



# Trasversalità della complessità e dell'immaginazione

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# Complexity: Some examples

Bigger fish eats smaller one: but is it really true?  
A flock of birds is organized to exploit the contrail  
effect to save energy during its flight

*Synchronization* Heart cells: We can

live thanks to the synchronization  
of our cardiac cells

Connect some old clocks and see what happens!

# Complexity: let's try to define it

Simple system:  $P_{l+1} = \sum_i P_{i,l}$

Complex system:  $P_{l+1} = \sum_i P_{i,l} + f(P_1, \dots, P_n)$   
Emerging properties



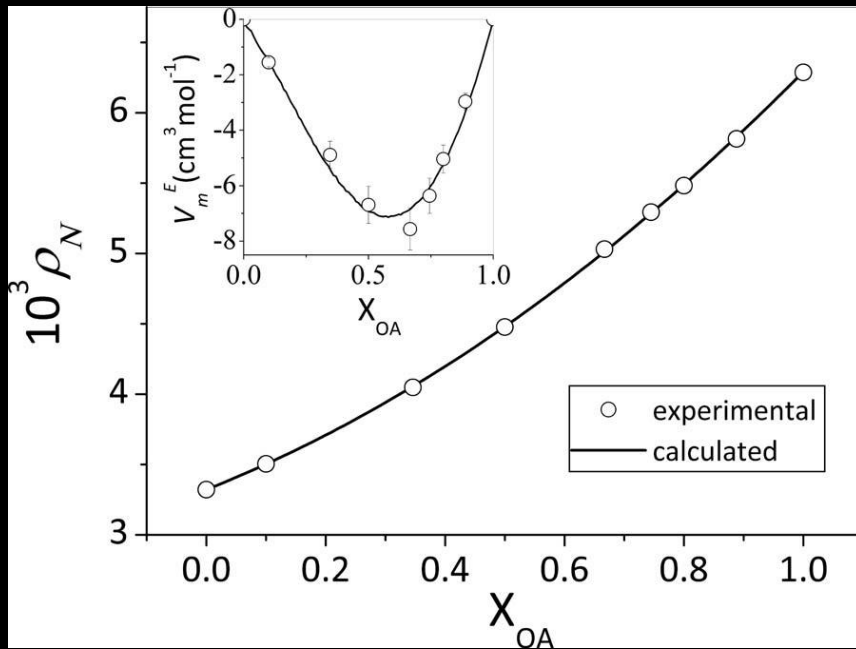
Mass:  
 $100\text{ g} + 10\text{ g}$   
leads (usually!) to  $110\text{ g}$



Volume:  
 $100\text{ ml water} + 10\text{ ml ethanol}$   
does not lead to  $110\text{ ml}$ !

