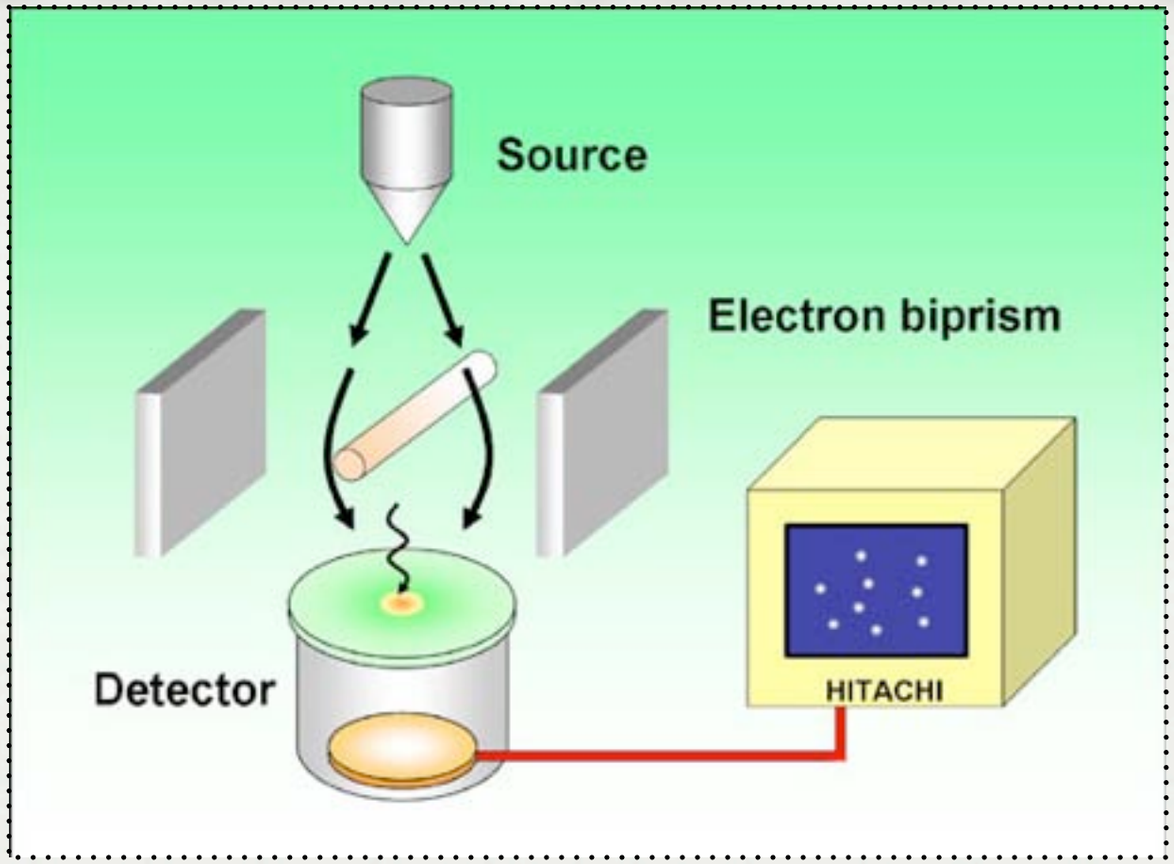
Measurement in Quantum Mechanics

YOUNG DOUBLE SLIT EXPERIMENT



Ref: A. Tonomura, J. Endo, T. Matsuda, T. Kawasaki and H. Ezawa Am. J. of Phys. 57, 117 (1989)

Electrons are emitted one by one from the source in the electron microscope. They pass through a device called the "electron biprism", which consists of two parallel plates and a fine filament at the center. The filament is thinner than 1 micron (1/1000 mm) in diameter. Electrons are then detected one by one as particles at the detector.

