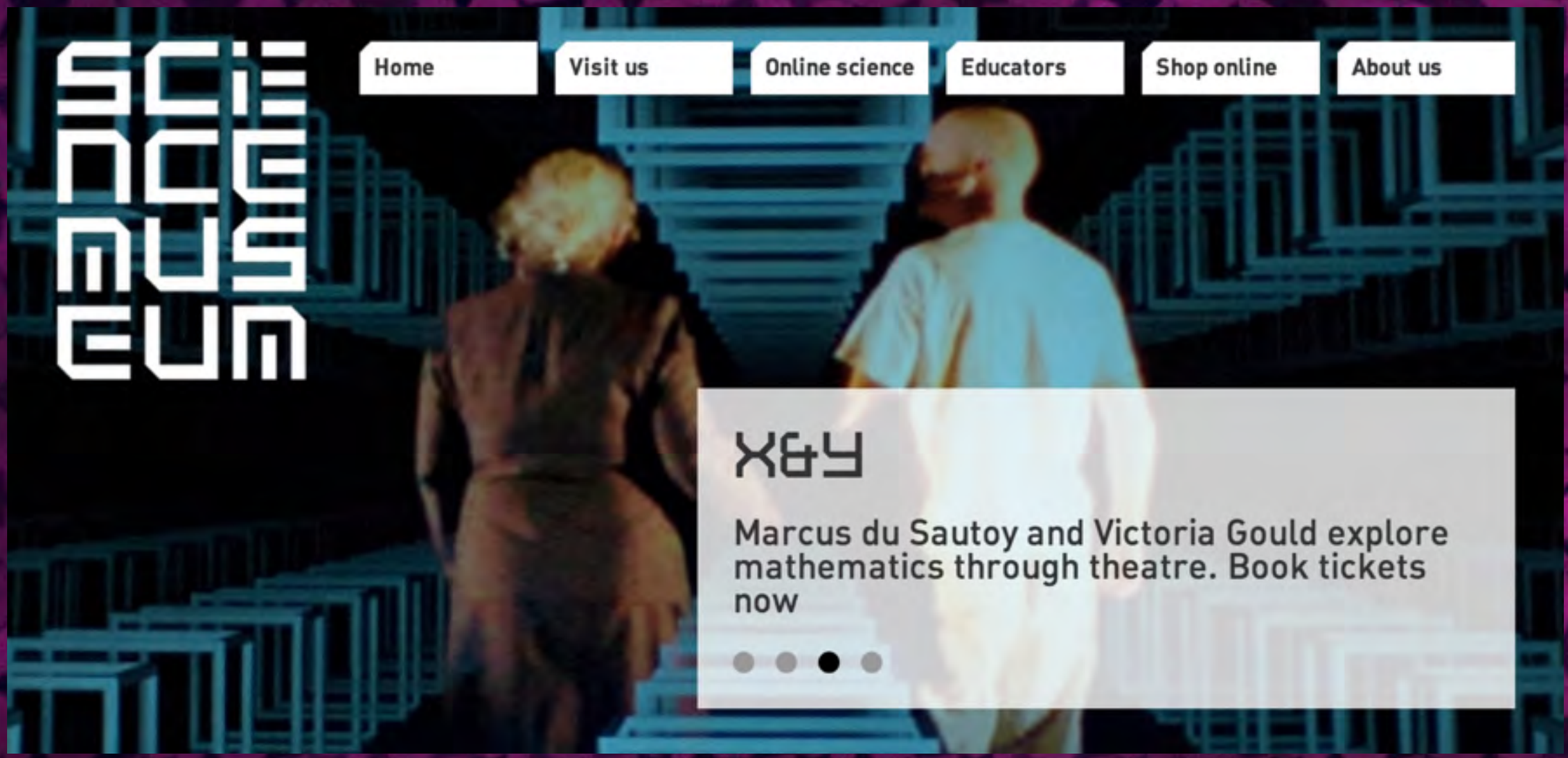


A universe that is finite but without boundary

A universe that is finite but without boundary

A universe that is finite but without boundary

A universe that is finite but without boundary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Prime Numbers

2,3,5,7,11,13...

