1) $\underline{175(1)}$: A Simple Refutation of Indeterminacy with the Compton Effect

The usual approach to indeterminacy is the interaction of a photon with a particle of mass m is sketched in Fig. (1):

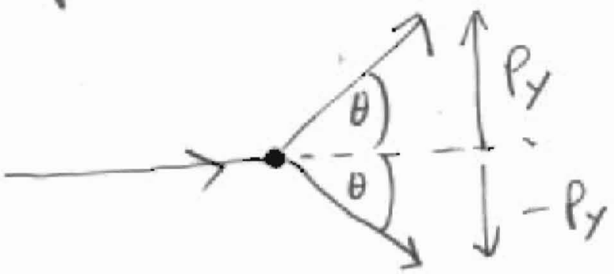
Fig (1)

The momentum equation is:

$$\hbar \underline{\kappa} = \hbar \underline{\kappa}' + \underline{p} \quad -(1)$$

where $\hbar \underline{\kappa}$ is the initial momentum of the photon, $\hbar \underline{\kappa}'$ is its final momentum. In the standard approach the photon is massless. The particle gains a momentum $\underline{p}$:

$$\underline{p} = \hbar (\underline{\kappa} - \underline{\kappa}') \quad -(2)$$

Two cases are considered:

1) $$\underline{p}_1 = p_x \underline{i} + p_y \underline{k} \quad -(3)$$

2) $$\underline{p}_2 = p_x \underline{i} - p_y \underline{k} . \quad -(4)$$

Then:
$$\Delta \underline{p} = \underline{p}_1 - \underline{p}_2 = 2 p_y \underline{k} \quad -(5)$$

so
$$| \Delta \underline{p} | = 2 p_y . \quad -(6)$$

Now use:

2)

$$\sin\theta = \pm p_y / (p_x^2 + p_y^2)^{1/2} \quad -(7)$$
$$= \pm p_y / p$$

So:
$$\partial p_y = \partial p \sin\theta \quad -(8)$$

The maximum value of θ is considered to be $\pi/2$,

so
$$\sin\frac{\pi}{2} = 1, \quad -(9)$$

and
$$\boxed{\Delta p = 2p} \quad -(10)$$

The de Broglie postulate is used in the format:
$$\underline{p} = \hbar \underline{\kappa} \quad -(11)$$

so
$$\Delta p = 2\hbar\kappa = \frac{2\hbar}{\lambda} \quad -(12)$$

Eq. (12) is considered to be an "uncertainty". The maximum theoretical resolution of the microscope is used to determine Δx. For the Abbe type of microscope:
$$\Delta x = \frac{\lambda}{2} \quad -(13)$$

so
$$\Delta p \Delta x = \hbar \quad -(14)$$

This is claimed to be the Heisenberg uncertainty principle. However, Croca has shown that Δx can be much smaller than $\lambda/2$ so eq. (14) is philosophically meaningless.

The complete treatment of the interaction of photon and a particle of mass $\underline{M}$ is given in UFT 158 ff and also refutes the so-called Heisenberg uncertainty principle. The energy of the particle after collision is:

$$E^2 = c^2 p^2 + m^2 c^4 \quad -(15)$$

where:

$$p^2 = \underline{p} \cdot \underline{p} = \hbar^2 (\underline{\kappa} - \underline{\kappa}') \cdot (\underline{\kappa} - \underline{\kappa}') \quad -(16)$$

Consider a photon that is travelling initially along the X axis:

$$\underline{\kappa} = \kappa_x \underline{i} \quad -(17)$$

The equation of conservation of energy is:

$$\hbar \omega + M_2 c^2 = \hbar \omega' + (p^2 c^2 + M_3^2 c^4)^{1/2} \quad -(18)$$

so the photon momentum enters into the fundamental eq. (18) as p^2. From eqs. (3) and (4):

$$p^2 = p_1^2 = p_2^2 \quad -(19)$$

and there is no "uncertainty" in p^2:

$$\Delta p^2 = 0 \quad -(20)$$

Solving eqs. (1) and (16) gives the Compton effect:

4) $$\lambda' - \lambda = \frac{h}{mc}\left(1 - \cos\theta\right) \quad -(21)$$

where $\cos\theta$ is defined by:

$$p^2 = \hbar^2\left(\kappa^2 + \kappa'^2 - 2\kappa\kappa'\cos\theta\right) \quad -(22)$$

Therefore there is no "uncertainty" in $\cos\theta$ and no "uncertainty" in $\lambda' - \lambda$, the change in wavelength of the photon. Therefore there is no "uncertainty" in the change in momentum of the photon:

$$|\Delta p\,(\text{photon})| = p' - p = \hbar\left(\frac{1}{\lambda'} - \frac{1}{\lambda}\right)$$

$$= 0 \quad -(22)$$

Eq. (22) means that if the electron momentum is p_1 or p_2, the photon "uncertainty" given by eq. (22) is zero. This means that the uncertainty in the position of the photon must be infinite.

Experimentally, the photon is obviously used in an optical microscope to view the particle with which it interacts, so the photon is not "indeterminate". The Heisenberg "principle" is completely incorrect.

Even worse for the Heisenberg Bohr fallacy is that the correct mathematical expression

5) for the equation involved is:

$$\delta A \, \delta B \geq \frac{1}{2} |\langle C \rangle| \quad -(23)$$

(P. W. Atkins, eq. (5.4.9.) of "Molecular Quantum Mechanics" (2nd ed.). Here:

$$\delta A = \left(\langle A^2 \rangle - \langle A \rangle^2 \right)^{1/2} \quad -(24)$$

$$\delta B = \left(\langle B^2 \rangle - \langle B \rangle^2 \right)^{1/2} \quad -(25)$$

If A denotes momentum, then:

$$\delta_p = \left(\langle p^2 \rangle - \langle p \rangle^2 \right)^{1/2} \quad -(26)$$

In the Compton effect however:

$$\langle p_1^2 \rangle = \langle p_2^2 \rangle = p^2 \quad -(27)$$

from eq. (22), so:

$$\boxed{\delta_p = 0} \quad -(28)$$

The momentum of the electron is known precisely, contradicting the Bohr Heisenberg principle. This momentum is:

$$\underline{p} = \gamma m \underline{v} = m \frac{d\underline{r}}{d\tau} = m \frac{d\underline{r}}{dt} \frac{dt}{d\tau} \quad -(29)$$

where

$$\frac{dt}{d\tau} = \gamma = \left(1 - \frac{v^2}{c^2} \right)^{-1/2} \quad -(30)$$

So:

$$\boxed{\delta r = 0} \quad -(31)$$

and

$$\boxed{\delta_p \, \delta r = 0} \quad -(32)$$

6) Eq. (33) shows that:

$$\delta_p \delta_r \geq \hbar \quad - (33)$$

is not changed at all in the Compton effect. As soon as photon mass is considered as in UFT 158 ff the whole quantum theory becomes untenable. The only known way forward is the R theory.

The conclusion is the obvious one, eqs. (3) and (4) do not measure "uncertainty" at all, being simply two possible momenta chosen at random. The resolution of a microscope has nothing whatsoever to do with "uncertainty".
