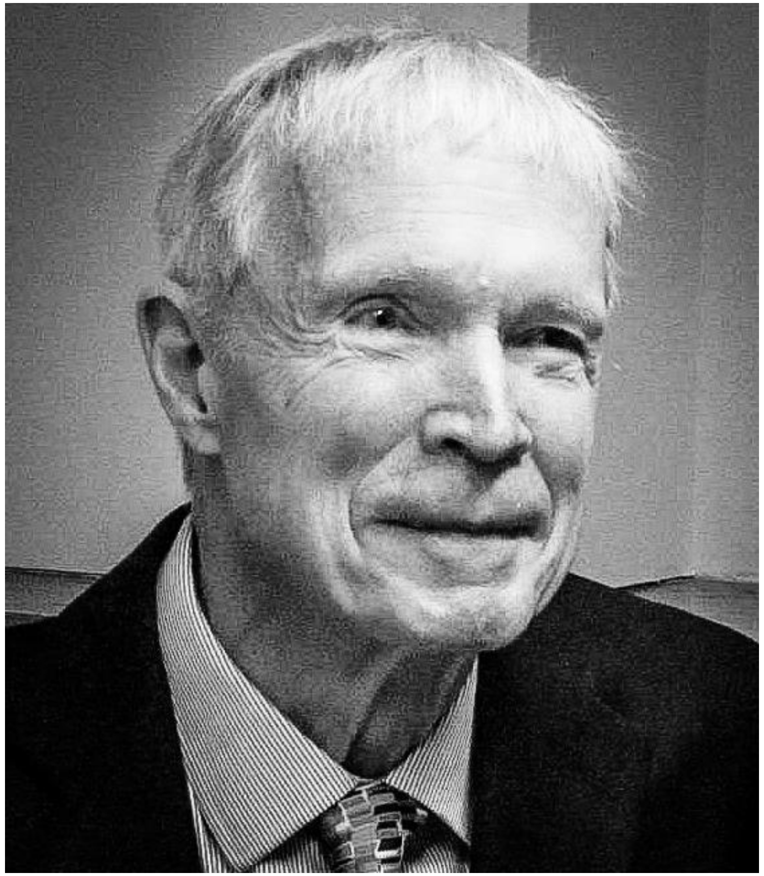
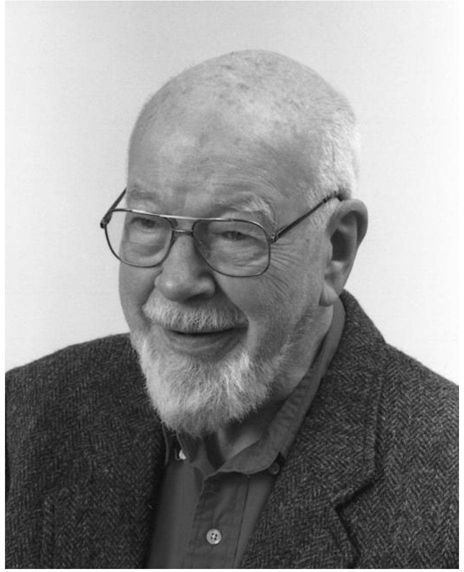


Physics is a point of view

John J Hopfield,
Princeton University,
Princeton, New Jersey
USA

The choice of problems is the primary determinant of what one accomplishes in science



William C. Elmore
(1909-2003)