The Atoms of Arithmetic

The Atoms of Arithmetic

The Periodic Table

	III	IV	V	VI	VII	0
1						4 He Helium 2
2	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86

1 H Hydrogen 1

Transition element

1										
2	7 Li Lithium 3	9 Be Beryllium 4								
3	23 Na Sodium 11	24 Mg Magnesium 12								
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28
	85.5 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46
	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178.5 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78
	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89							

	64 Cu Copper 29	65 Zn Zinc 30													
	108 Ag Silver 47	112 Cd Cadmium 48													
	197 Au Gold 79	201 Hg Mercury 80													

139 La Lanthanum 57	140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162.5 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
227 Ac Actinium 89	232 Th Thorium 90	231 Pa Protactinium 91	238 U Uranium 92	237 Np Neptunium 93	242 Pu Plutonium 94	243 Am Americium 95	247 Cm Curium 96	247 Bk Berkelium 97	251 Cf Californium 98	254 Es Einsteinium 99	253 Fm Fermium 100	256 Md Mendelevium 101	254 No Nobelium 102	257 Lw Lawrencium 103

Key

Atomic Mass
Symbol
Name
Atomic Number

Euclid

(ca. 350-300 B.C.)

Proposition 20 of Euclid's Elements

There are infinitely many prime numbers.

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Suppose you thought that

2,3,5,7,11,13,17,19,23,29,31,37,41,43

were the only primes.

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Euclid's Number: 2x3x5x...x37x41x43 + 1

Proposition 20 of Euclid's Elements

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were the only primes.

Euclid's Number: 2x3x5x...x37x41x43 + 1

Euclid's number is not divisible by any of the primes on your list.

Hence you must have missed some primes.

Record Breaking Primes

$$2^{57,885,161} - 1$$

In 2013 a new record was set by the Great Internet Mersenne Prime Search

This prime has over 17 million digits.

www.mersenne.org

Prime Number Cicadas

The *Magicicada septendecim* hide in the ground for 17 years then emerge for a six week party. They sing loudly, mate, eat, lay eggs then die. The forest goes quiet for another 17 years.

