Assignment A2b: Photon Detection

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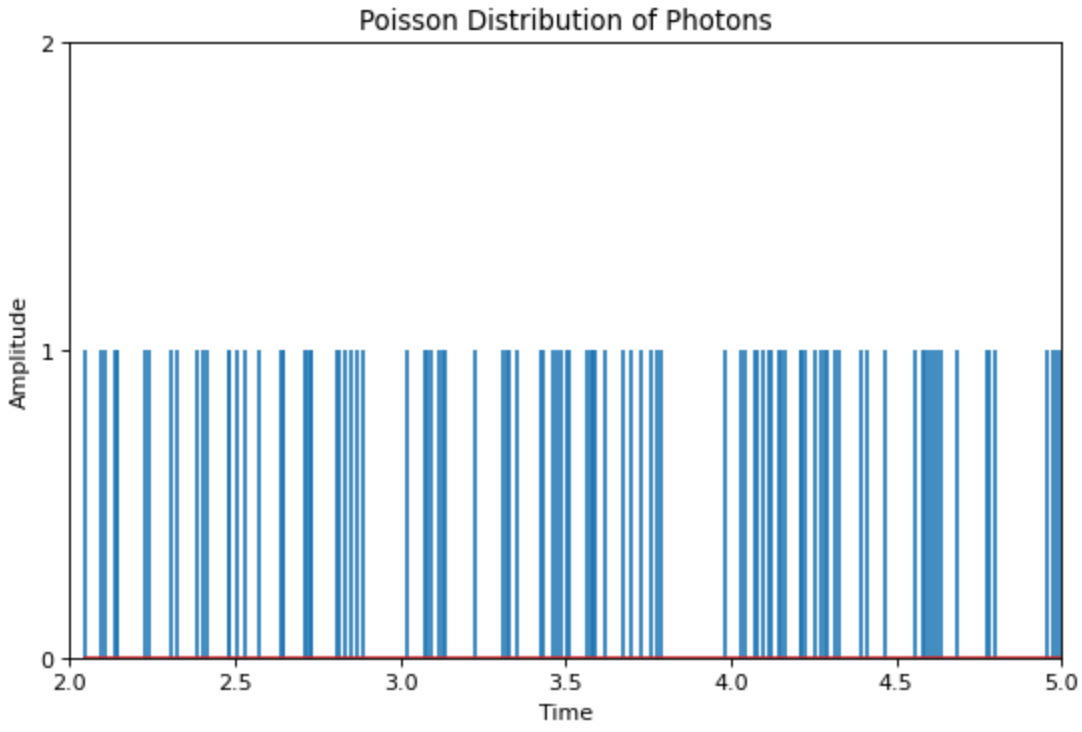
1. Simulating a dim flash of light

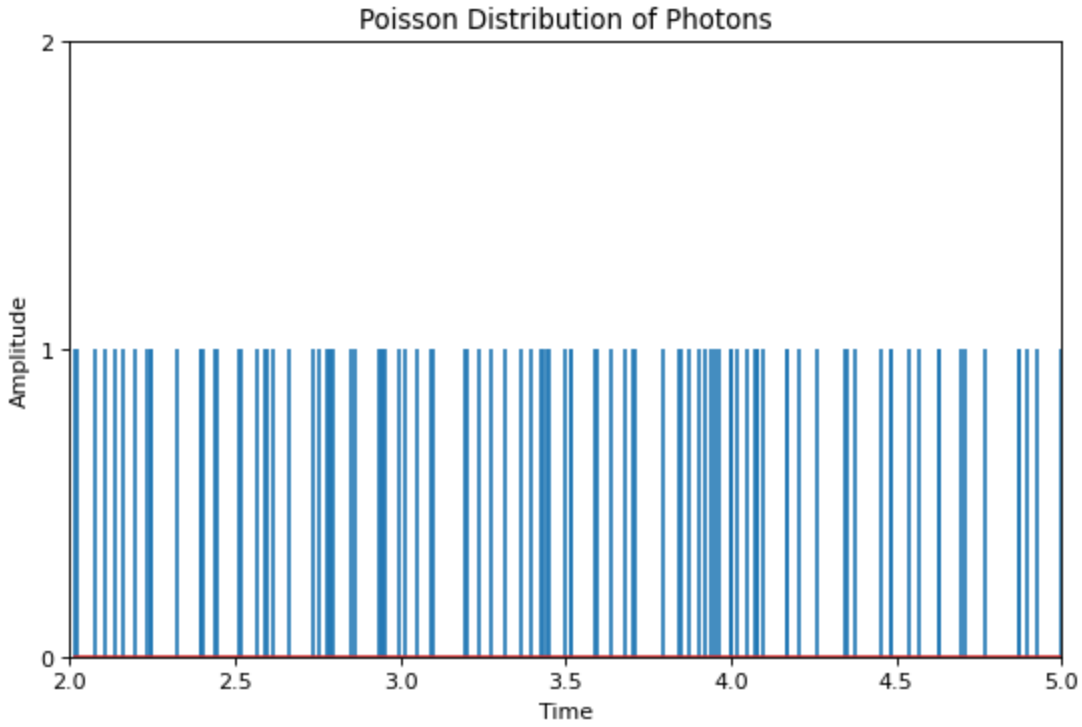
In [ ]:
```
# Appropriate Libraries
import numpy as np
import matplotlib as mpl
import matplotlib.pyplot as plt
import math
mpl.rcdefaults()

from A2b_code import *
```

