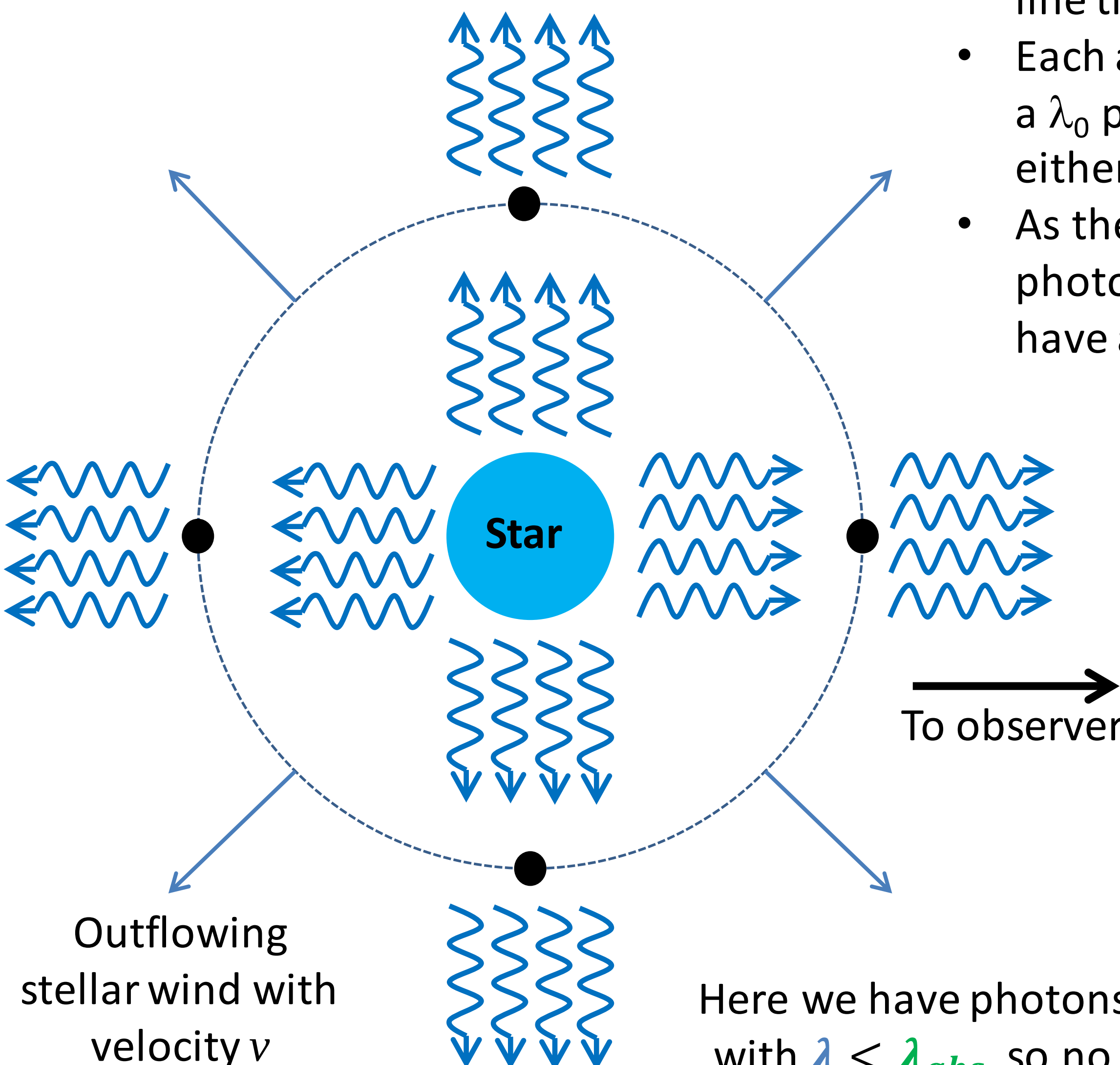
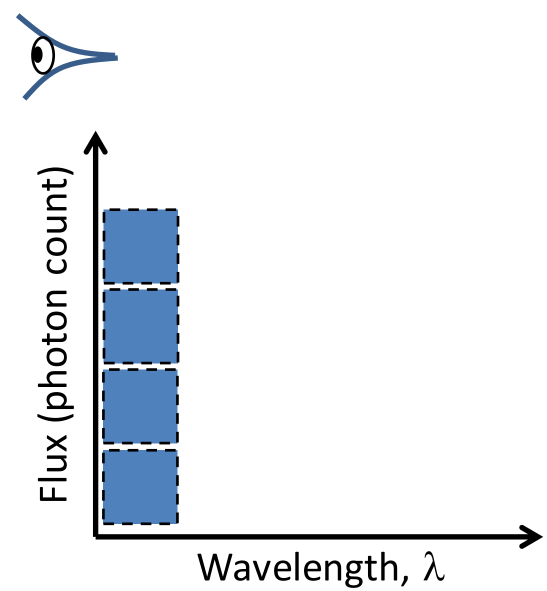
Formation of the P-Cygni profile: a schematic diagram

