Question Description

Write a program to plot images that show the difference between the probability density of the sum of two wave resultant intensities and the probability density of one wave resultant intensity.

Answer

In [3]:
```
# import the libs
import numpy as np
import matplotlib.pyplot as plt
```

Different λ will lead to different results, the specific formula is as follows:

$$f_Z(z) = \begin{cases} \frac{\lambda_X \lambda_Y}{\lambda_Y - \lambda_X}\left(e^{-\lambda_X z} - e^{-\lambda_Y z}\right) & \text{when } \lambda_Y \neq \lambda_X \\ z\lambda^2 e^{-\lambda z} & \text{when } \lambda = \lambda_X = \lambda_Y \end{cases}$$

In [4]:
```
def get_intensity(lambda_):
    return np.exp(-nums * lambda_) * lambda_


def get_sum_intensity(l1, l2):
    if l1 == l2:
        # f_z = z * λ^2 * exp(-λ * z)
        return nums * l1 ** 2 * np.exp(-nums * l1)
    else:
        # f_z = λX * λY / (λY - λX) * (exp(-z * λX) - exp(-z * λY))
        return (l2 * l1) / (l1 - l2) * (np.exp(-nums * l2) - np.exp(-nums * l1))
```

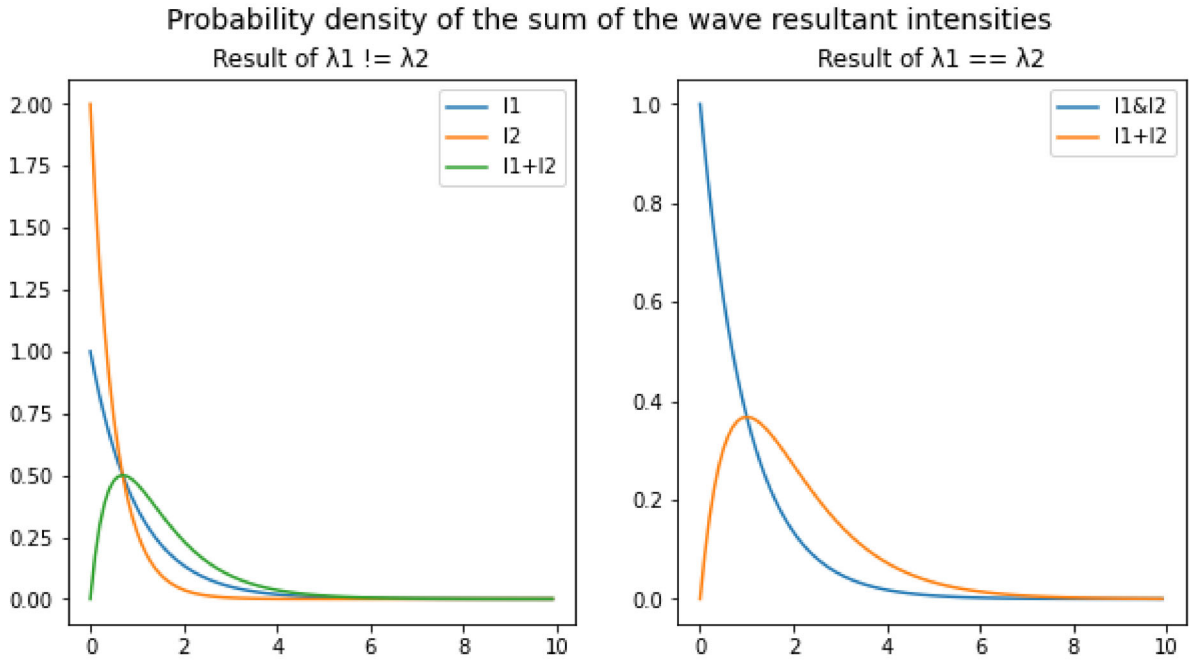
In [8]:
```
if __name__ == '__main__':
    nums = np.arange(0, 10, 0.1)

    fig = plt.figure(figsize=(10, 5))
    fig.suptitle('Probability density of the sum of the wave resultant intensities', fonts

    ax1 = fig.add_subplot(121)
    plt.plot(nums, get_intensity(1), label="I1")
    plt.plot(nums, get_intensity(2), label="I2")
    plt.plot(nums, get_sum_intensity(2, 1), label="I1+I2")
    plt.title("Result of λ1 != λ2")
    plt.legend()

    ax2 = fig.add_subplot(122)
    plt.plot(nums, get_intensity(1), label="I1&I2")
    plt.plot(nums, get_sum_intensity(1, 1), label="I1+I2")
    plt.title("Result of λ1 == λ2")
    plt.legend()

    plt.savefig('Q4_Probability_density_of_the_sum_of_the_wave_resultant_intensities')
    plt.show()
```


Probability density of the sum of the wave resultant intensities
Result of λ1 != λ2
I1
I2
I1+I2
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
2
4
6
8
10
Result of λ1 == λ2
I1&I2
I1+I2
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10