1a. Random times

In [ ]:
```
t = randtimes(100, 2, 5)
plotflash(t, 2, 5)
```

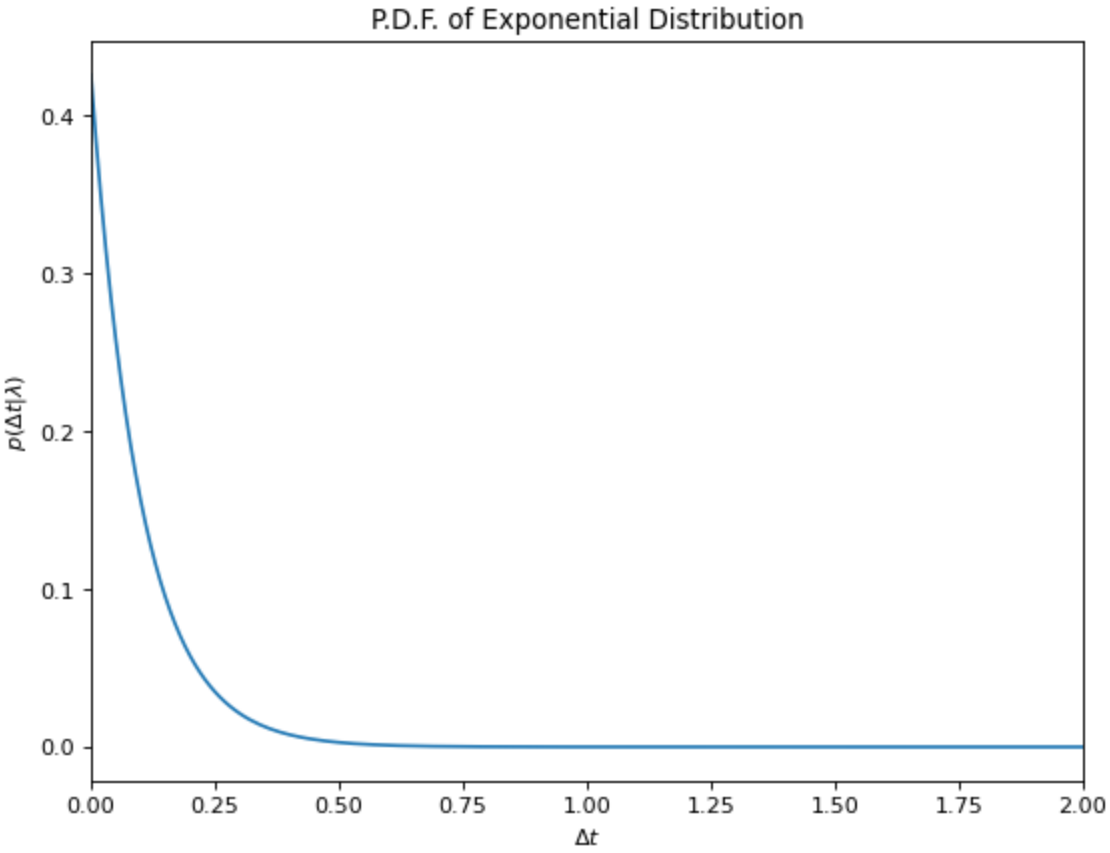


In [ ]:
```
t = randtimes(100, 2, 5)
plotflash(t, 2, 5)
```

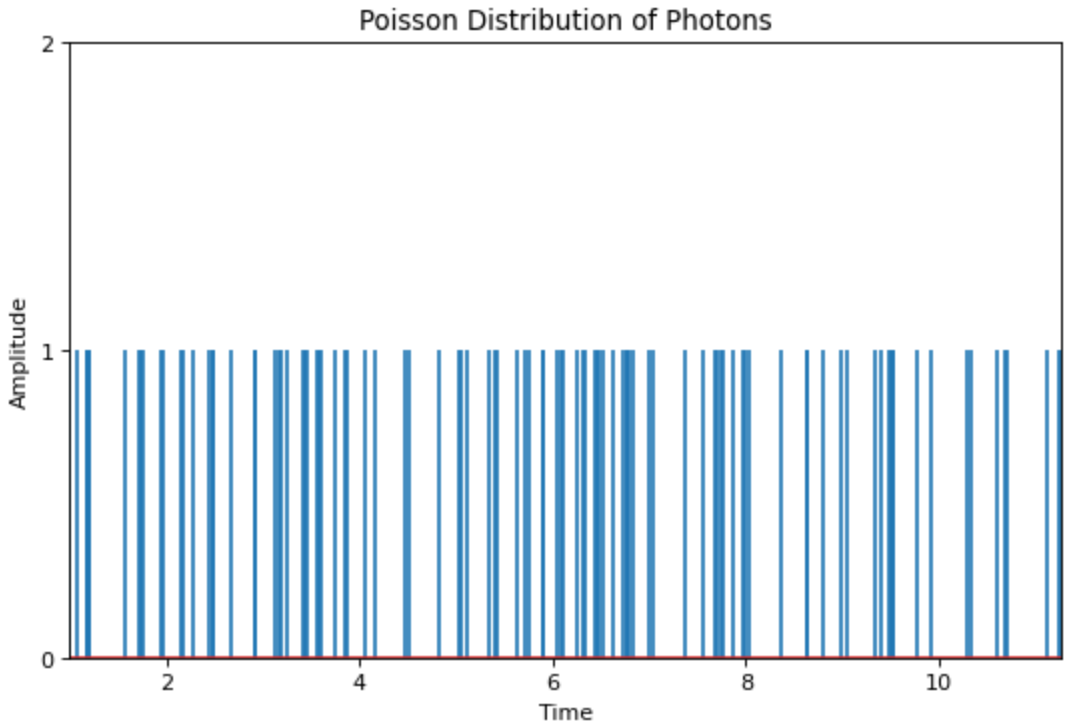


1b. Random intervals

In [ ]:
```
plotpdfexp(lam=10)
```



In [ ]:
```
t = randintervals(100, 10, 1)
plotflash(t, 1)
```