# Complexity: let's try to define it

example



Complex system:  $V = V_1 + V_2 + f(V_1, V_2)$

Emerging properties

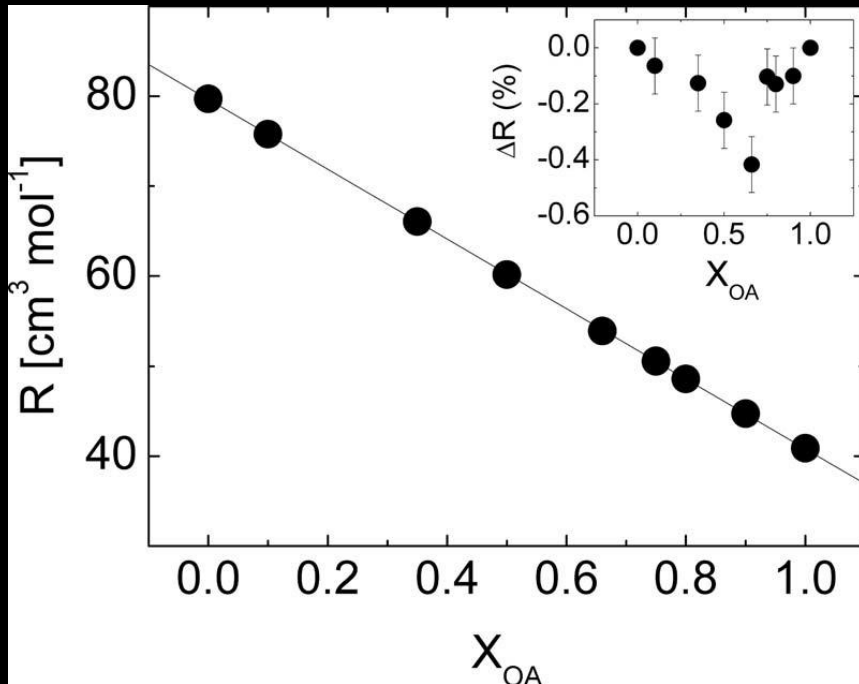


Volume:

100 ml water + 10 ml ethanol  
does not lead to 110 ml!

