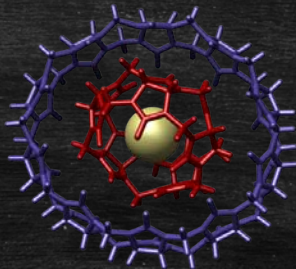


# Le proprietà emergenti

*Una Lettura dal mondo delle scienze chimiche*



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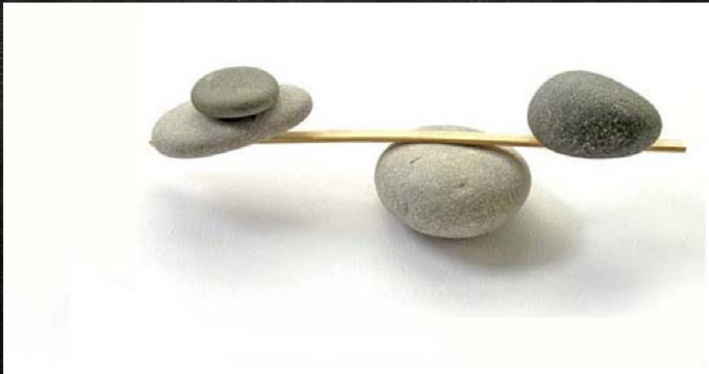
**Antonino Puglisi** *PhD, MRSC, CChem*

Senior Scientist - *Oxford Nanopore Technologies Ltd* - Oxford (UK)



## Riduzionismo & Complessita'

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## Diversi tipi di riduzionismo

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metodologico

epistemologico

ontologico

# Riduzionismo metodologico

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Tutto decomponibile nelle  
sue parti costituenti



# Riduzionismo epistemologico

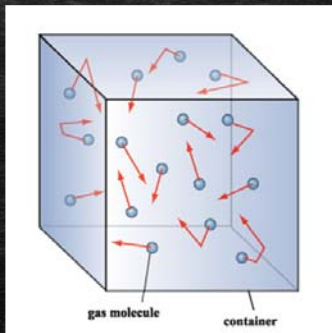
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parte

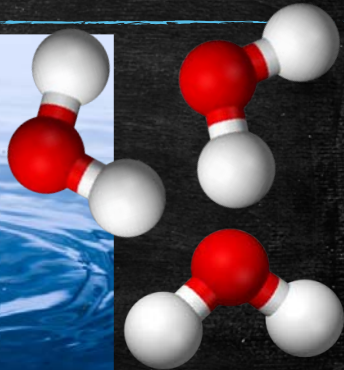
$$\frac{1}{2} m v^2 = \frac{3}{2} K T$$

tutto

*I concetti applicabili al tutto possono essere interamente espressi in termini di concetti che si applicano alle parti*



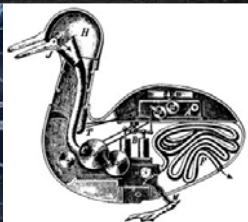
# Riduzionismo epistemologico



# Riduzionismo ontologico

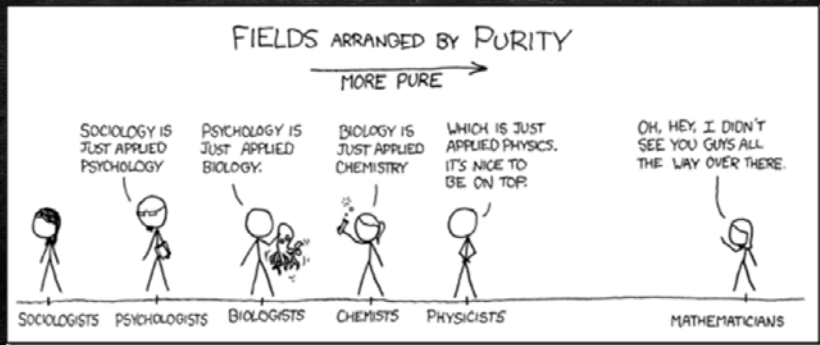
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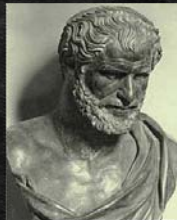
*Il tutto e' solamente la somma delle parti*





# Una disciplina fondamentale?





*'L'universo e' composto di atomi e vuoto'*

Democrito

# Riduzionismo ontologico



***'Just because my bathroom scales can't tell me what I'm thinking.***

***That doesn't say I'm not thinking'***

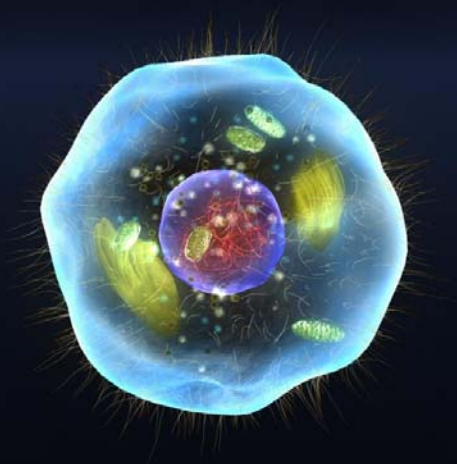
*Robert J Russell*

Founder and Director of the Center for Theology and the Natural Sciences (CTNS) – Berkeley (USA)