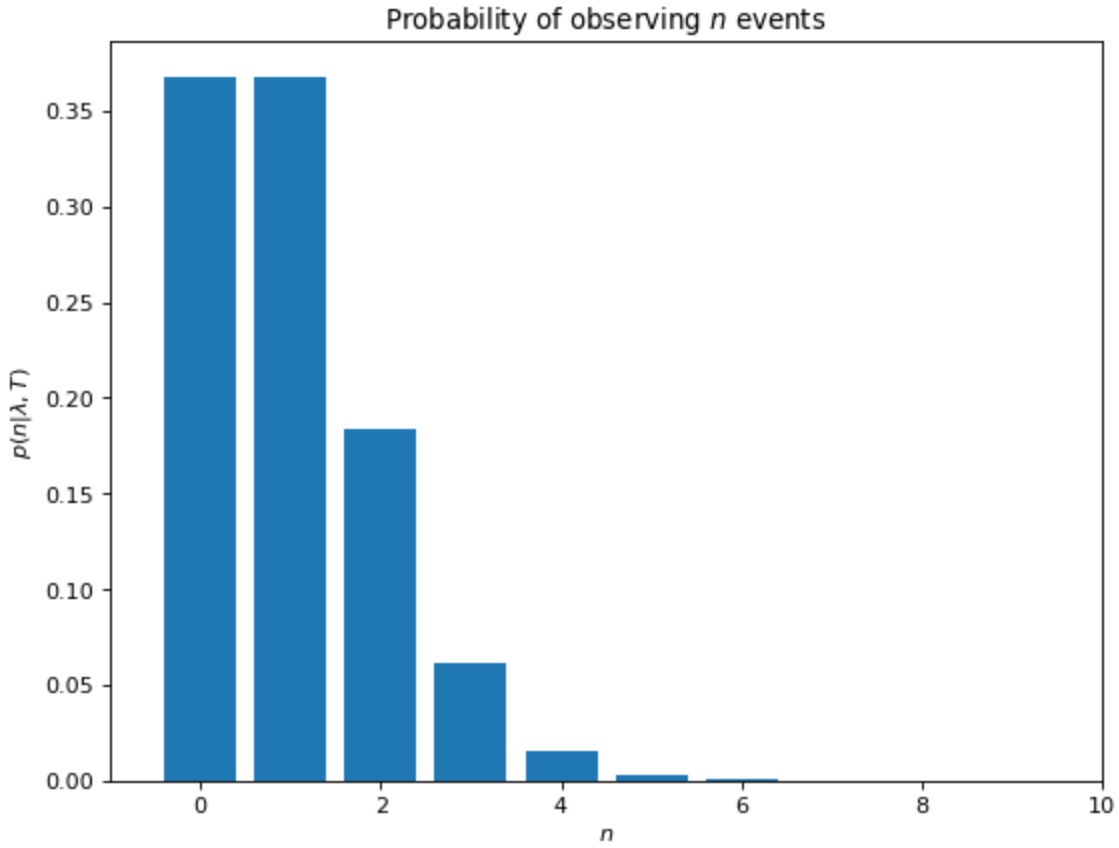
1c. Seeing the flash

answer

2. Calculating the probability detection

2a. The probability of K photons

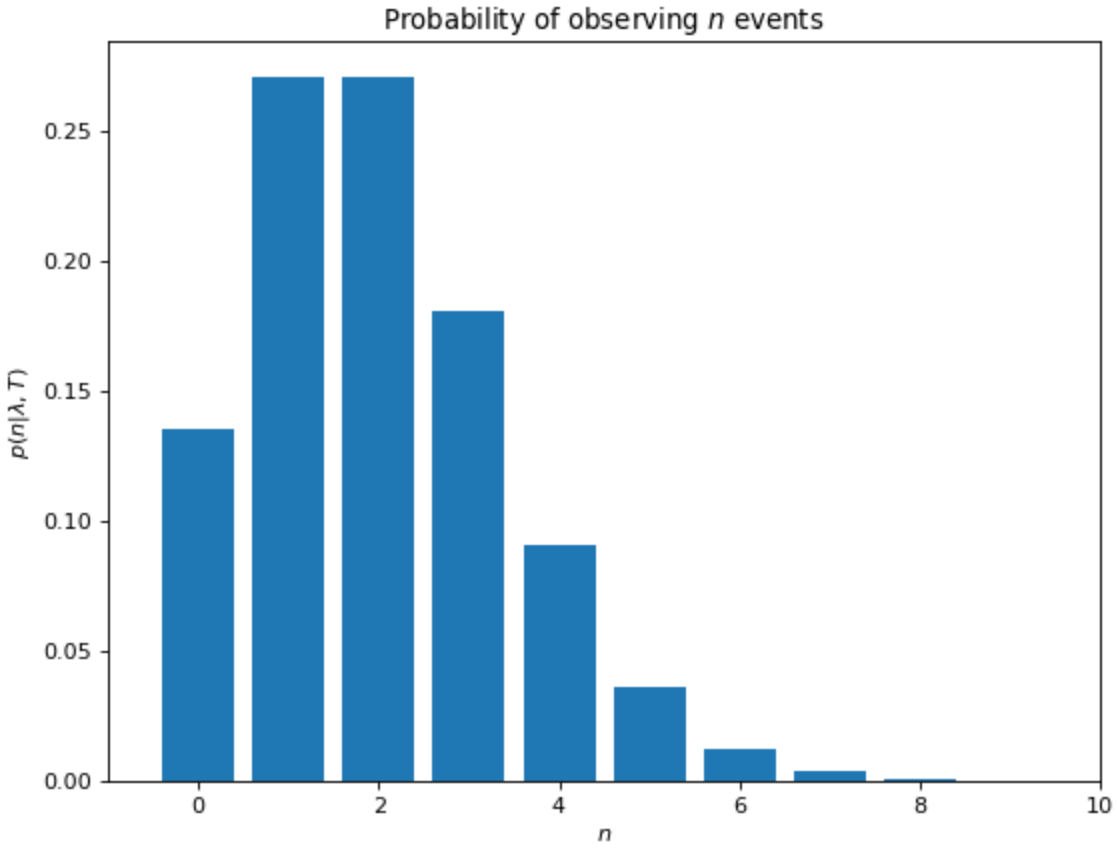
In [ ]:
```
K = np.arange(0, 10)
plotbarpdfphotons(K, lam=10)
```



At this rate, the subject would most likely not see the flash, as the probabilities of seeing 6, 7, 8, ... photons are close to 0.