Chair, Physics Department (1950)
Swarthmore College

John J Hopfield

Physics or Chemistry

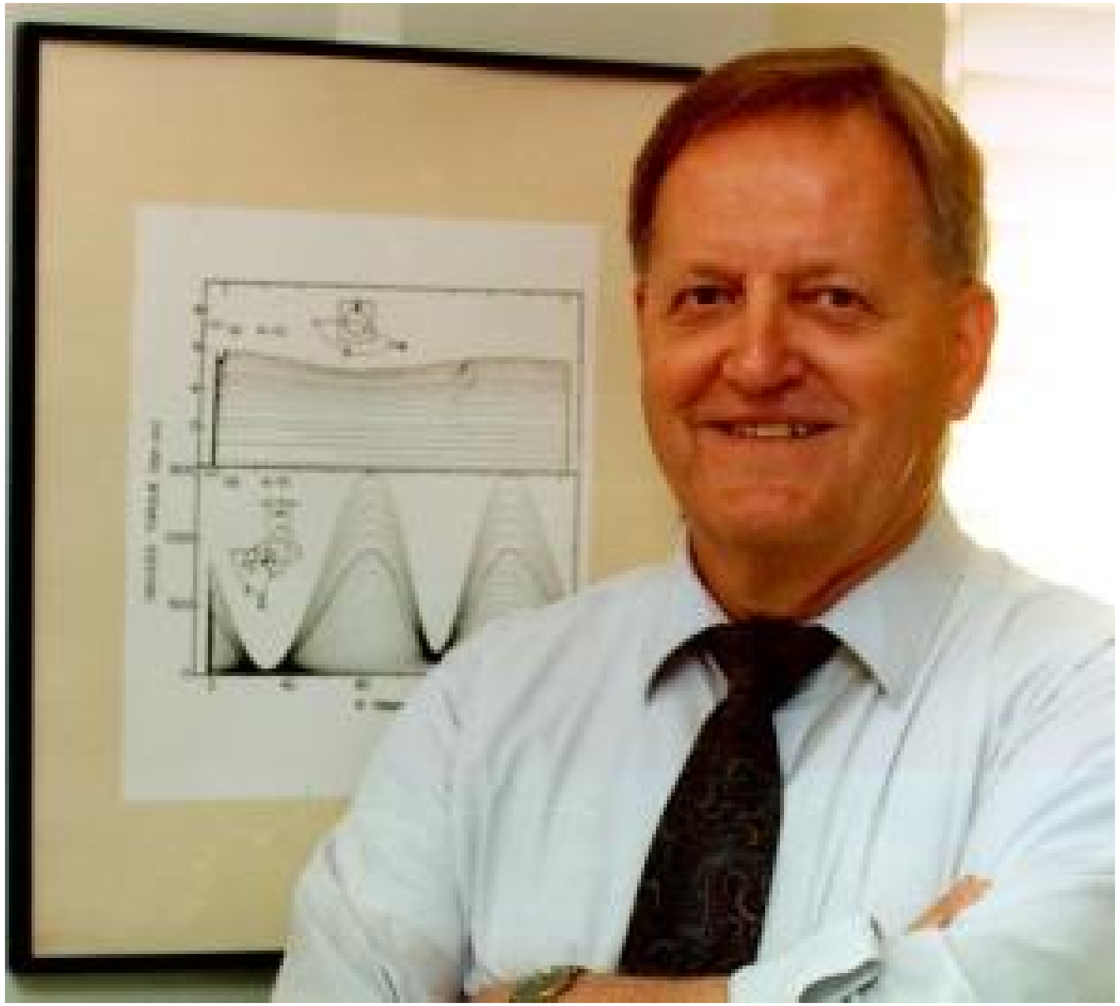
John J Hopfield

Physics ~~or Chemistry~~

Albert W. Overhauser

(1925-2011)
Purdue University

Thesis advisor, Cornell University