# Complexity: let's try to define it

Other example



Complex system:  $V = V_1 + V_2 + f(V_1, V_2)$

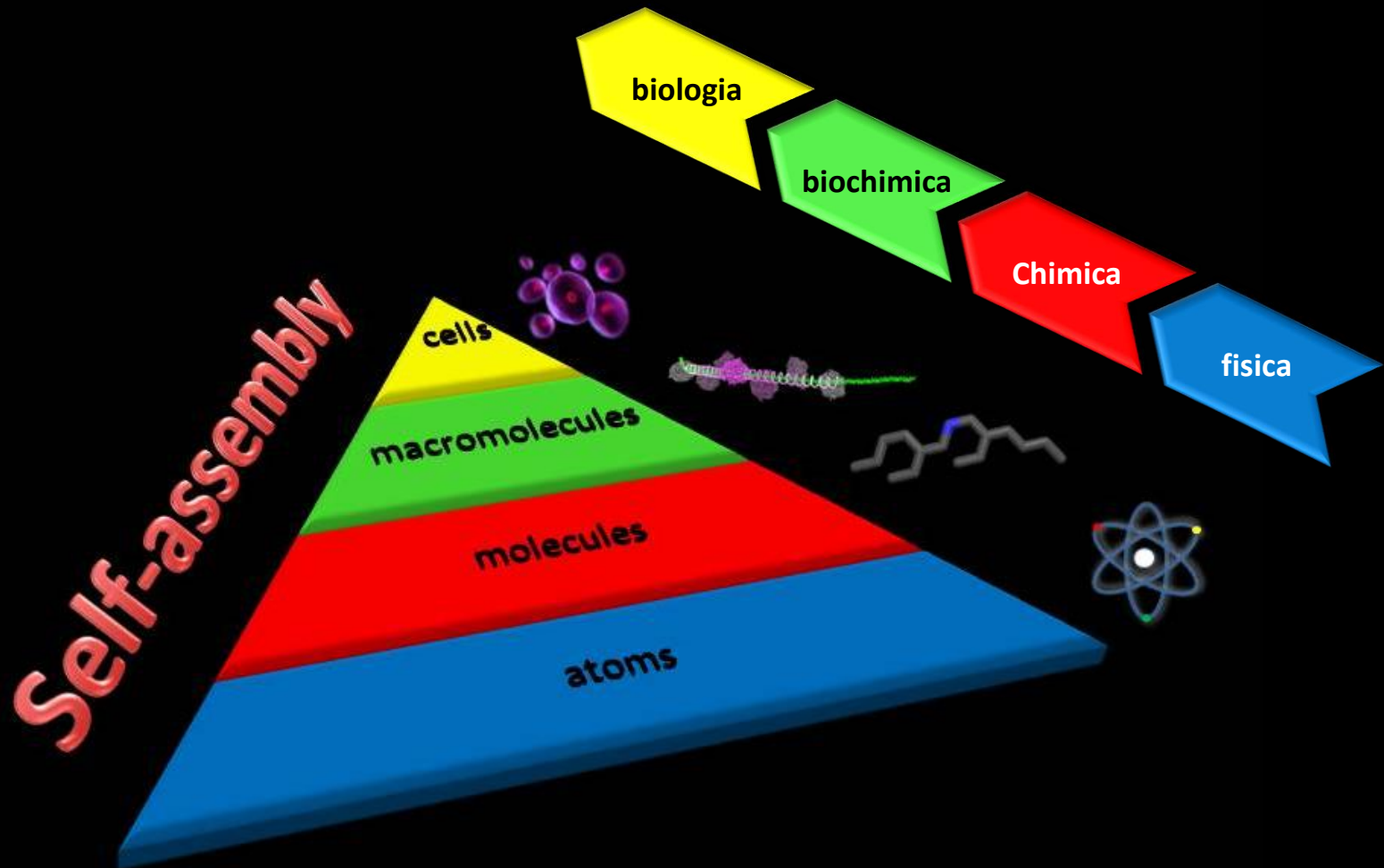
Emerging properties



Volume:

100 ml water + 10 ml ethanol  
does not lead to 110 ml!