The electrons were accelerated to 50 kV, and therefore their speed is about 40% of the speed of the light (120,000 km/sec). So they pass through a one-meter-long electron microscope in 10^{-8}s. There is no more than one electron in the microscope at one time, since only 10 electrons are emitted per second. The experiment lasts 20 minutes (video 1 min!)

VIDEO

HITACHI RESEARCH LAB.

HTTP://WWW.HITACHI.COM/RD/RESEARCH/EM/DOUBLESLIT.HTML

Each electron position is random...

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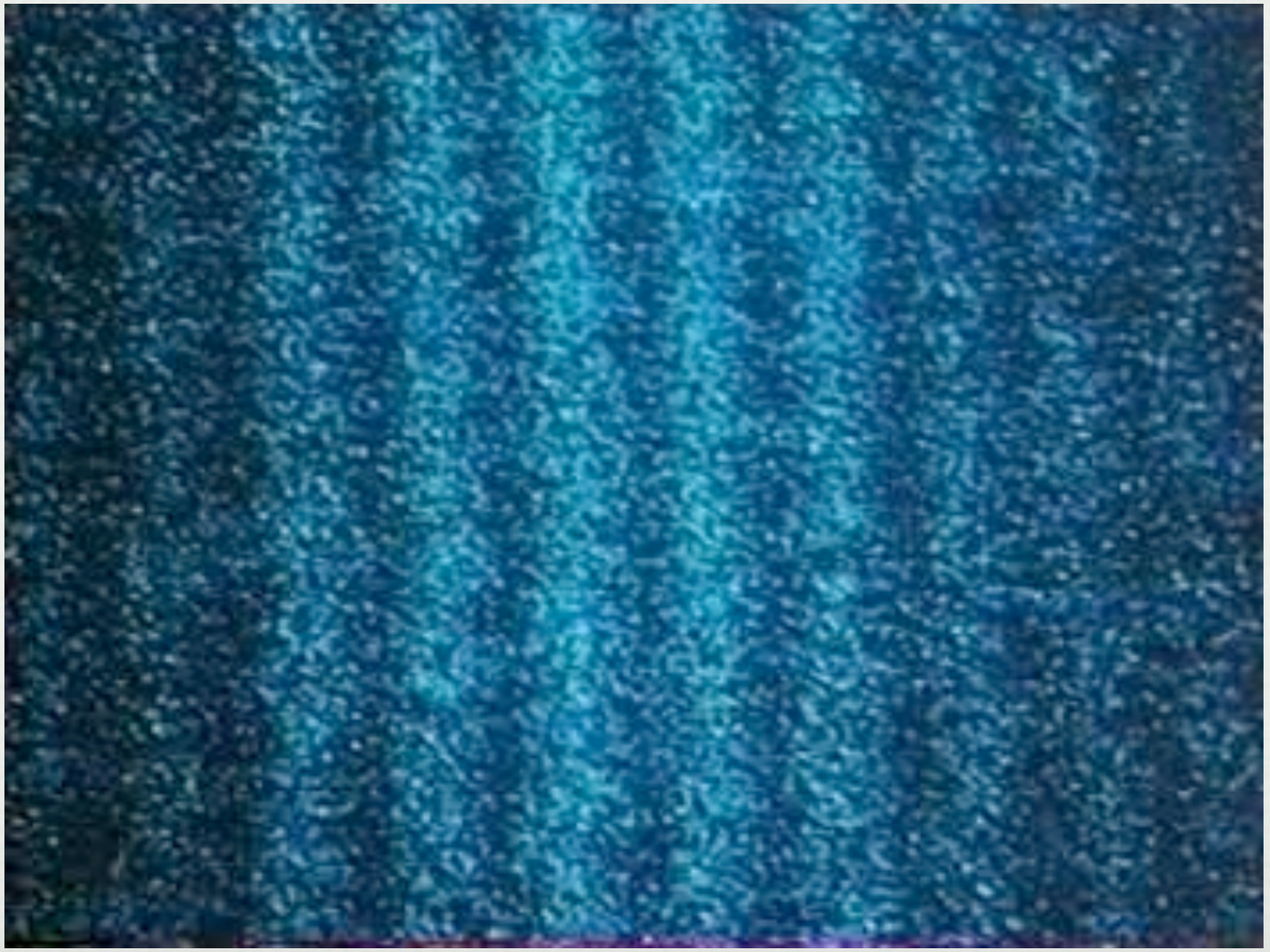
... but the probability of its position is predicted by the wavefunction: $P(x) = |\ \ (x)|^2$.

