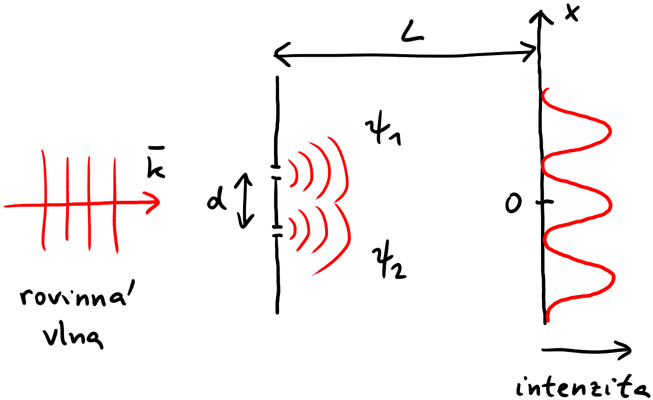
Dvouštěrbinový experiment



skládání vln v bodě x

$$I(x) \sim |\psi_1 + \psi_2|^2$$

$$\sim \left| \frac{1}{\sqrt{r_1}} e^{ikr_1} + \frac{1}{\sqrt{r_2}} e^{ikr_2} \right|^2$$

Fraunhoferova aproximace

$$\to \quad I(x) \sim \cos^2 \frac{kxd}{2R}$$

$$k = 2\pi/\lambda$$

pokusy se světlem:

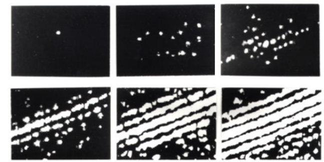
Thomas Young - okolo roku 1801

G. I. Taylor
Interference fringes with feeble light
Proceedings of the Cambridge Philosophical Society 15, 114 (1909)

Diracův problematický komentář k interferenci: "each photon then interferes only with itself"

C. Jönsson
Elektroneninterferenzen an mehreren künstlich hergestellten Feinspalten
Zeitschrift für Physik 161, 454 (1961)

P. G. Merli, G. F. Missiroli, and G. Pozzi
On the statistical aspect of electron interference phenomena
American Journal of Physics 44, 306 (1976)



A. Tonomura, J. Endo, T. Matsuda, T. Kawasaki, and H. Ezawa
Demonstration of single-electron build-up of an interference pattern
Am. J. Phys. 57, 117 (1989)

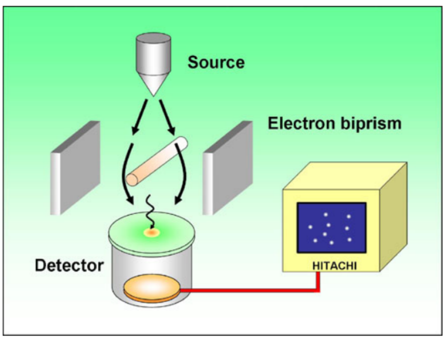


Fig. 1 Double-slit experiment with single electrons

Electrons emitted from a source are sent to the electron biprism. The electrons are attracted towards the central filament and overlap in the electrons arrived lower detector plane at the detector are displayed as bright spots on the monitor. Even when the electron arrival rate is as low as 10 electrons/sec, the accumulation of single electrons forms a biprism interference pattern.

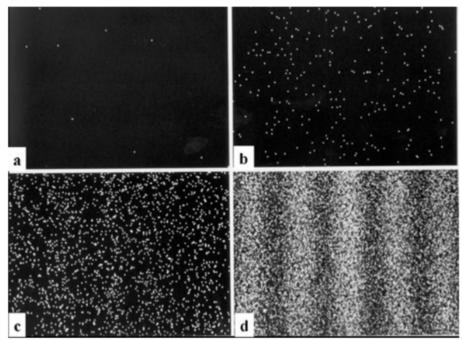


Fig. 2 Single electron events build up to from an interference pattern in the double-slit experiments.

The number of electron accumulated on the screen. (a) 8 electrons; (b) 270 electrons; (c) 2000 electrons; (d) 160,000. The total exponsure time from the beginning to the stage (d) is 20 min.

A. Zeilinger, R. Gähler, C. G. Shull, W. Treimer, and W. Mampe
Single- and double-slit diffraction of neutrons
Rev. Mod. Phys. 60, 1067 (1988)

$\lambda_{dB} = 2nm$

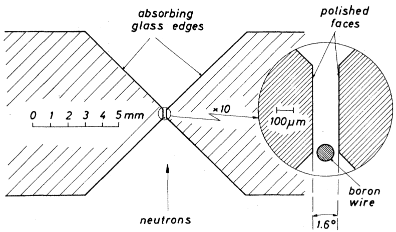
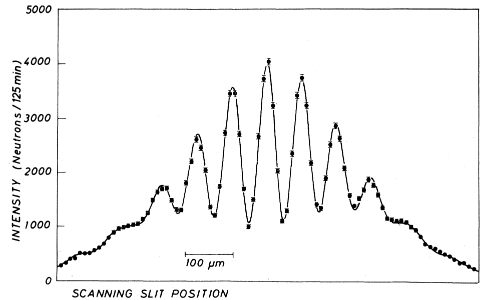


FIG. 6. Horizontal section through the double slit.