Cicada = 9 years

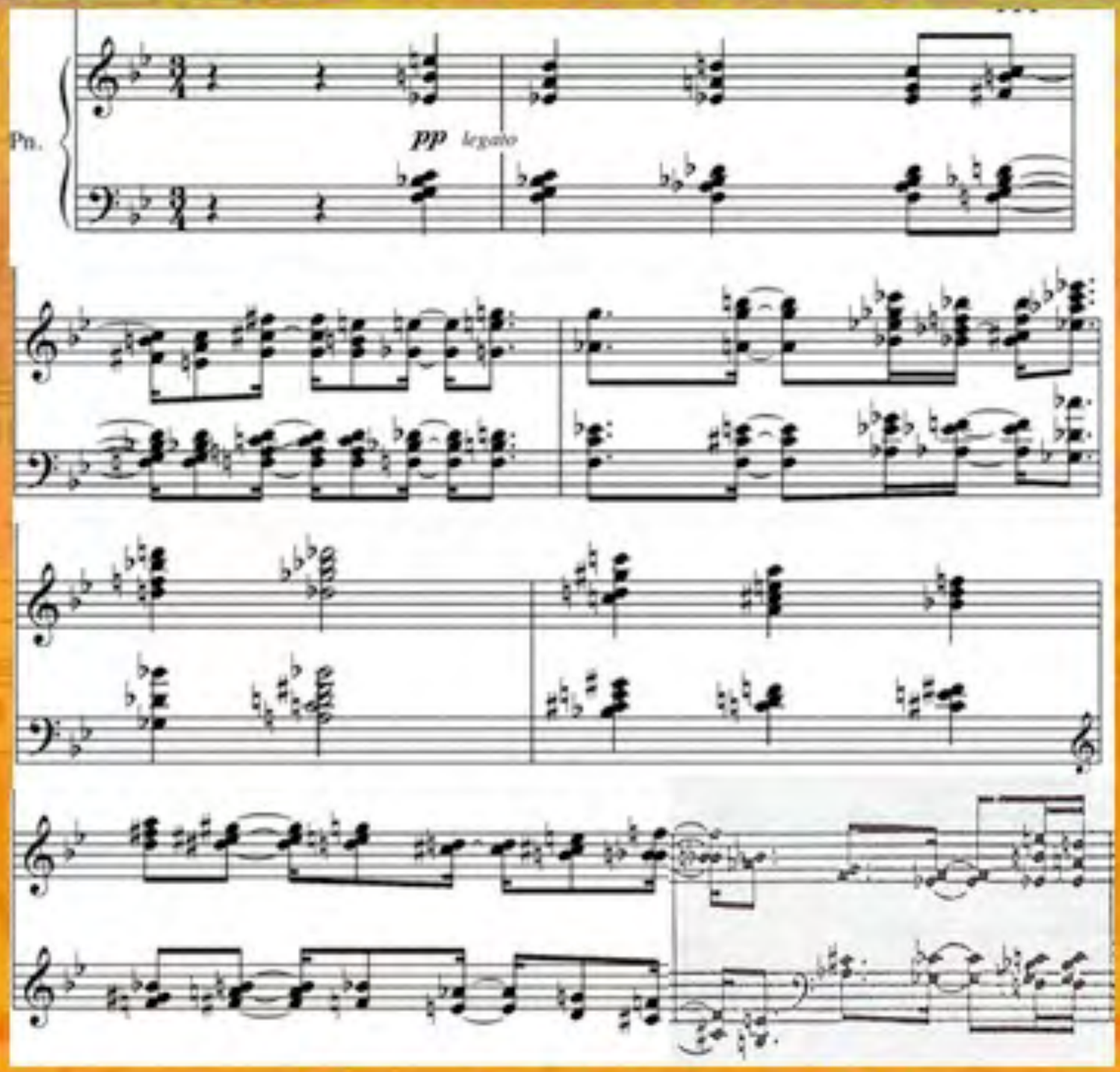
Predator = 6 years

1	2	3	4	5		7	8		10
11		13	14	15	16	17		19	20
21	22	23		25	26		28	29	
31	32	33	34	35		37	38	39	40
41		43	44		46	47		49	50
51	52	53		55	56	57	58	59	
61	62		64	65		67	68	69	70
71		73	74	75	76	77		79	80
	82	83		85	86	87	88	89	
91	92	93	94	95		97	98		100

