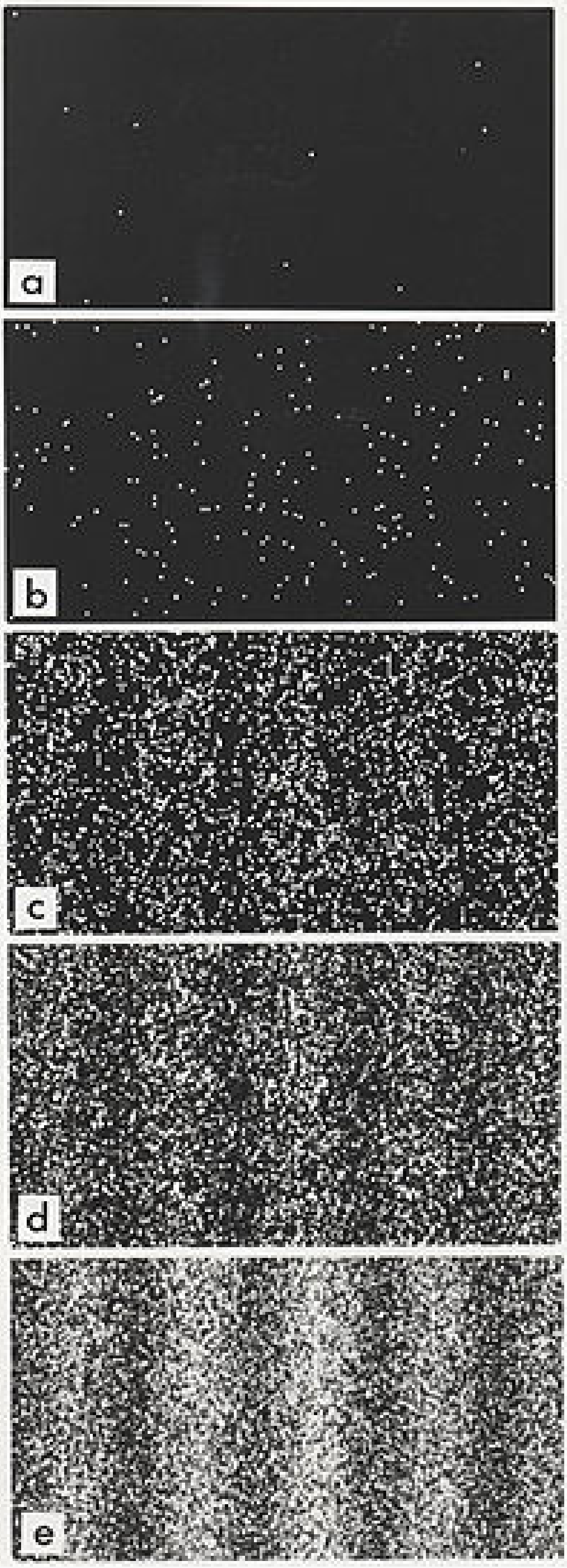
Interference of individual particles[edit]



Electron buildup over time

An important version of this experiment involves single particles (or waves—for consistency, they are called particles here). Sending particles through a double-slit apparatus one at a time results in single particles appearing on the screen, as expected. Remarkably, however, an interference pattern emerges when these particles are allowed to build up one by one (see the image to the right). This demonstrates the wave-particle duality, which states that all matter exhibits both wave and particle properties: the particle is measured as a single pulse at a single position, while the wave describes the probability of absorbing the particle at a specific place of the detector.[24] This phenomenon has been shown to occur with photons, electrons, atoms and even some molecules, includingbuckyballs.[25][26][27][28][29] So experiments with electrons add confirmatory evidence to the view that electrons, protons, neutrons, and even larger entities that are ordinarily called particles nevertheless have their own wave nature and even their own specific frequencies.

The probability of detection is the square of the amplitude of the wave and can be calculated with classical waves (see below). The particles do not arrive at the screen in a predictable order, so knowing where all the previous particles appeared on the screen and in what order tells nothing about where a future particle will be detected.[30] If there is a cancellation of waves at some point, that does not mean that a particle disappears; it will appear somewhere else. Ever since the origination of quantum mechanics, some theorists have searched for ways to incorporate additional determinants or "hidden variables" that, were they to become known, would account for the location of each individual impact with the target.[31]

More complicated systems that involve two or more particles in superposition are not amenable to the above explanation.[32]