O. Carnal and J. Mlynek
Young's double-slit experiment with atoms: a simple atom interferometer
Phys. Rev. Lett. 66, 2689 (1991)

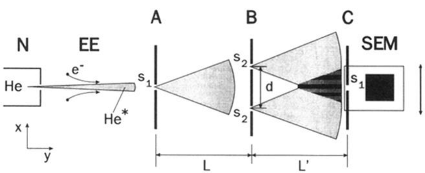


FIG. 2. Schematic representation of the experimental setup: nozzle system and gas reservoir N; electron impact excitation EE; entrance slit A, double slit B, and detector screen C; secondary electron multiplier SEM (mounted together with C on a translation stage). Dimensions: $d=8$ μm, $L=L'=64$ cm; slit widths: $s_1=2$ μm, $s_2=1$ μm.

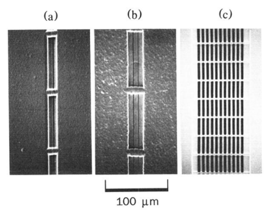
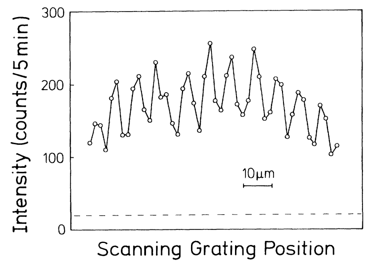


FIG. 3. Scanning-electron-microscope pictures of the microfabricated transmission structures, with the slit structures in the vertical direction and the support gratings in the horizontal direction: (a) entrance and detection slit (slit width $s_1=2$ μm); (b) double slit (slit width $s_2=1$ μm and slit separation $d=8$ μm); (c) detection grating (grating periodicity 8 μm). The 100-μm scale is the same for all three pictures.



M. Arndt, O. Nairz, J. Vos-Andreae, C. Keller, G. van der Zouw, and A. Zeilinger
Wave-particle duality of C60 molecules
Nature 401, 680 (1999)

$\lambda_{dB} = 2.5\,pm \quad \phi(C_{60}) = 0.7\,nm$

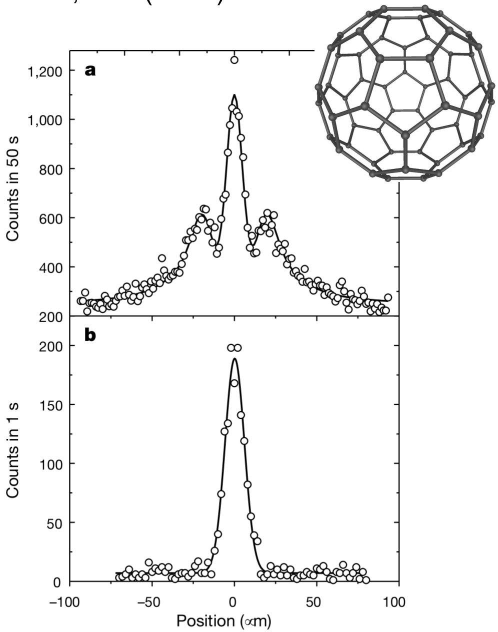


Figure 2 Interference pattern produced by C_{60} molecules. **a**, Experimental recording (open circles) and fit using Kirchhoff diffraction theory (continuous line). The expected zeroth and first-order maxima can be clearly seen. Details of the theory are discussed in the text. **b**, The molecular beam profile without the grating in the path of the molecules.

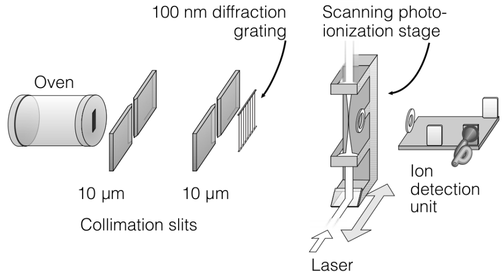


Figure 1 Diagram of the experimental set-up (not to scale). Hot, neutral C_{60} molecules leave the oven through a nozzle of 0.33 mm × 1.3 mm × 0.25 mm (width × height × depth), pass through two collimating slits of 0.01 mm × 5 mm (width × height) separated by 1.04 m, traverse a SiN_x grating (period 100 nm) 0.1 m after the second slit, and are detected via thermal ionization by a laser 1.25 m behind the grating. The ions are then accelerated and directed towards a conversion electrode. The ejected electrons are subsequently counted by a Channeltron electron multiplier. The laser focus can be reproducibly scanned transversely to the beam with 1-μm resolution.

In our experiment, the de Broglie wavelength of the interfering fullerenes is already smaller than their diameter by a factor of almost 400. It would certainly be interesting to investigate the interference of objects the size of which is equal to or even bigger than the diffracting structure. Methods analogous to those used for the present work, probably extended to the use of optical diffraction structures, could also be applied to study quantum interference of even larger macromolecules or clusters, up to small viruses[25,26]. □