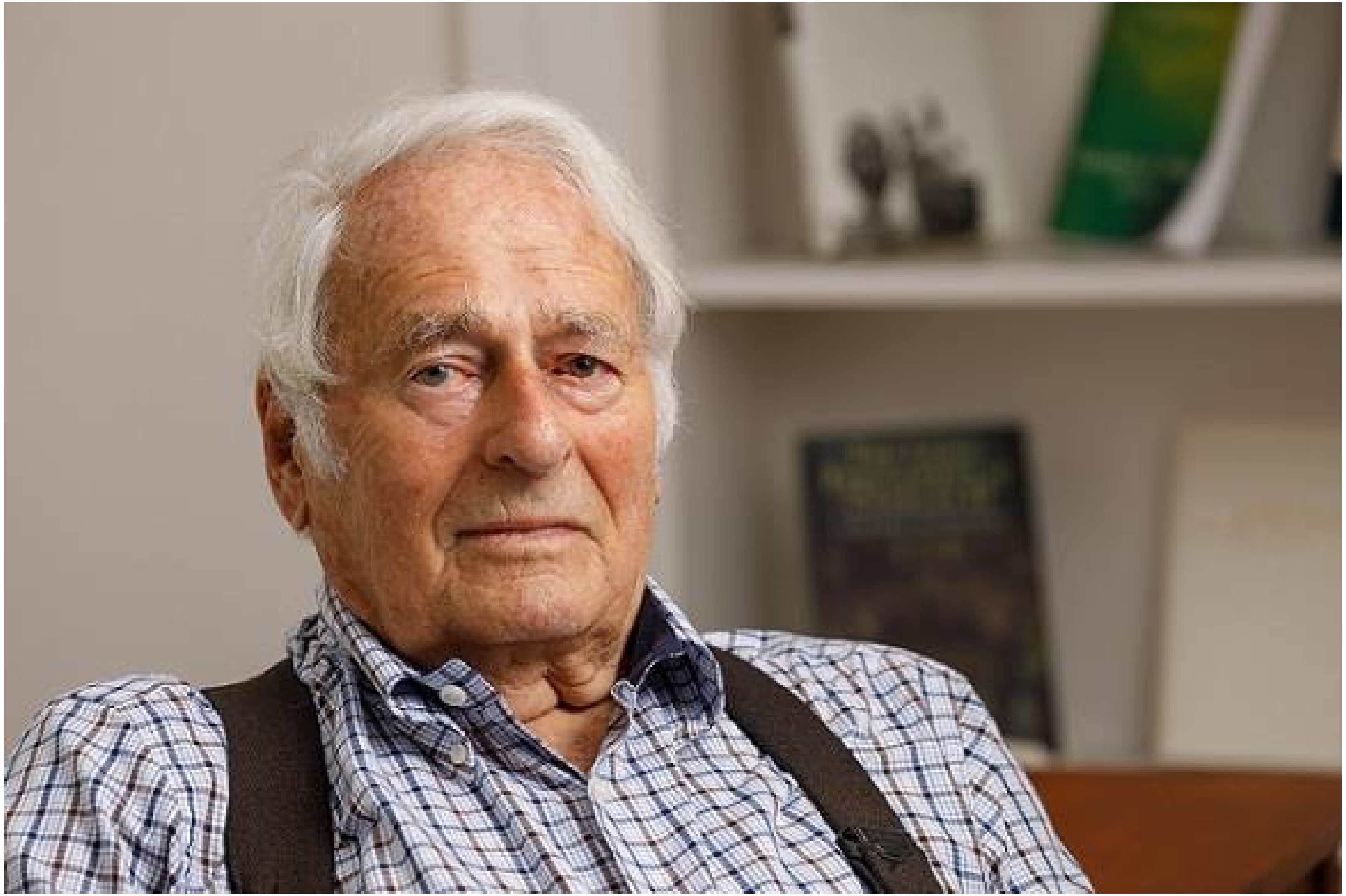
David G. Thomas

(1928-2015)

AIP Emilio Segrè Visual Archives,
Physics Today Collection

David G Thomas, receiving his half of the 1969 Buckley Prize we shared
from Nobelist Luis Alvarez, the 1969 President of the American Physical Society.