Doubling the rate:

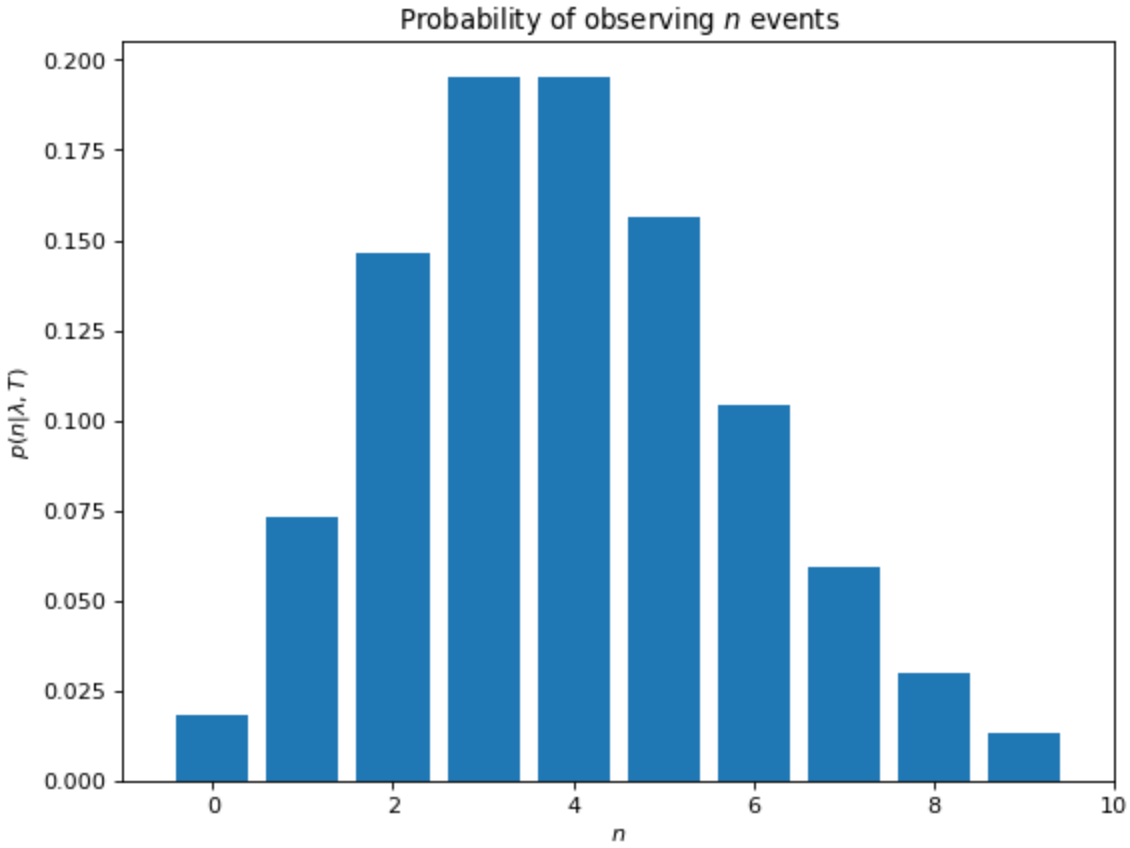
In [ ]:
```
plotbarpdfphotons(K, lam=20)
```



Doubling the rate again:

In [ ]:

```
plotbarpdfphotons(K, lam=40)
```



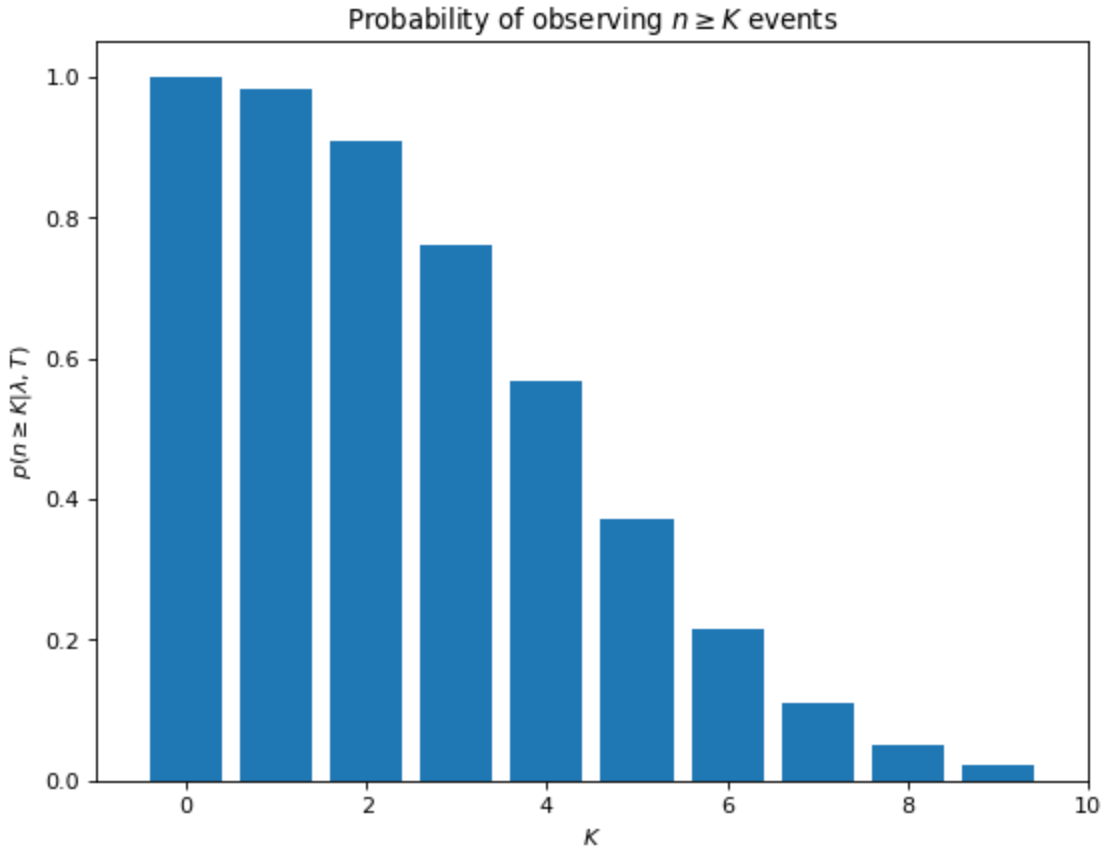
As the rate goes up, the mean of the distribuition increases, and becomes closer to 6.

