Basic principles of SPR

• When monochromatic, polarised light hits an interface of two transparent media, such as a glass prism and a buffer solution, from the side of the media with the highest refractive index (glass prism), the light is partly reflected and partly refracted towards the plane of the interface.

• However, above a certain incidence angle, all of the light is reflected and none of it is refracted. This phenomenon is called Total Internal Reflection (TIR).

• In SPR, the glass prism is coated with a Au film. In conducting metals, such as Au, the free conduction electrons form periodic oscillations, called plasma waves. Like every periodic electromagnetic wave, this can also be described in a particle fashion. Like photons and phonons are the particle names for light and sound waves, respectively, a plasmon is the particle name for the plasma wave.

• Surface plasmons are those plasmons that are confined to the surface of the metal. They occur at the interface of the Au surface and the buffer. These plasmons create an electric field that extends about 100 nm both into the buffer solution and into the Au film and glass prism. This electrical field is called an evanescent wave, because it decays exponentially with distance.

• When the incident light beam has the correct incidence angle within TIR, surface plasmon resonance occurs. At this so-called ‘resonance angle’, \( \theta \), the photons in the light beam have a momentum (vector with magnitude and direction) equal to the momentum of the surface plasmons, and the photons are converted into plasmons. In other words, optical energy is coupled into the Au surface. As a result, reflection is decreased at this resonance angle.

• Any change in the composition of the material at the interface between the Au and the buffer, such as the binding of target by immobilized aptamers, will alter the momentum of the surface plasmons, and their associated evanescent wave. As a consequence, SPR no longer occurs at the previous incidence angle, and a SPR shift takes place. The shift in the resonance angle is directly proportional to the change in mass at the Au surface.