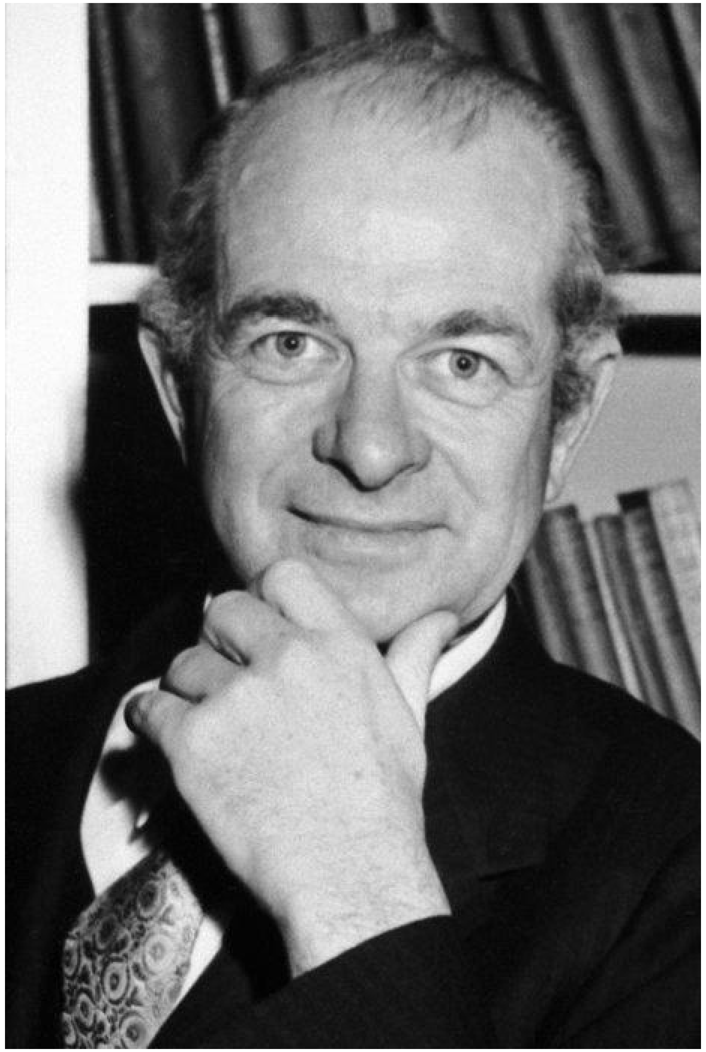
Thomas went on to a distinguished career in the administration of Bell Laboratories



Robert G. Shulman
(1924-)
Yale University

Bell Labs
Biophysics department head

'I ask myself whether the problem I am considering is one to which *I* am likely to be able to make a contributi*on*'



Linus Pauling

1901-1994
Nobel Foundation

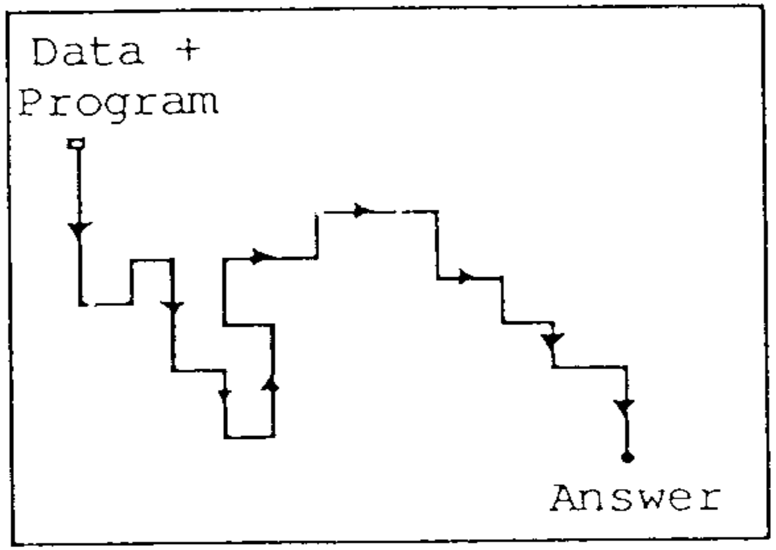
My 1974 paper on kinetic proof-reading was important in my approach to biological problems.