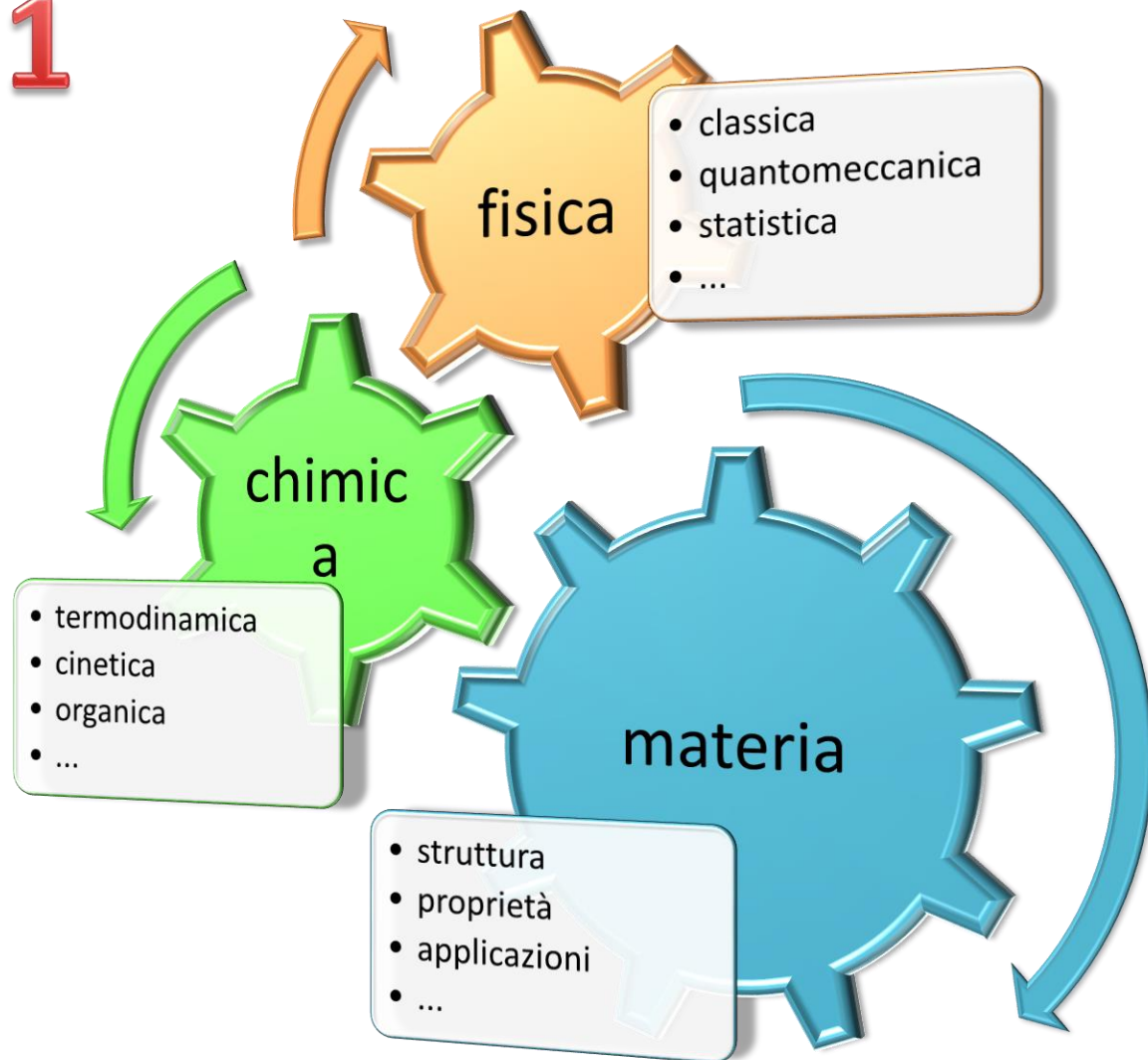
# self assembly in matter



# Many aspects



# Take-home message 1

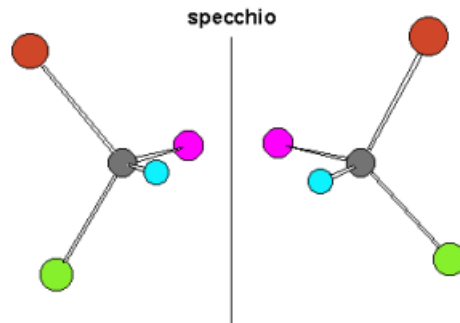




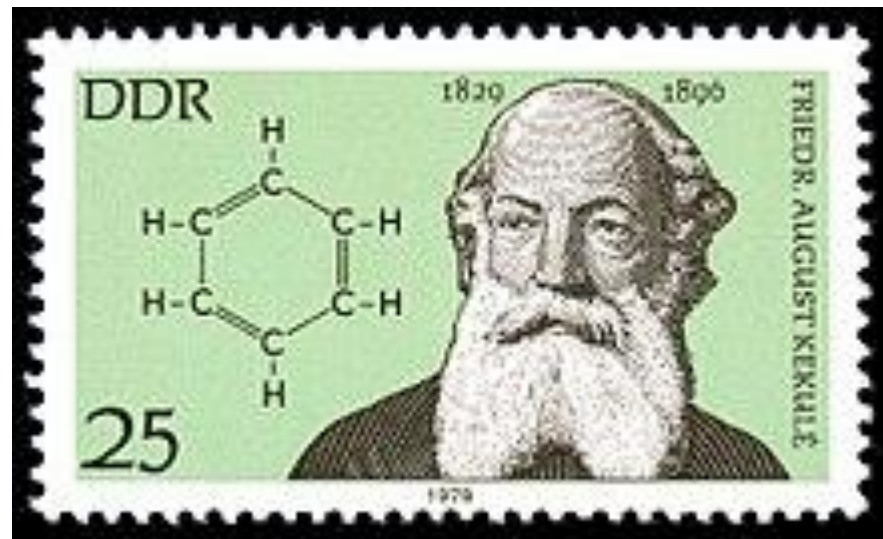
# Jacobus Henricus van 't Hoff

## 1852-1911

$$\frac{d}{dT} \ln K_{\text{eq}} = \frac{\Delta H^{\ominus}}{RT^2} \quad \Pi = \underline{i} c R T$$