2b. The probability of K or more photons

In [ ]:
```
detectionprob(6)
```

Out[ ]:
```
0.21486961296959484
```

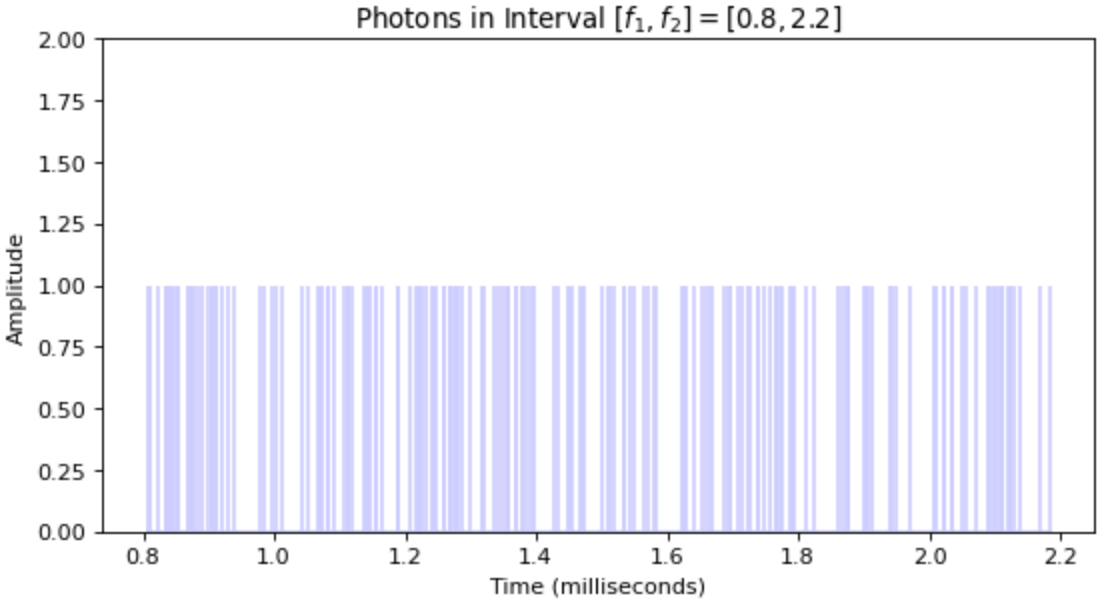
In [ ]:
```
K = np.arange(0, 10)
plotbarcdfphotons(K)
```

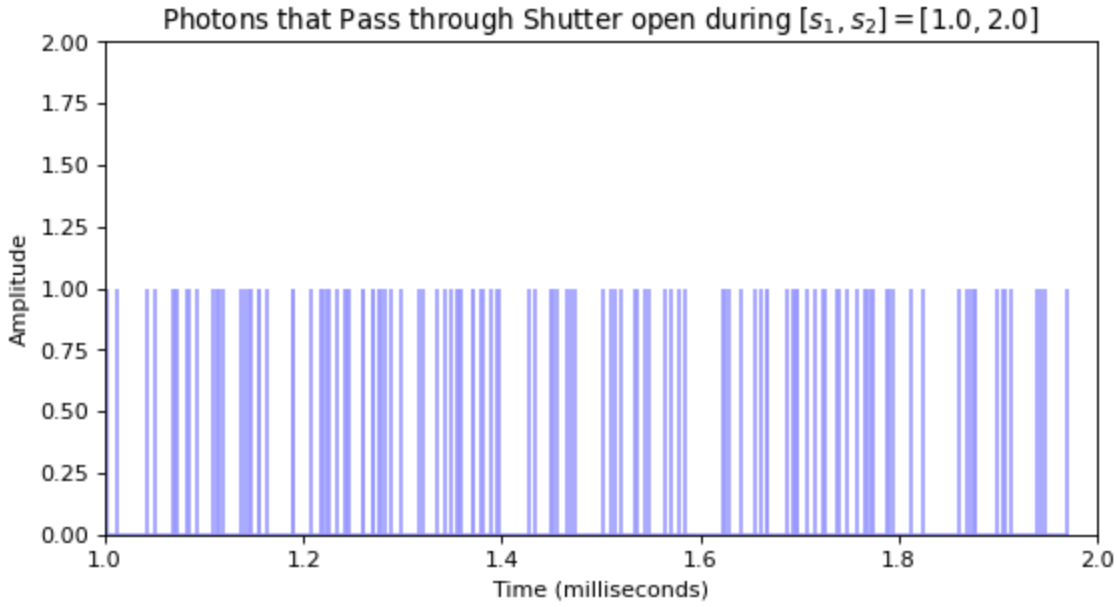


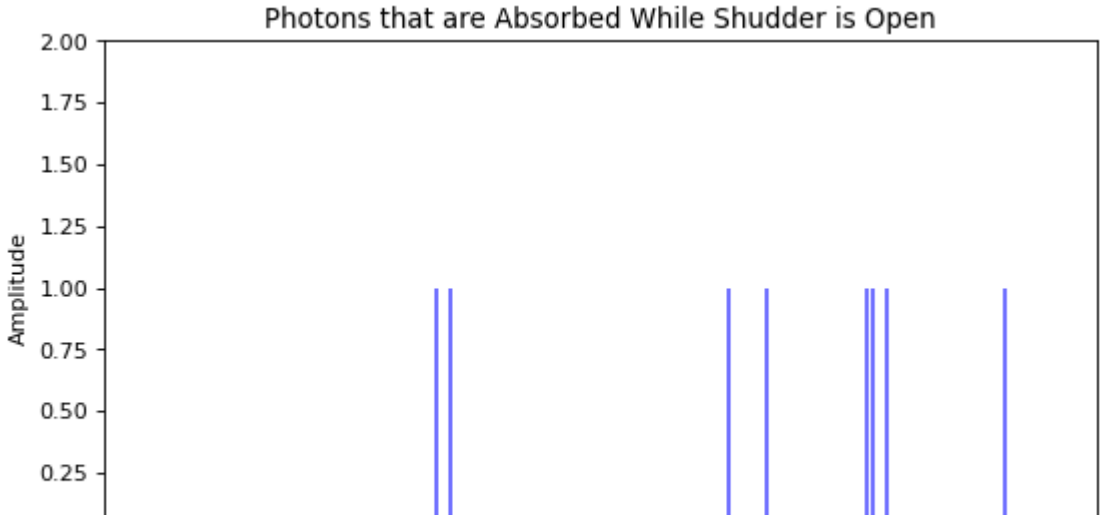
3. Estimating the threshold from experimental data