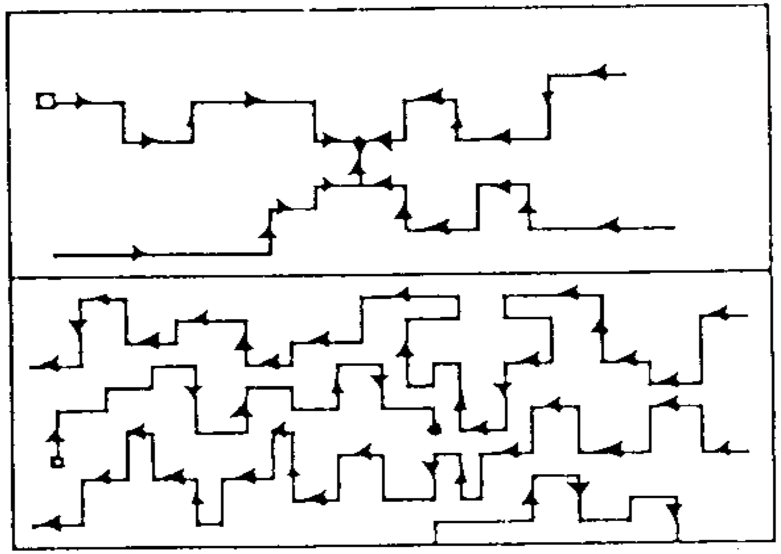
It led me to think about the function of the structure of reaction *networks* in biology, rather than the structure of the molecules themselves.

How mind emerges from brain is to me the deepest question posed by our humanity

BATCH-MODE DIGITAL COMPUTATION

state space of long binary words 10001111000101000101001110.....





Proc. Natl. Acad. Sci. USA
Vol. 79, pp. 2554–2558, April 1982
Biophysics

Neural networks and physical systems with emergent collective computational abilities

(associative memory/parallel processing/categorization/content-addressable memory/fail-soft devices)

J. J. HOPFIELD

Division of Chemistry and Biology, California Institute of Technology, Pasadena, California 91125; and Bell Laboratories, Murray Hill, New Jersey 07974

Contributed by John J. Hopfield, January 15, 1982

ABSTRACT Computational properties of use to biological organisms or to the construction of computers can emerge as collective properties of systems having a large number of simple equivalent components (or neurons). The physical meaning of content-addressable memory is described by an appropriate phase space flow of the state of a system. A model of such a system is given, based on aspects of neurobiology but readily adapted to integrated circuits. The collective properties of this model produce a content-addressable memory which correctly yields an entire memory from any subpart of sufficient size. The algorithm for the time evolution of the state of the system is based on asynchronous parallel processing. Additional emergent collective properties include some capacity for generalization, familiarity recognition, categorization, error correction, and time sequence retention. The collective properties are only weakly sensitive to details of the modeling or the failure of individual devices.

calized content-addressable memory or categorizer using extensive asynchronous parallel processing.

The general content-addressable memory of a physical system

Suppose that an item stored in memory is "H. A. Kramers & G. H. Wannier *Phys. Rev.* **60,** 252 (1941)." A general content-addressable memory would be capable of retrieving this entire memory item on the basis of sufficient partial information. The input "& Wannier, (1941)" might suffice. An ideal memory could deal with errors and retrieve this reference even from the input "Vannier, (1941)". In computers, only relatively simple forms of content-addressable memory have been made in hardware (10, 11). Sophisticated ideas like error correction in accessing information are usually introduced as software (10).

There are classes of physical systems whose spontaneous behavior can be used as a form of general (and error-correcting)

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