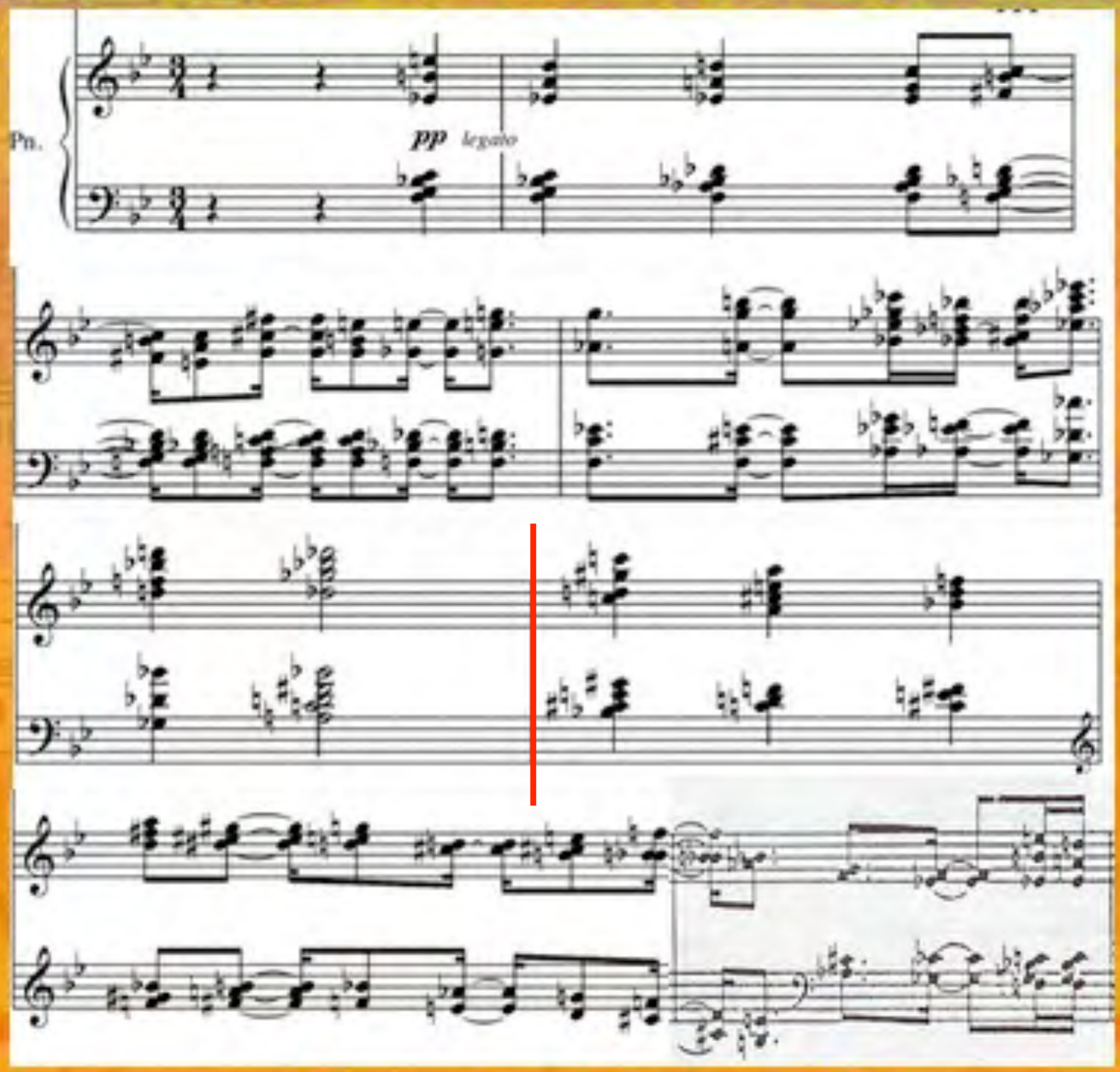
Cicada = 7 years Predator = 6 years

1	2	3	4	5			8	9	10
11		13		15	16	17		19	20
	22	23		25	26	27		29	
31	32	33	34			37	38	39	40
41		43	44	45	46	47			50
51	52	53		55		57	58	59	
61	62		64	65		67	68	69	
71		73	74	75	76			79	80
81	82	83		85	86	87	88	89	
	92	93	94	95		97		99	100

Olivier Messiaen: composer and mathematician



Quartet for the End of Time
Liturgie de Cristal: uses primes 17 and 29



Quartet for the End of Time
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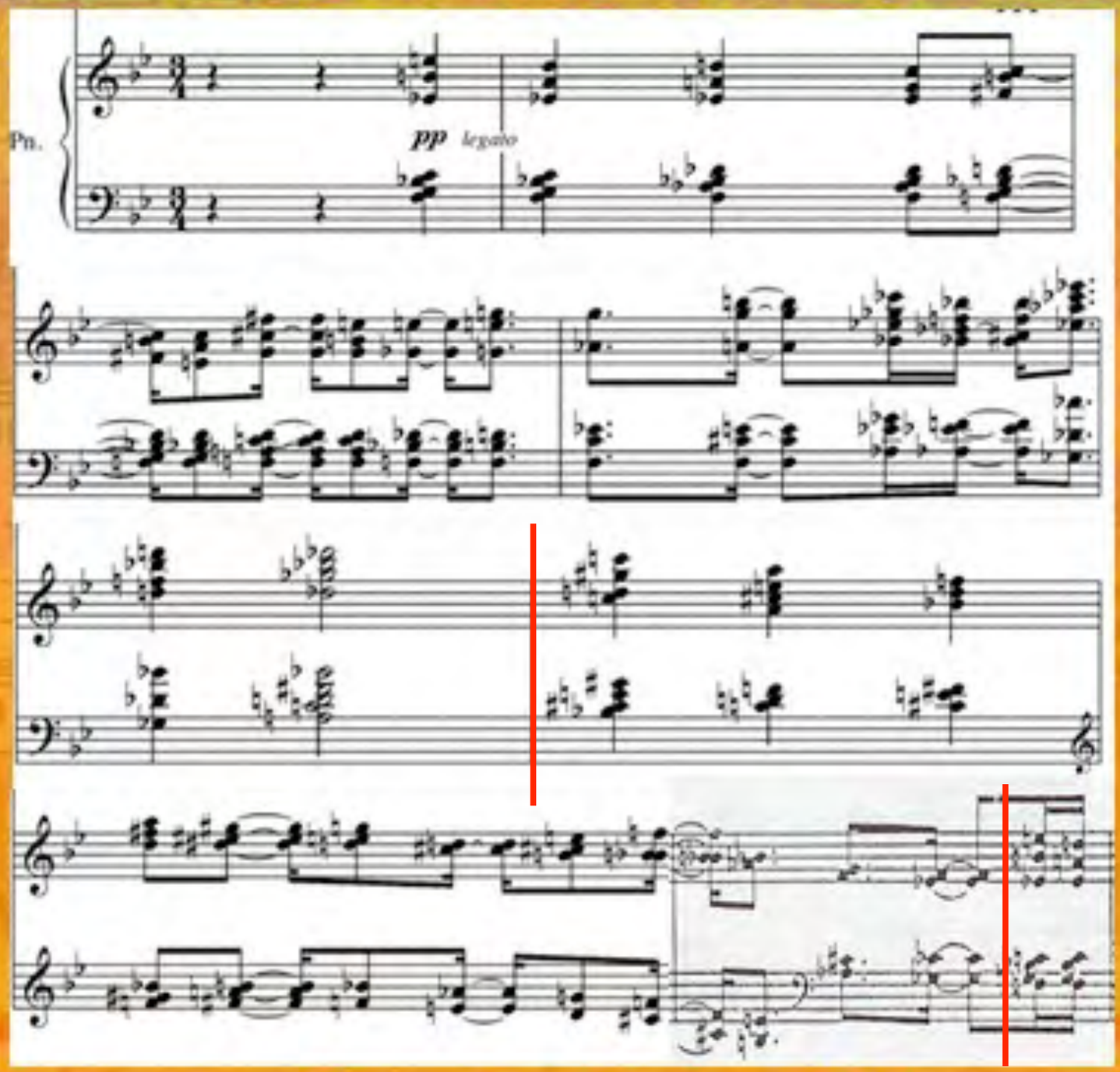