# Friedrich August Kekulé (1829-1896)



# Dmitrij Ivanovič Mendeleev (1834-1907)

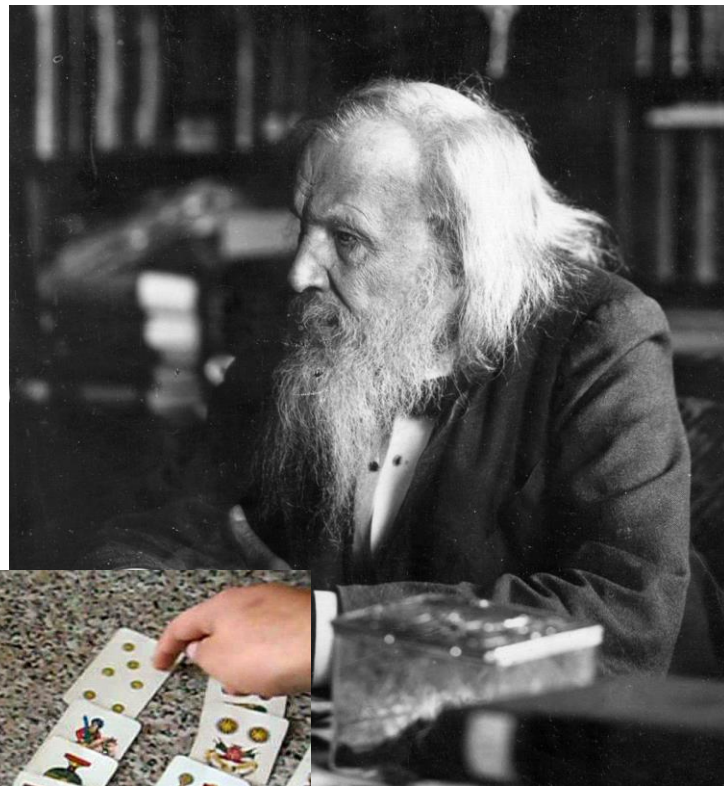
1 Nuovo Originale

■ Metalli alcalini    ■ Attinidi    C Solidi  
■ Metalli alcalino terrosi    ■ Metalli del blocco p    Br Liquidi  
■ Metalli del blocco d    ■ Nonmetalli    H Gas  
■ Lantanidi    ■ Gas nobili    Tc Artificiali

1 H 1,00794	2 He 4,002602											18 Ar 39,948	19 K 39,0983	20 Ca 40,078	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr					
3 Li 6,941	4 Be 9,012182											13 Al 26,9815386	14 Si 28,0855836	15 P 30,973762	16 S 32,065	17 Cl 35,453	18 Ar 39,948	19 K 39,0983	20 Ca 40,078	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5 Na 22,98976928	6 Mg 24,304											13 Al 26,9815386	14 Si 28,0855836	15 P 30,973762	16 S 32,065	17 Cl 35,453	18 Ar 39,948	19 K 39,0983	20 Ca 40,078	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
7 Rb 85,4678	8 Sr 87,62	9 Y 88,905848	10 Zr 91,224	11 Nb 92,90638	12 Mo 95,94	13 Tc	14 Ru 101,07	15 Rh 102,90550	16 Pd 106,42	17 Ag 107,8682	18 Cd 112,411	19 In 114,818	20 Sn 118,710	21 Sb 121,757	22 Te 127,60	23 I 126,90547	24 Xe 131,29	25 Ba 137,327	26 La	27 Ce	28 Pr	29 Nd	30 Pm	31 Sm	32 Eu	33 Gd	34 Tb	35 Dy	36 Ho	37 Er	38 Tm	39 Yb	40 Lu		
8 Cs 132,90545196	9 Ba 137,327	10 La	11 Ce	12 Pr	13 Nd	14 Pm	15 Sm	16 Eu	17 Gd	18 Tb	19 Dy	20 Ho	21 Er	22 Tm	23 Yb	24 Lu	25 Hf	26 Ta	27 W	28 Re	29 Os	30 Ir	31 Pt	32 Au	33 Hg	34 Tl	35 Pb	36 Bi	37 Po	38 At	39 Rn	40 Fr			
9 Fr 223,0187832	10 Ra 226,0254	11 Ac	12 Th	13 Pa	14 U	15 Np	16 Pu	17 Am	18 Cm	19 Bk	20 Cf	21 Es	22 Fm	23 Md	24 No	25 Lr	26 Rf	27 Db	28 Sg	29 Bh	30 Hs	31 Mt	32 Ds	33 Rg	34 Uub	35 Uuq	36 Uup	37 Uuq	38 Uus	39 Uuo	40 Uuq				

Le masse atomiche tra sono quelle degli isotopi più stabili o più comuni.

Nota: il sotto gruppo dei numeri 1-10 è stato adottato nel 1984 dalla International Union of Pure and Applied Chemistry (IUPAC). I nomi degli elementi 112-118 sono gli equivalenti latini di quei nomi.