Measuring the position of many electrons, we learn about average properties, $\langle x \rangle = \int x |\ \ (x)|^2 dx$.



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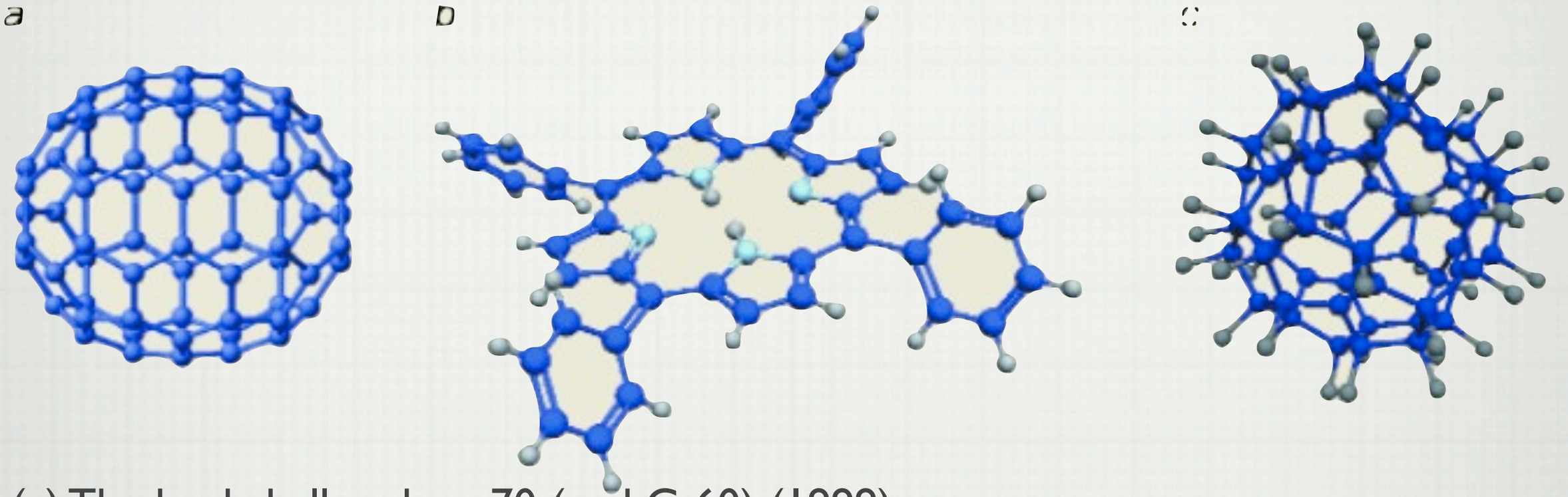
Here, we discover the probability distribution of their positions

MOLECULE INTERFEROMETRY

M. ARNDT, K. HORNBERGER, A. ZEILINGER



(a) The buckyball carbon-70 (and C-60) (1999)
(b) the pancake-shaped biomolecule tetraphenylporphyrin (TPP) $C_{44}H_{30}N_4$; (2003)
(c) the fluorinated fullerene $C_{60}F_{48}$. (2004)

TPP is the first-ever biomolecule to show its wave nature.
$C_{60}F_{48}$ has an atomic mass of 1632 units and currently holds the world record for the most massive and complex molecule to show interference.

22.02 Introduction to Applied Nuclear Physics

Spring 2012