Quartet for the End of Time
Liturgie de Cristal: uses primes 17 and 29

Code cracking:
Find two primes p and q so that
$126{,}619 = p \times q$

Prime numbers are literally the key to making and breaking RSA, the cryptographic code that powers internet commerce

"A mathematician, like a painter or poet, is a maker of patterns... I am interested in mathematics only as a creative art."

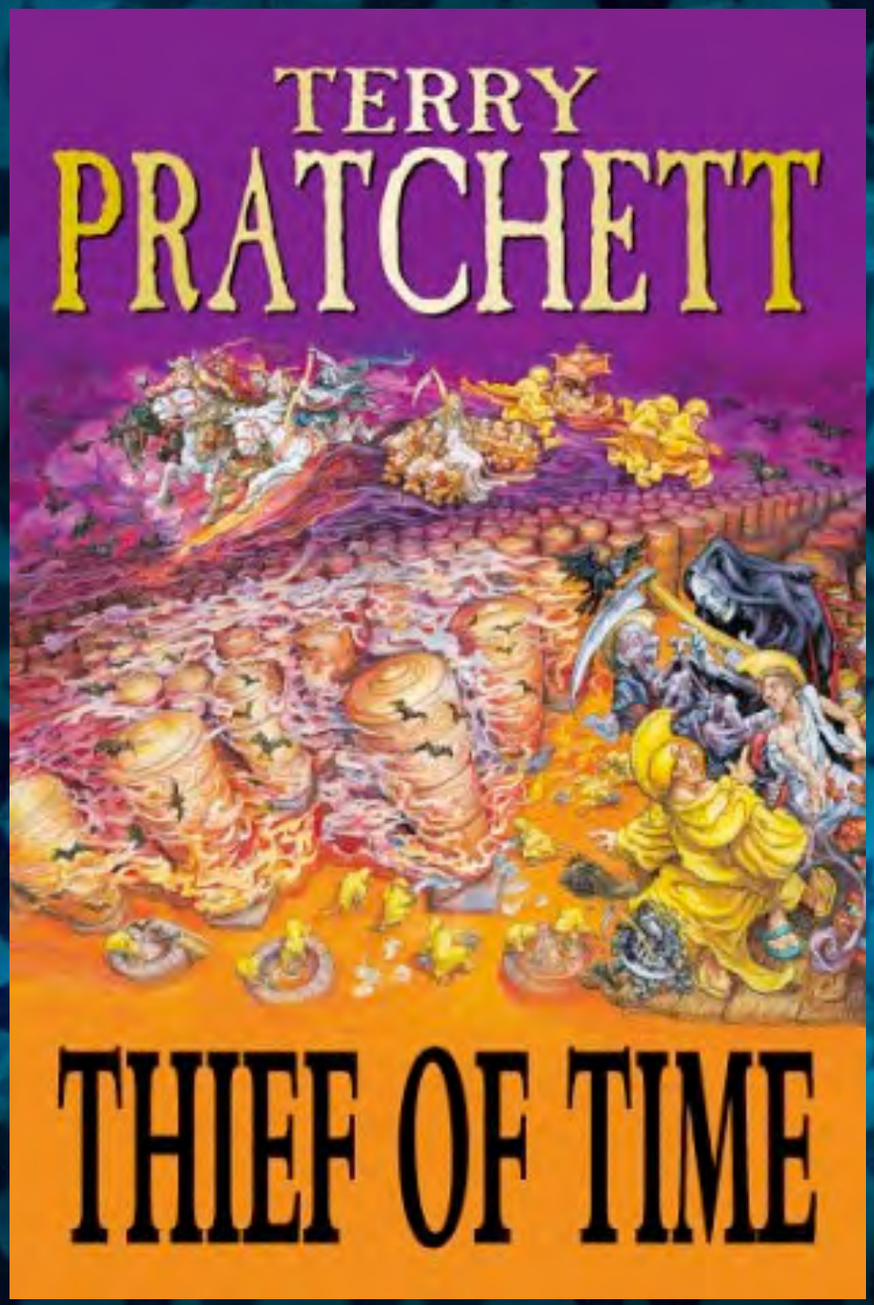
From Terry Prachett's *Thief of Time*.