## Riduzionismo *soft*

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...alcuni fenomeni complessi possono essere meglio interpretati in termini di 'emergenza' di comportamenti a un livello organizzativo piu' alto che non e' riducibile al comportamento dei suoi componenti



## Life's Irreducible Structure

live mechanisms and information in DNA are boundary conditions with a sequence of boundaries above them.

Michael Polanyi

If all men were exterminated, this would not affect the laws of inanimate nature. But the production of machines would stop, and not until men arose again could machines be formed once more. Some animals can produce tools, but only men can construct machines; machines are human artifacts, made of inanimate material.

The *Oxford Dictionary* describes a machine as "an apparatus for applying mechanical power, consisting of a number of interrelated parts, each having a definite function." It might be, for example, a machine for sewing or printing. Let us assume that the power driving the machine is built in, and regard the fact that it has to be re-manufactured from time to time. We can say, from the cutting suitably shaped

So the machine as a whole works under the control of two distinct principles. The higher one is the principle of the machine's design, and this harnesses the lower one, which consists in the physical-chemical processes on which the machine relies. We commonly form such a two-levelled structure in conducting an experiment; but there is a difference between constructing a machine and rigging up an experiment. The experimenter imposes restrictions on nature in order to observe its behavior under these restrictions, while the constructor of a machine restricts nature in order to harness its workings. But we may borrow these useful restrictions of nature as the imposing of boundary conditions on the laws of physics and chemistry.

### Living Mechanisms Are Classed with Machines

From machines we pass to living beings, by remembering that animals move about mechanically and that they have internal organs which perform functions as parts of a machine do—organisms much as a machine keeps the working of parts of a machine going. For centuries past, the workings of life have been likened to the working of machines and physiology has been seeking to interpret the organization as a complex network of mechanisms. Organs are, accordingly, defined by their life-preserving functions.

whereas the second is attention-type. By shifting our attention, we sometimes change a boundary from type to another.

All communications form a machine type of boundary, and these boundaries form a whole hierarchy of consecutive levels of action. A vocabulary sets the spoken voice; a grammar and the sentences words to form sentences, and the sentences are shaped into a text which conveys a communication. At all these stages we are interested in the boundaries imposed by a comprehensive restrictive power, rather than in the principles harnessed by them.



Michael Polanyi, FRS 1891-1976

Science 21 June 1968  
Vol. 160 no. 3834 pp. 1308-1312

*'(...) emergent entities (properties or substances)  
'arise' out of more fundamental entities and yet are  
'novel' or 'irreducible' with respect to them'*

*Stanford Encyclopedia of Philosophy*

<http://plato.stanford.edu/entries/properties-emergent/>

# La chimica come 'scienza di mezzo'

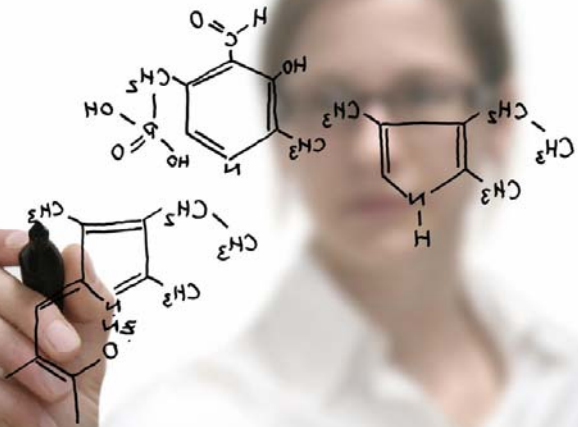


Biologia

Chimica

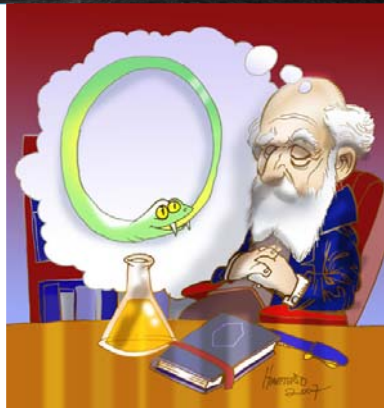
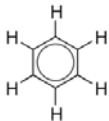
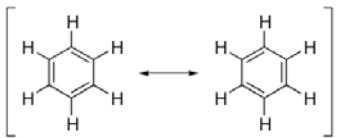
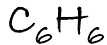
Fisica