Very simplified case:

- Wind consists of four atoms/ions with a line transition centred at wavelength λ_0
- Each atom has a 25% chance on absorbing a λ_0 photon and re-emitting* it randomly either up, down, left or right**
- As the wind is moving away from the star photons will actually be absorbed if they have a wavelength of $\lambda_{abs} = \lambda_0(1 - {}^{v}/_{c})$

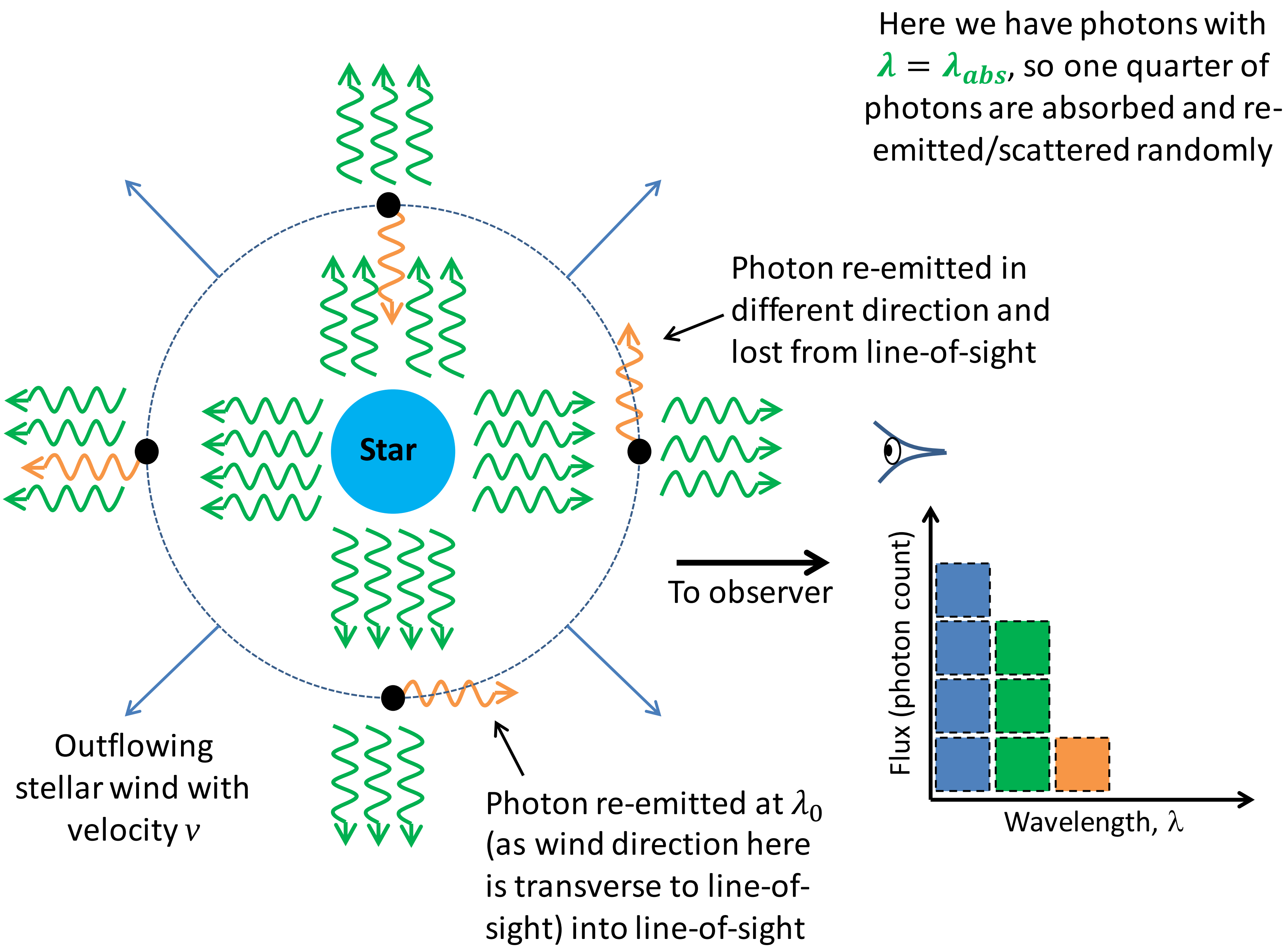


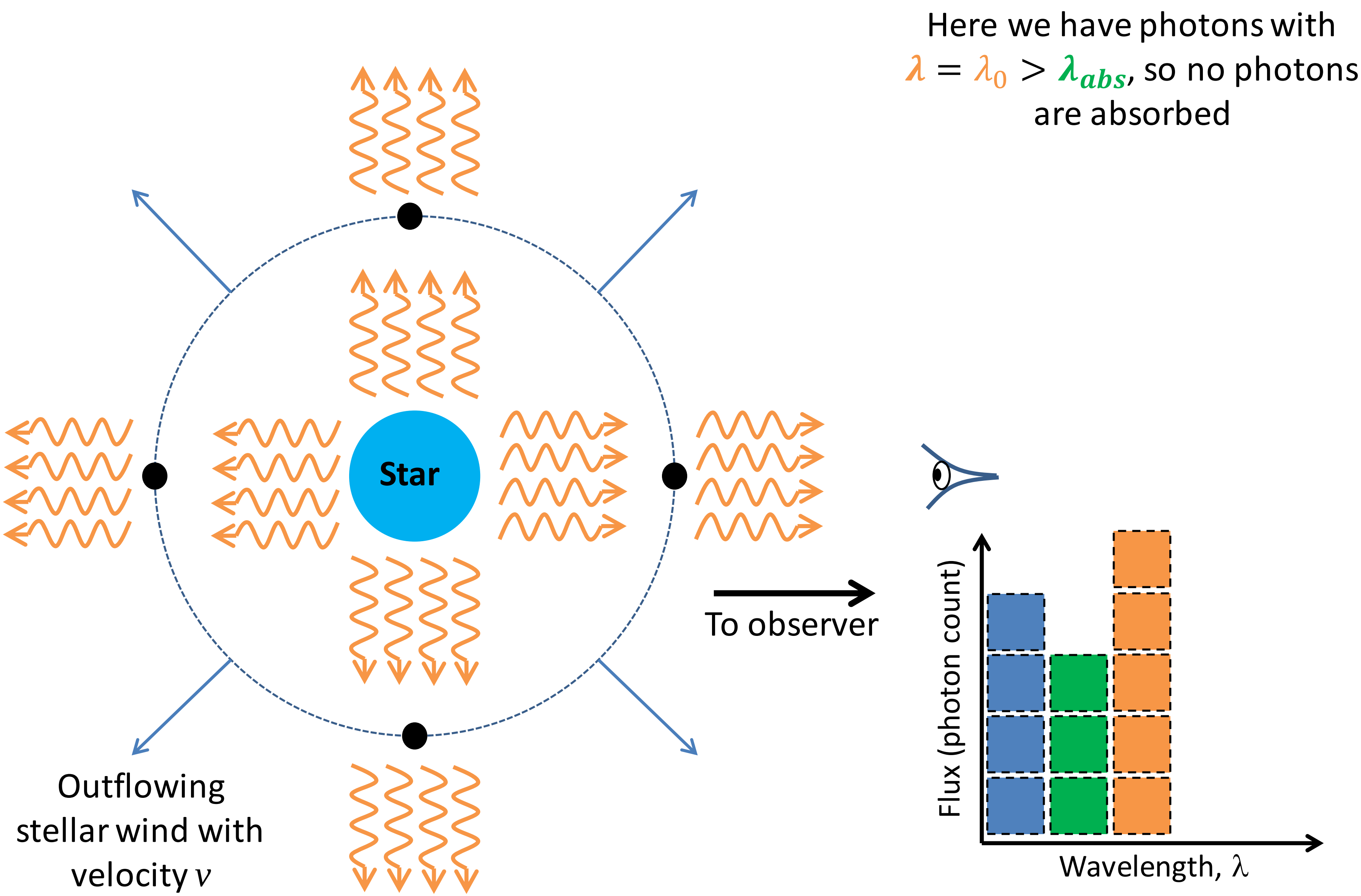
Here we have photons with $\lambda < \lambda_{abs}$, so no photons are absorbed