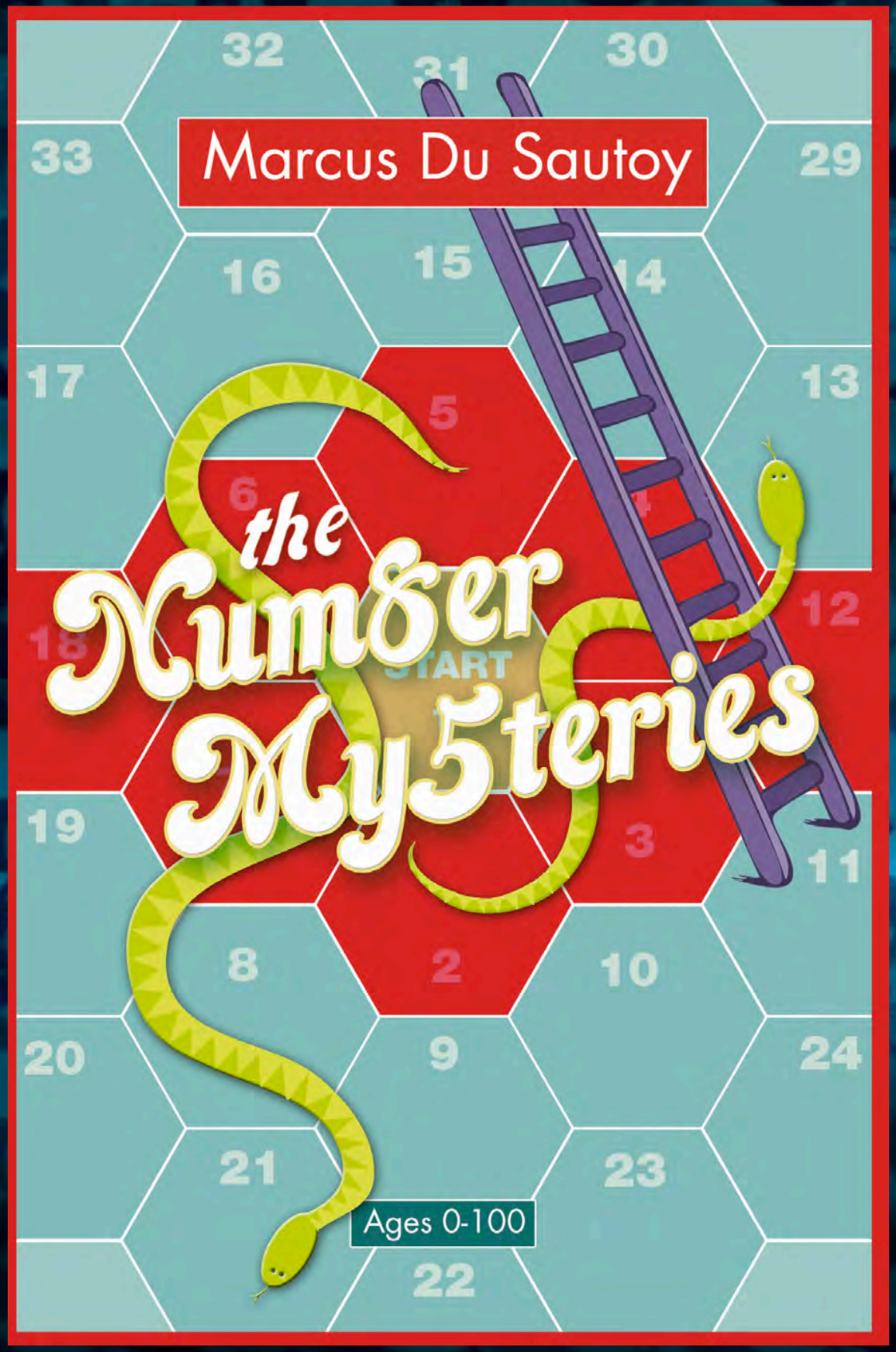
Susan is a teacher talking to her Head teacher:

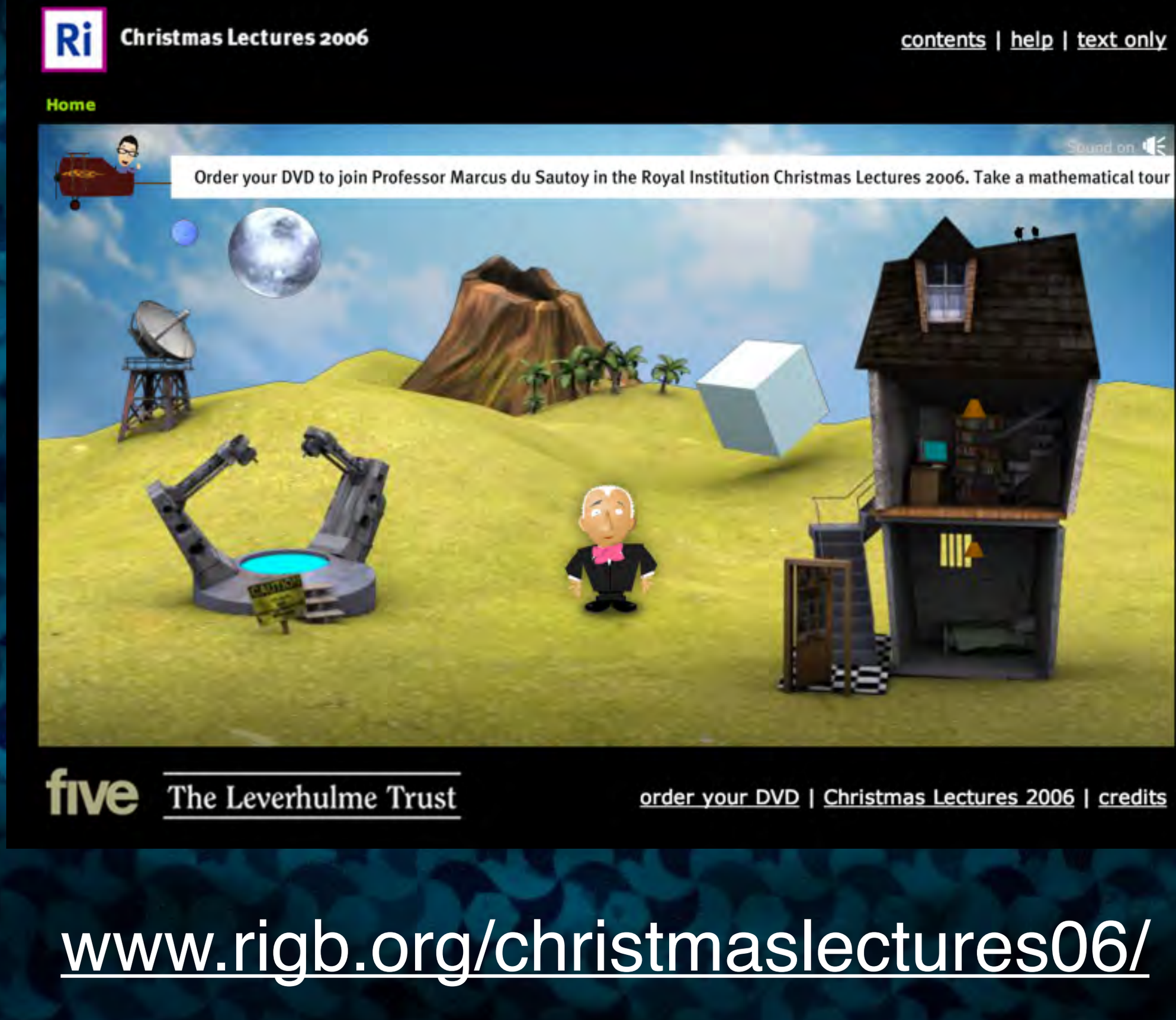
"What precisely was it that you wanted madam?" she said. "It's just that I have left the class doing algebra and they get restless when they've finished".

