Young's photon double slit experiment: **Are the diffraction pattern results due to surface plasmon polaritons (SPP's) instead of constructive and destructive waves?**

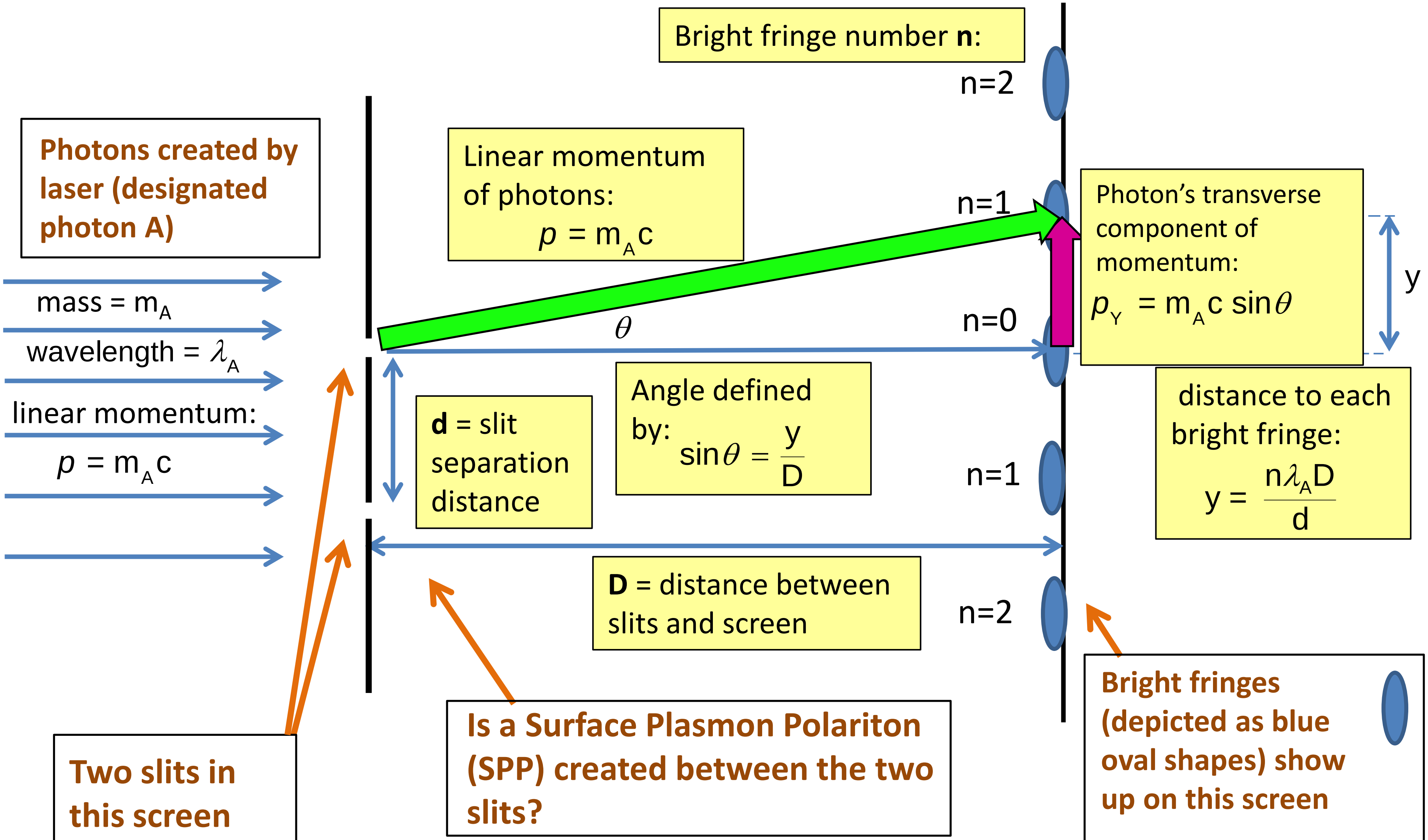

Figure 1. Top view of double slit experiment.

As seen in Figure 1, the transverse component of momentum (shown as a purple arrow) for the photon (bright green arrow) that creates any fringe **n** is:

$$p_Y = m_A c \sin\theta \qquad \text{(Eq. 1)}$$

And the sine of the angle to any fringe **n** is:

$$\sin\theta = \frac{y}{D} \qquad \text{(Eq. 2)}$$

The distance from the centerline to any fringe **n** is:

$$y = \frac{n\lambda_A D}{d} \qquad \text{(Eq. 3)}$$

The de Broglie wavelength equation for the photons created by the laser is:

$$\lambda_A = \frac{h}{p} = \frac{h}{m_A c} \qquad \text{(Eq. 4)}$$

inserting Eqs. (2), (3) and (4) into Eq. (1) gives the transverse component of momentum for the photon that creates fringe **n**:

$$p_Y = \frac{nh}{d} \qquad \text{(Eq. 5)}$$

where

p_Y = transverse momentum depicted in Figure 1 as a purple arrow.

m_A = mass of photon created by laser (designated photon-A)

y = distance to each bright fringe from the center of the screen

λ_A = wavelength of laser light source (coming from left in Figure 1)

D = distance between slits and screen

d = separation distance between two slits

n = bright fringe number

h = planck's constant

Repeating Eq. (5) from the previous page:

$$p_Y = \frac{nh}{d} \qquad \text{(Eq. 5)}$$

Eq. (5) shows that the photon that is deflected at the slits has a transverse component of momentum equal to **n** multiplied by planck's constant **h** divided by the slit separation distance **d**. It is proposed in this paper that this transverse momentum is created by a "kick" from a surface plamson polariton (SPP) created at the slits which has a wavelength equal to the slit separation distance **d.** This SPP can be created by a photon having the momentum shown in Eq. (5). In other words, the transverse momentum of the photon that creates the dark/light bands of the diffraction pattern matches the linear momentum of a photon that creates the SPP. An SPP can have wavelengths equal to 1, 1/2, 1/3, 1/4 … 1/**n** of the slit separation distance which create the bright fringes labeled 1, 2, 3 … **n**. Note that Eq. (5) already incorporates these fractional wavelengths with the "**n**" in the equation.

The following three double slit experiments using matter (as opposed to photons) use the exact same equations as above and could also be explained by SPP's created at the slit:

1. The electron double slit experiment.
2. The neutron double slit experiment.
3. The molecule double slit experiment.

Also, the following phenomena use the same equations and can be explained by SPP's and another type of plasmon called a bulk plasmon that travel within the crystal volume as opposed to on the surface.

1. Bragg's Law where x-rays create a diffraction pattern when x-rays reflect off metallic crystal surfaces.
2. Low energy electron diffraction (LEED) which is seen when electrons reflect off metallic crystal surfaces.
3. Reflective and transmissive photon diffraction gratings.

It is known that the same conditions that promote distinct and clear diffraction patterns in the photon / neutron / molecule double slit experiment are the same conditions that promote creation of SPP’s with those conditions being an electrically conductive surface and sharp edges for the slits.

It should be possible to come up with an experimental method to prove that diffraction patterns are caused by SPP's although it may be difficult due to the fact that was just mentioned, namely the conditions that suppress / amplify SPP's are the same conditions that suppress / amplify diffraction patterns.

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4/18/2018