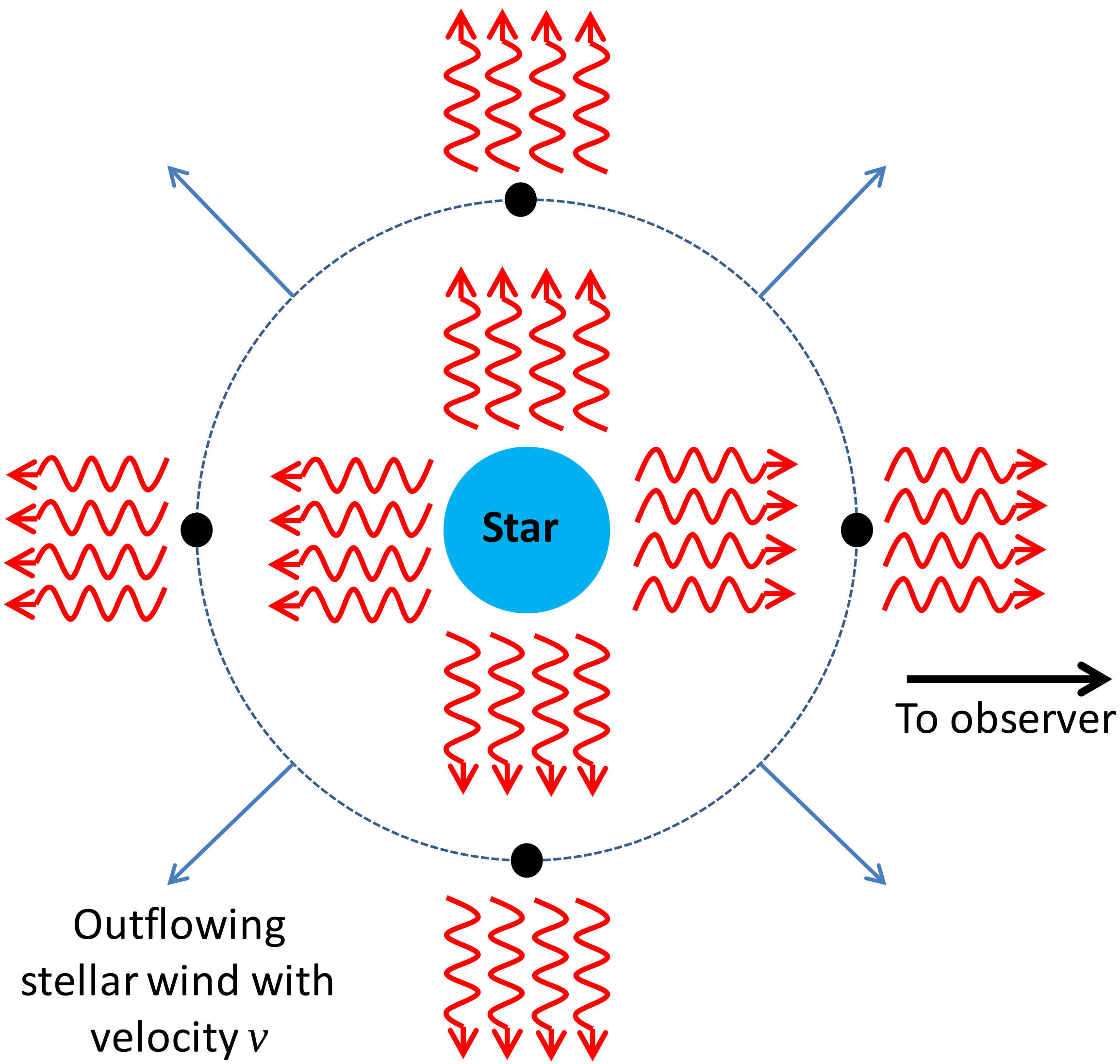
*The probability for absorption and emission are really set by the Einstein coefficients of the transition, and will be much smaller than 25%