"Algebra?" said Madam Frout. "But that's far too difficult for seven-year-olds!"

"Yes but I didn't tell them that, and so far they haven't found out" said Susan.




Marcus Du Sautoy
the Number Mysteries
Ages 0-100



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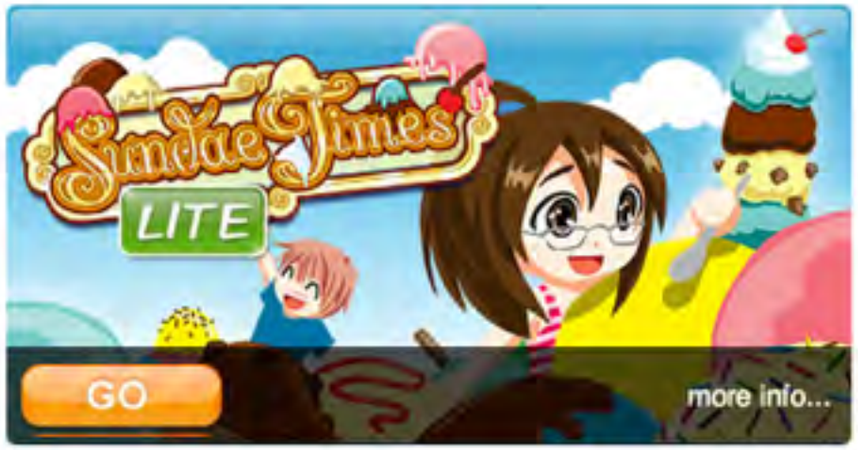

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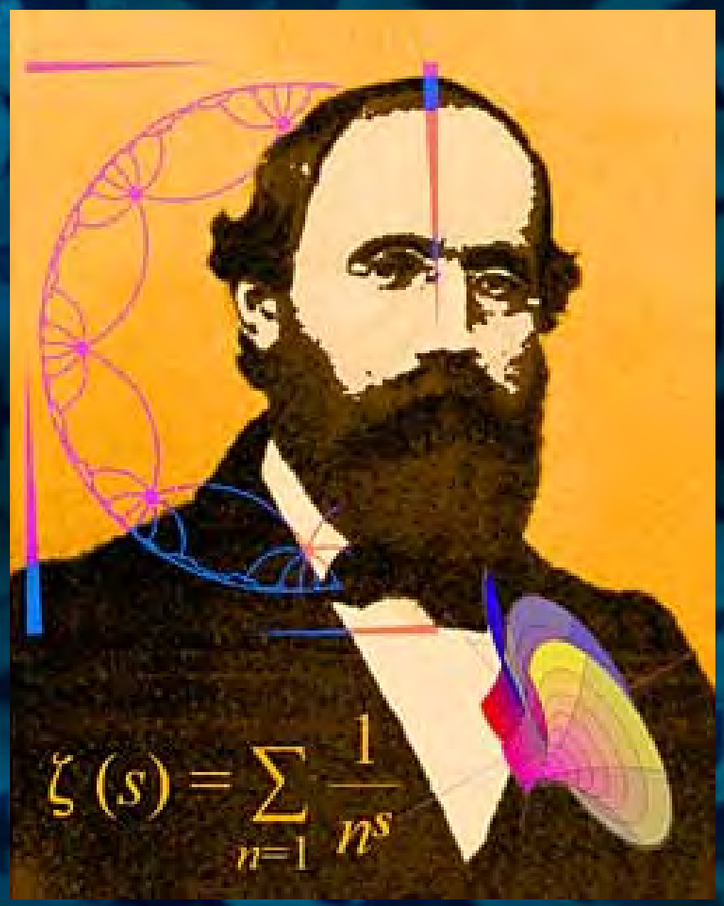

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