3a. Simulating the photon stream

In [ ]:
```
plotHSPsimulation()
```







3b. Probability of seeing

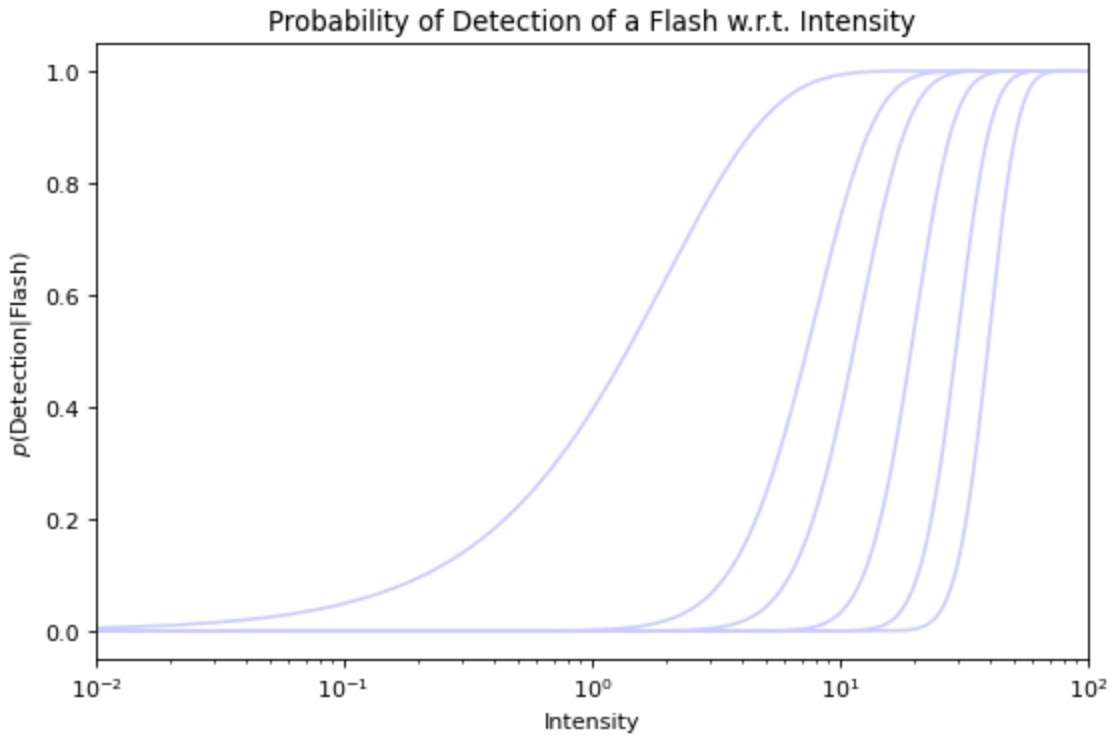
In [ ]:
```
probseeing(I=100)
```

Out[ ]: 0.5543203586353891

3c. Plotting % detected vs light intensity for different parameters

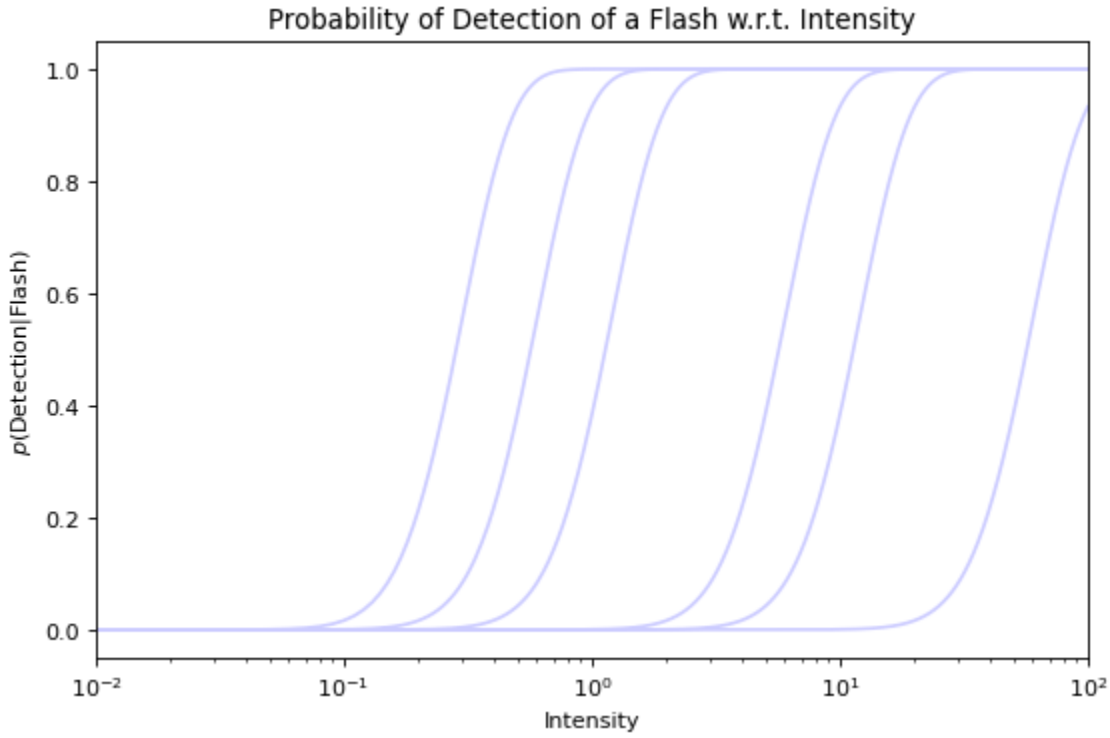
Changing only K

In [ ]:
```
plotdetectioncurve(alpha = [0.5, 0.5, 0.5, 0.5, 0.5, 0.5], K=[1.1, 4, 6, 10,
```