## TAKE HOME MESSAGE 2:

IL PROGRESSO AVVIENE ANCHE GRAZIE A TENTATIVI  
SUI QUALI NON AVRETE SCOMMESSO UNA CICCA

1978: 2.35 METRI

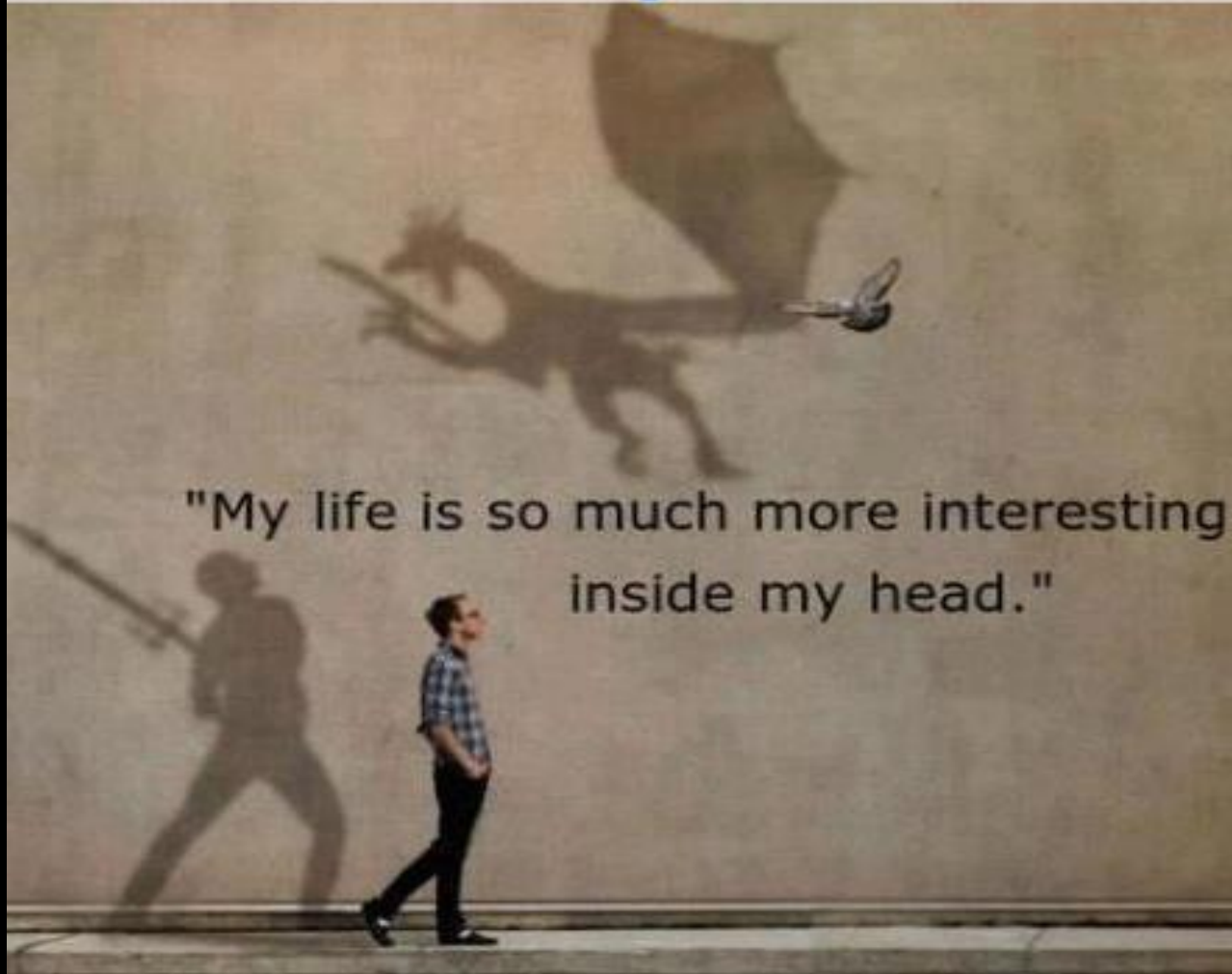


1993: 2.45 METRI



# MANY THANKS

 [www.qbarz.it](http://www.qbarz.it)



"My life is so much more interesting  
inside my head."