

Summary of observations

- There are always individual light flashes, each electron accounts for one flash. There are never two light flashes at the same time, i.e. the electrons do not split.

→ particle feature

- After many events there is a regular pattern, namely the typical two-slit interference pattern.

→ wave feature

- Light flashes appear randomly. One cannot determine where the next light flash will occur. However, there are regions (maxima of interference pattern) where it is more likely to find the electron and others (minima of interference pattern) where it is less likely to find the electron.

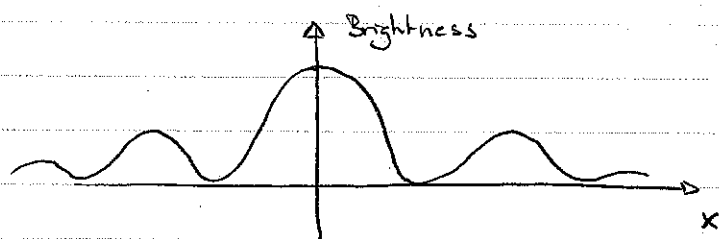
→ probabilistic aspect

Thus, we can clearly see that this experiment cannot be described with means of classical physics.

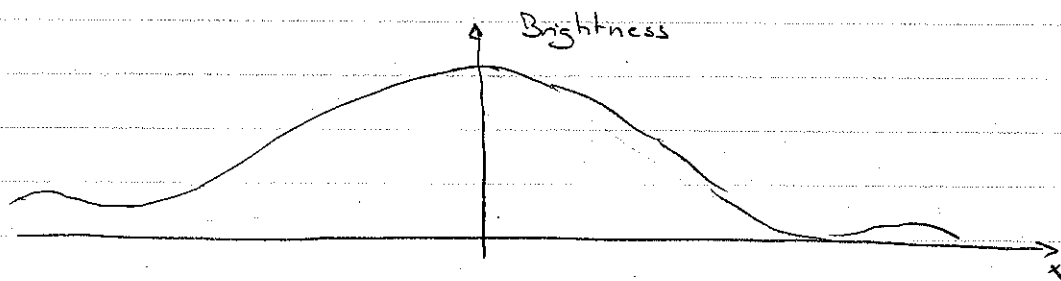
- Concepts of particles and waves are not anymore mutually different. They must be related.
- There are (many) aspects that are probabilistic and not deterministic.

We will see soon that there is a precise quantum theory to relate wave and particle aspects. But, let us before briefly mention the curious point that the double-slit experiment forces us to interpret such that the electron must have passed through both slits. Why? Think about the following:

Double slit interference pattern is given by:

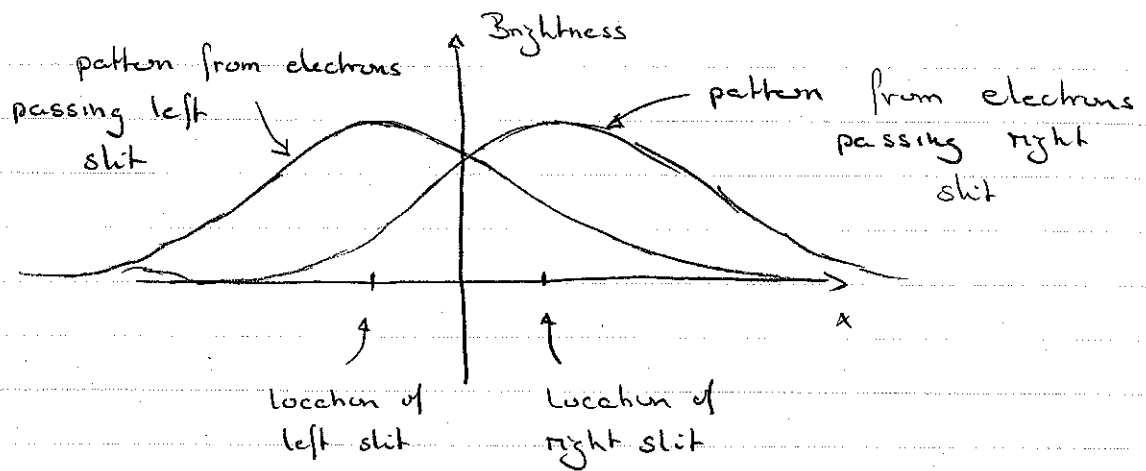


A single slit interference pattern however looks like

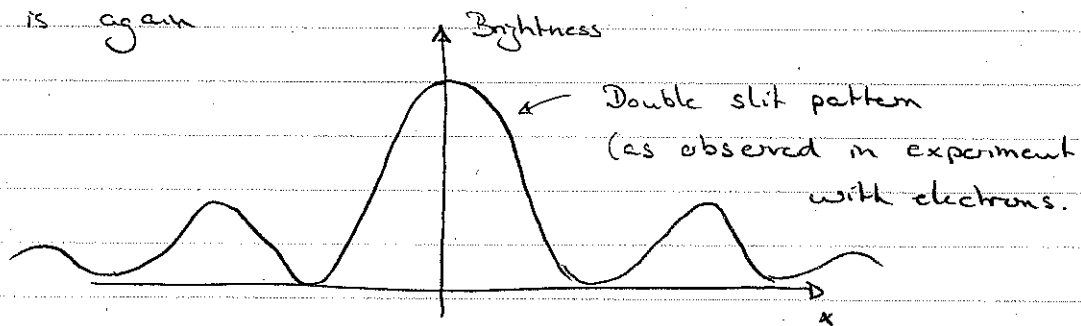


(for same dimensions of slit)

If each electron would pass either through the left or through the right slit, we would expect the sum of two single slit patterns (one from the passed-left group and one from the passed-right group). This however does not reproduce the double slit pattern (see next page for a sketch).



Do you see that the sum of both will never give the double slit pattern, because it is again



Thus, we need to conclude that each electron has passed through both slits and interferes with itself, just like wave.

These interference phenomena have been also observed for other massive particles, even larger ones like C_{60} .

And for single photons and this will give us the opportunity to understand the concept of a wavefunction for massive particles.