The amplitude for particle 1 to go from a to b is

$$K_1(b,a)$$

The amplitude for particle 2 to go from c to d is

$$K_2(d,c)$$

The probability density for particle 1 to go from a to b is

$$f_1(b,a) = |K_1(b,a)|^2 = K_1(b,a)K_1^*(b,a)$$

The probability density for particle 2 to go from c to d is

$$f_2(d,c) = |K_2(d,c)|^2 = K_2(d,c)K_2^*(d,c)$$

Assuming independence of particles 1 and 2, the joint probability density is

$$f_{12}(d,c,b,a) = f_1(b,a)f_2(d,c) = |K_1(b,a)|^2|K_2(d,c)|^2$$

Noting that

$$|K_1(b,a)|^2|K_2(d,c)|^2 = |K_1(b,a)K_2(d,c)|^2$$

the joint amplitude for particles 1 and 2 is

$$K_{12}(d,c,b,a) = K_1(b,a)K_2(d,c)$$

Now suppose the particles are not independent. What is the joint amplitude?