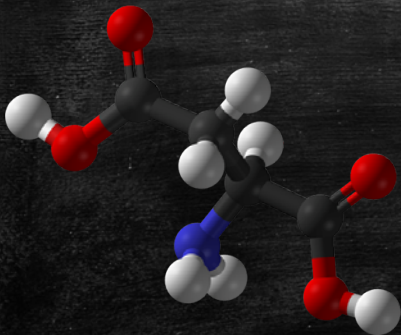
81 million organic and inorganic substances

# Formula bruta - Formula di struttura



## Formula bruta - Formula di struttura

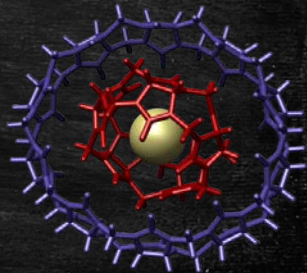
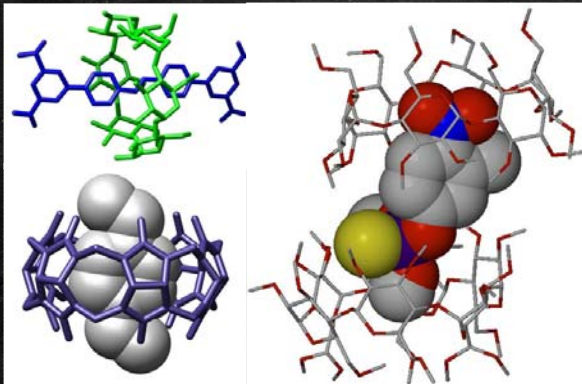
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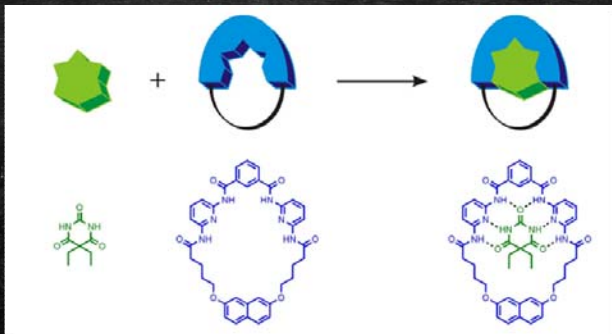
La **Struttura molecolare**  
proprietà' emergente del  
sistema complesso molecola

# La chimica oltre le molecole

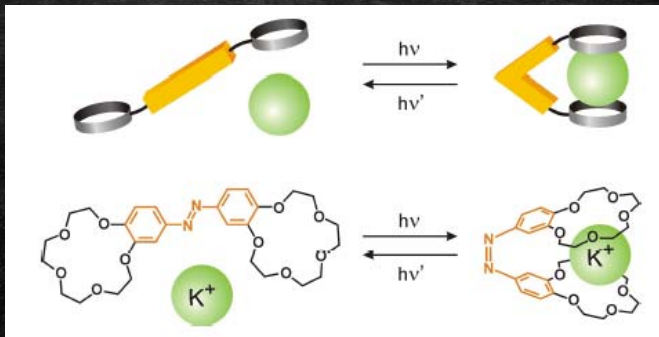
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# La chimica oltre le molecole

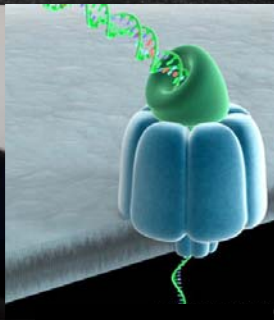


# Macchine molecolari

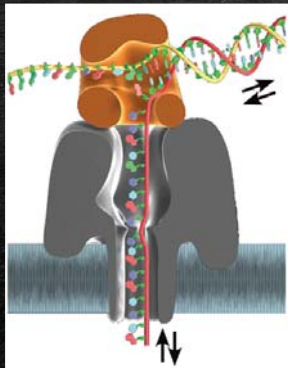


# Nanomachine *Bio-inspired*

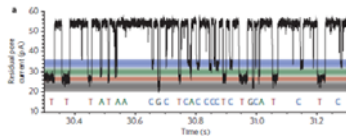
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# Nanomachine *Bio-inspired*