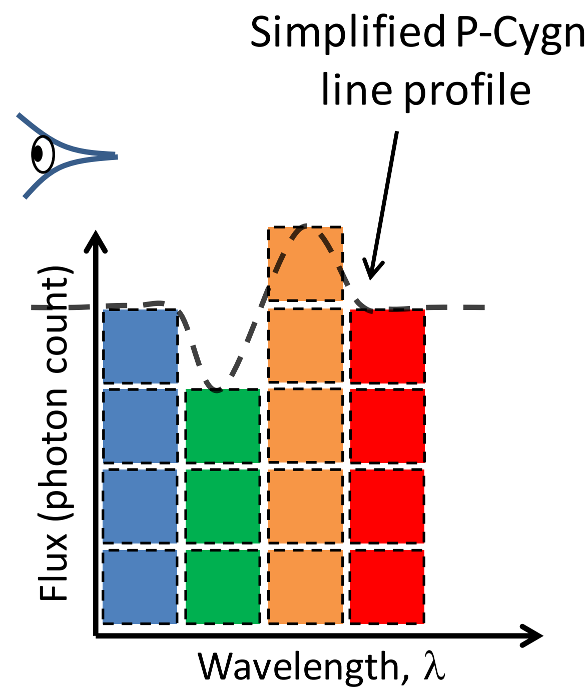
**Re-emission will actually be isotropic


Here we have photons with $\lambda = \lambda_{abs}$, so one quarter of photons are absorbed and re-emitted/scattered randomly
Star
Photon re-emitted in different direction and lost from line-of-sight
To observer
Flux (photon count)
Wavelength, λ
Outflowing stellar wind with velocity v
Photon re-emitted at λ_0 (as wind direction here is transverse to line-of-sight) into line-of-sight


Here we have photons with
$\lambda = \lambda_0 > \boldsymbol{\lambda_{abs}}$, so no photons
are absorbed
Star
To observer
Outflowing
stellar wind with
velocity v
Flux (photon count)
Wavelength, λ

Here we have photons with $\lambda > \lambda_0$, so no photons are absorbed





Note that in reality different shells in the wind with different wind velocities, and the turbulent nature of the wind, will lead to Doppler broadening of the absorption and emission line profiles.