Changing only α

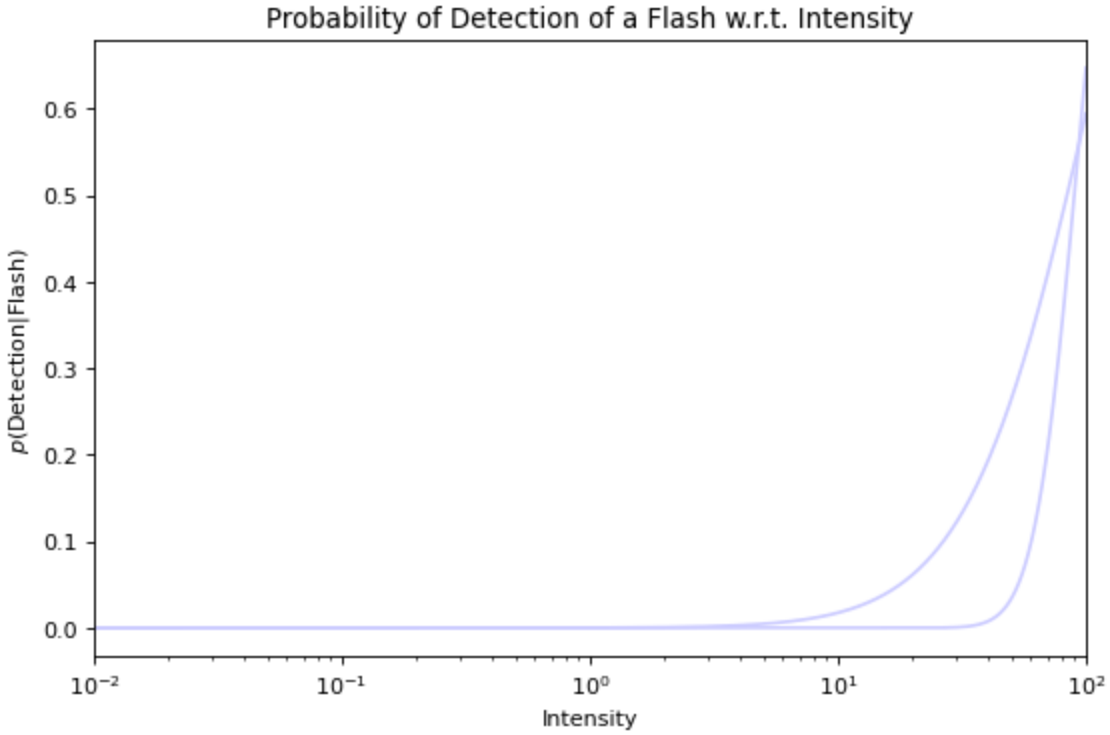
In [ ]:
```
plotdetectioncurve(alpha = [0.1, 0.5, 1.0, 5.0, 10.0, 20.0], K=[6, 6, 6, 6, 6
```



3d. Fitting parameters to experimental data

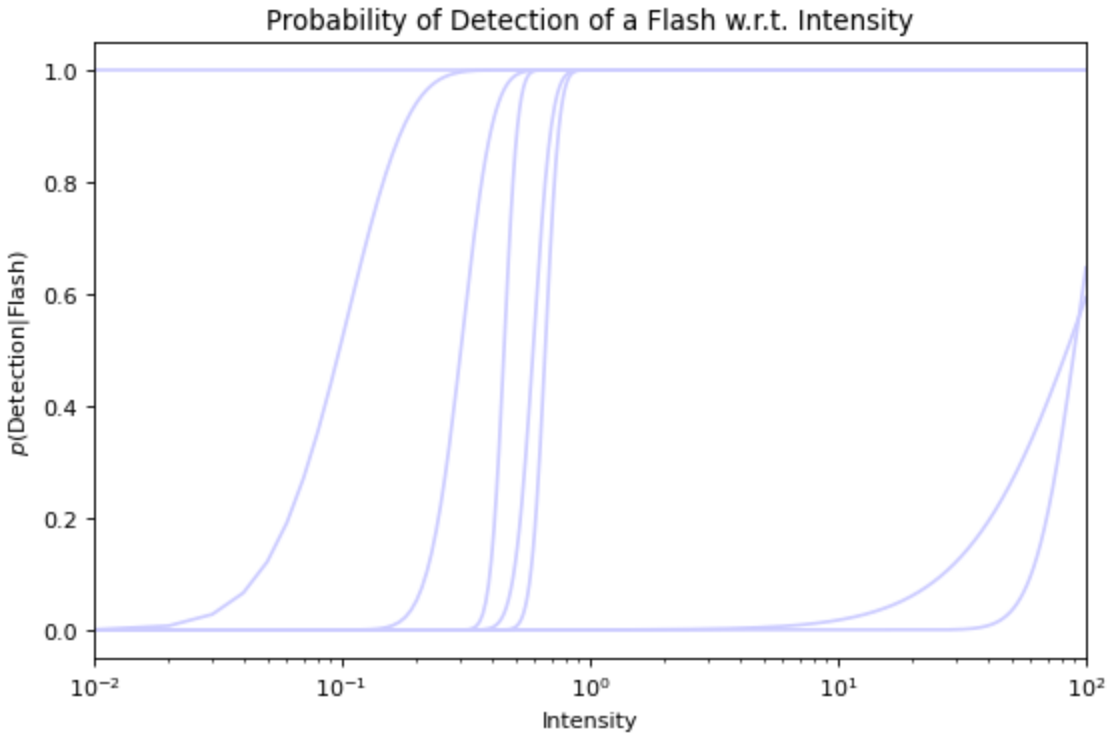
Just the two pairs of data:

In [ ]:
```
plotdetectioncurve(alpha = [0.02, 0.13], K=[2, 12])
```



Original two pairs overlaid on the HSP subject SS's pairs:

In [ ]:
```
plotdetectioncurve(alpha = [0.02, 0.13, 24.1, 37.6, 58.6, 91.0, 141.9, 221.3]
```