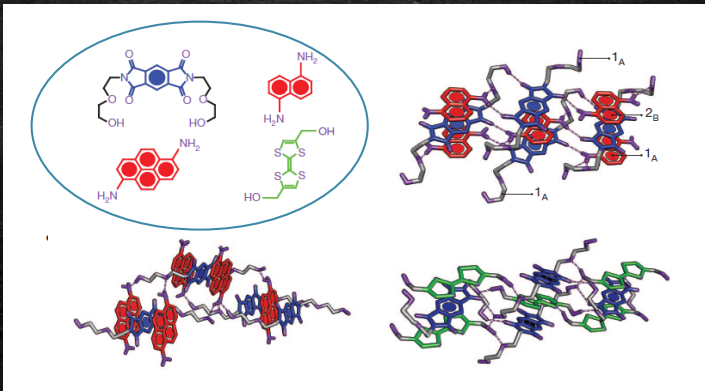


**NATURE NANOTECHNOLOGY** DOI: 10.1038/NNNANO.2009.12

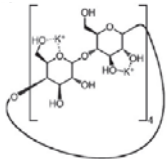
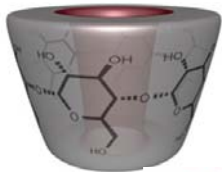




# Proprieta' emergenti e sistemi supramolecolari - 1

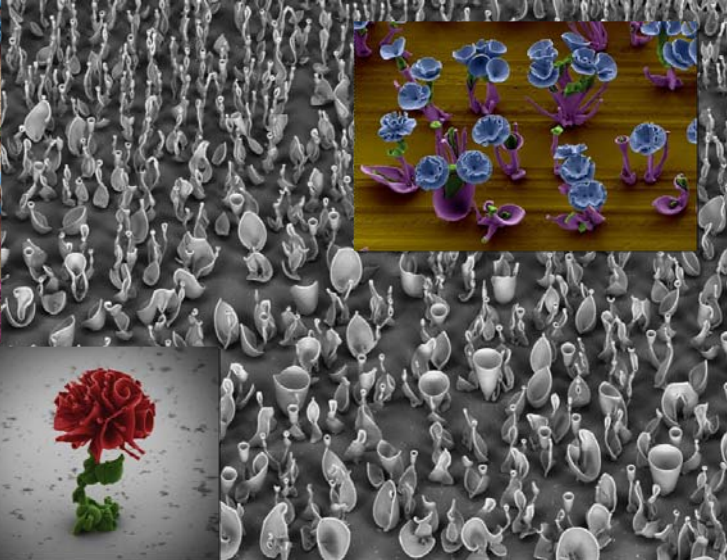


# Proprieta' emergenti e sistemi supramolecolari - 2



Science

17 May 2013



SCIENCE 17 MAY 2013  
VOL 340, ISSUE 6134, 777-892

Emerging  
Microarchitectures



# Embracing Complexity

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*'The time has come for us to embrace complexity (...) put much more of our effort into studying complex mixtures of interacting molecules.*

*An excellent reason for responding positively to the intellectual challenge posed by systems chemistry is that complexity very often gives rise to emergent properties that are not present in the components of a complex mixture but come to light only as a result of interactions between molecules'*

*From Supramolecular to Systems Chemistry: Complexity Emerging out of Simplicity*  
**Angew. Chem. Int. Ed.** 2012, 51, 12902 – 12903

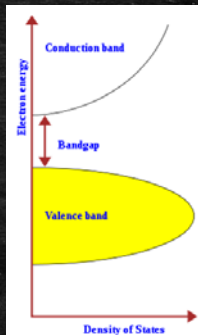
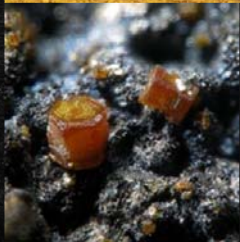


**Sir James Fraser Stoddart**  
FRS FRSE FRSC  
Department of Chemistry  
Northwestern University (US)

La realta' una unita' a molti livelli?

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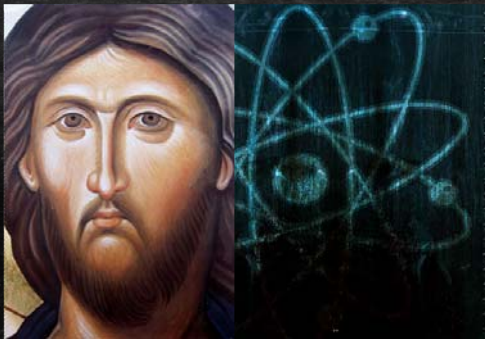






# Atomi e icone

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'Un uomo che guarda un  
vetro/ può fissarvi sopra  
il suo sguardo / o, se  
vuole, può guardarvi  
attraverso,  
e scorgere allora il cielo.

*'A man that looks on glass/ On  
it may stay his eye  
/Or if he pleaseth,  
through it pass,  
And then the heaven espy.'*



*By George Herbert (1593-1633) –  
from 'The Temple'*

'I'm a very passionate believer in the unity of knowledge. There is one world of reality - one world of our experience that we're seeking to describe'



*John Polkinghorne*  
English theoretical physicist, theologian,  
writer, and Anglican priest

Extra

# Macchine Molecolari