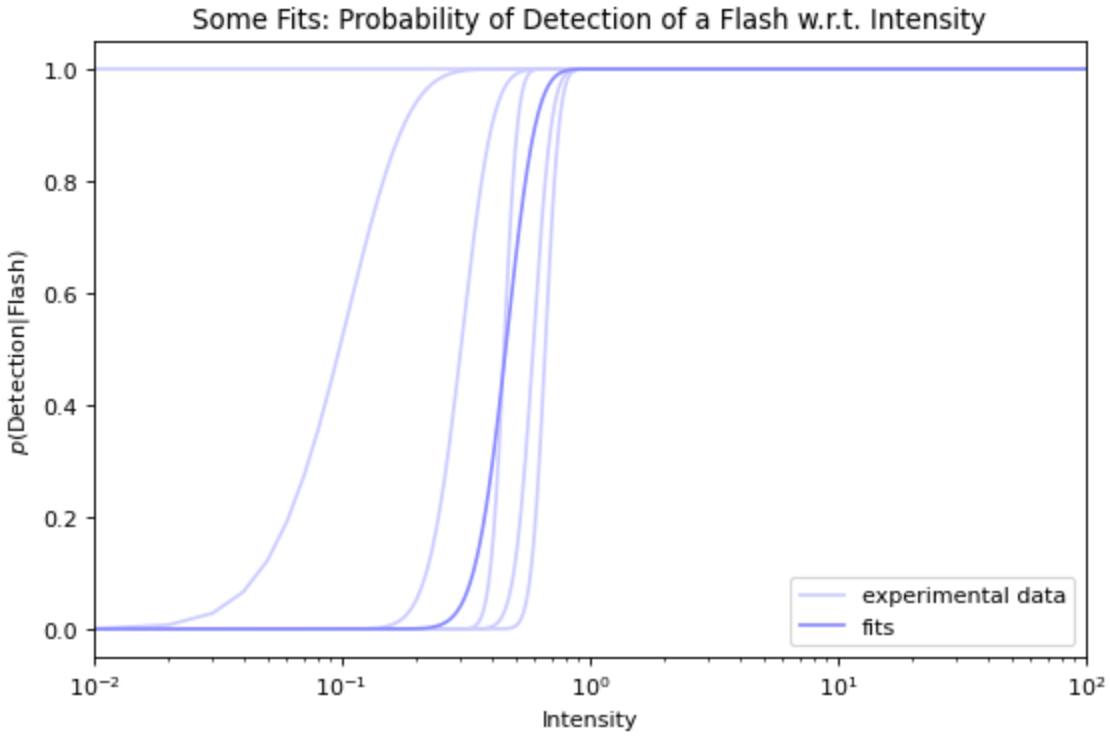


For now, I am assuming that $(\alpha = 0.02, K = 2)$ and $(\alpha = 0.13, K = 12)$ are not to be included in the experimental data. I am a bit unclear as to whether or not they should be

included in order to find the fit, but I did not include them here:

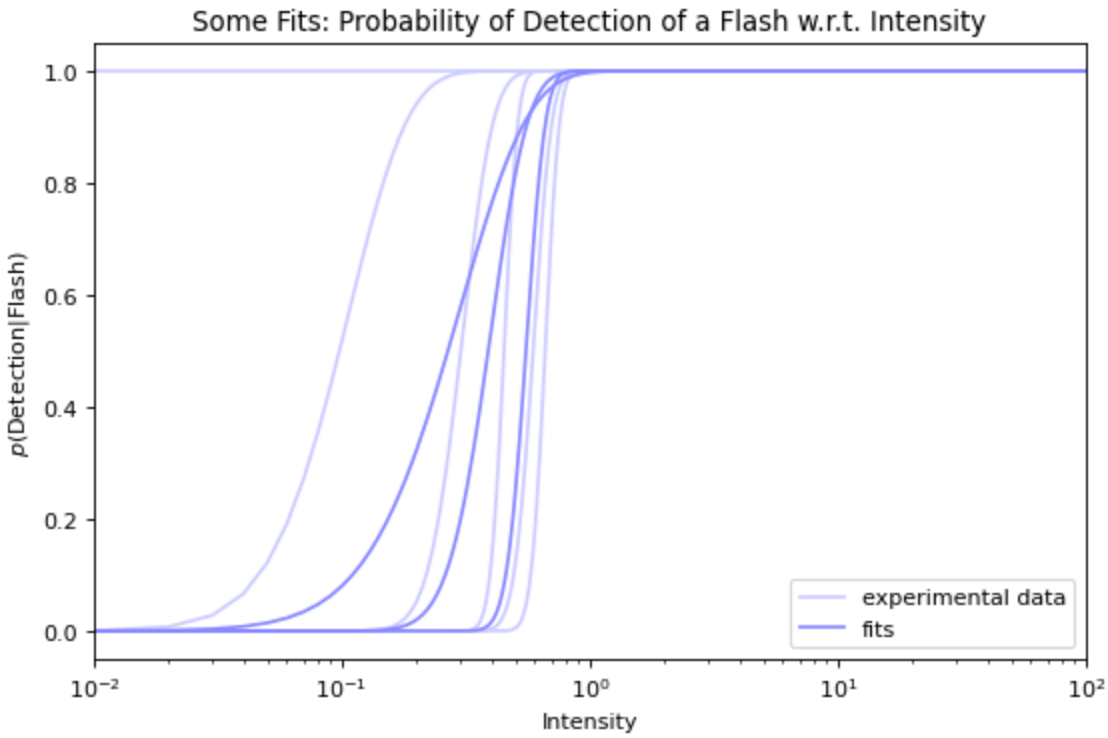
Approximately Optimal Results: $\alpha = 43.0$ and $K = 20.0$

In [ ]:
```
plotfit(alpha=43, K=20)
```



Some not-so optimal fits:

In [ ]:
```
plotfit(alpha=[10, 30, 90], K=[3, 12, 50])
#10, 3
#30, 12
#90, 50
```



I would explain that, in order to see a dim flash of light, assuming there is a tight mean that can describe the α probability of a photon being absorbed by the human retina $\approx 43\%$, it takes around 20 photons arriving within a given timespan, usually with a maximum of 100 ms, in order to be detectable.