Fluctuation properties of chaotic light

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❖ *Two types of light source*

- Chaotic light

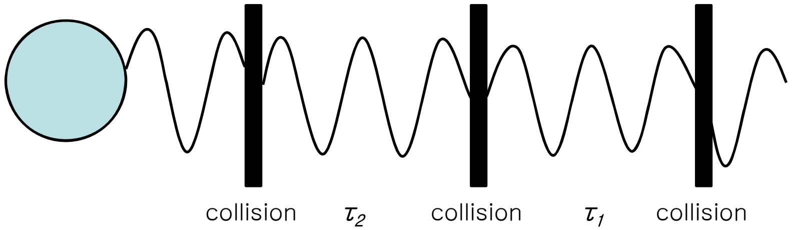
  (thermal cavity, filament lamp)

  The different atoms are excited by an electrical discharge and emit their radiation independently of one another.

  The shape of an emission line is determined by the statistical spread in atomic velocities and the random occurrence of collisions.

- Laser

❖ Model of collision-broadened light source

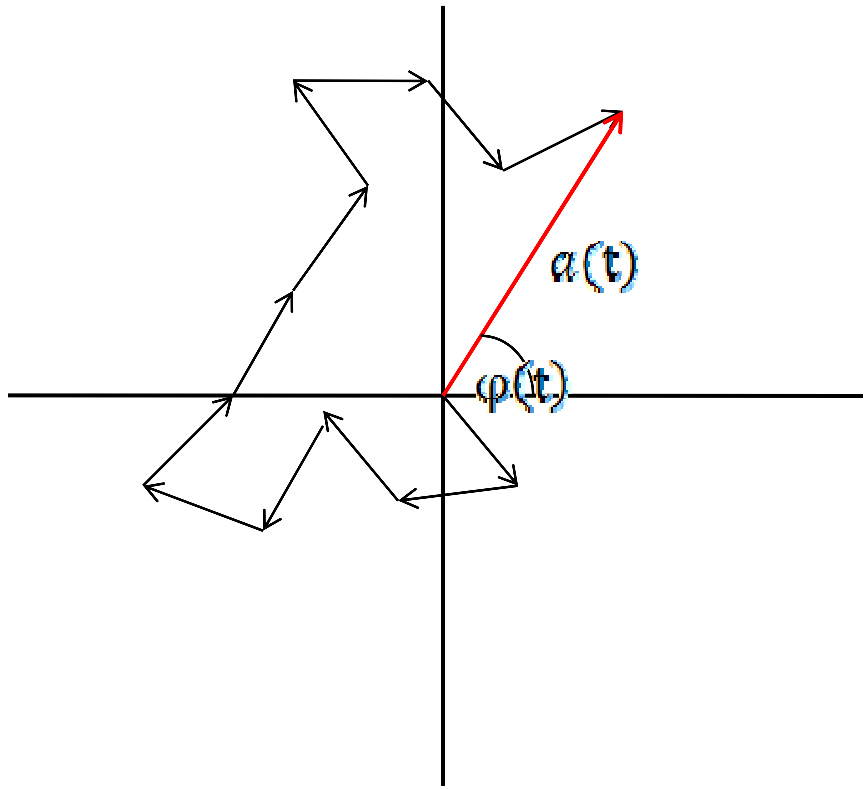


$$E(t) = E_0 \exp\{-i\omega_0 t + i\phi(t)\}$$

The phase $\phi(t)$ remains constant during periods of free flight but changes abruptly each time a collision occurs. The amplitude E_0 And frequency ω_0 are the same for any period. If there is a large number v of such atoms, the total electric field amplitude is

$$\begin{aligned} E(t) &= E_1(t) + E_2(t) + \cdots + E_v(t) \\ &= E_0 \exp(-i\omega_0 t)\left\{\exp\left(i\phi_1(t)\right) + \exp\left(i\phi_2(t)\right) + \cdots + \exp\left(i\phi_v(t)\right)\right\} \\ &= E_0 \exp(-i\omega_0 t)a(t)\exp\left(i\varphi(t)\right) \end{aligned}$$

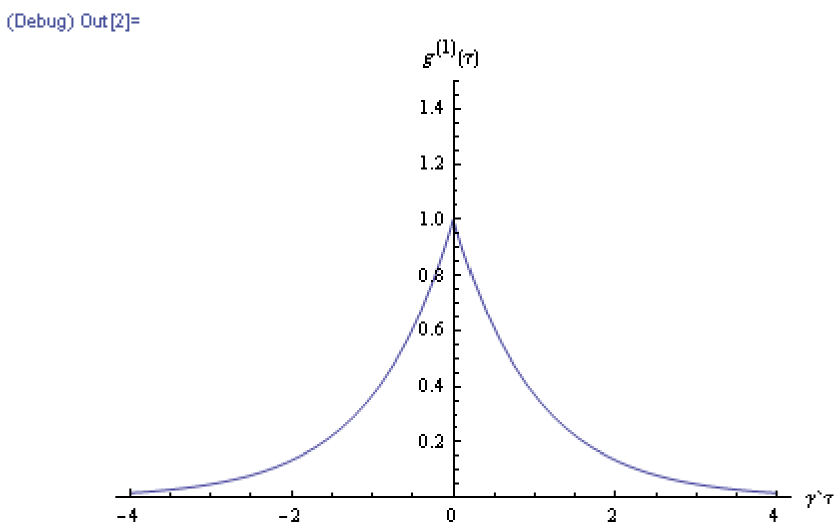
❖ Model of collision-broadened light source



Argand diagram to show the amplitude and phase of the resultant vector formed by a large number of unit vectors, each of which has a randomly chosen phase angle.

❖ Degree of first-order coherence

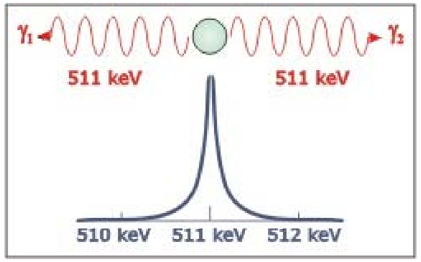
$$g^{(1)}(z_1, t_1, z_2, t_2) \equiv g^{(1)}(\tau) = e^{-i\omega_0\tau - \gamma`|\tau|}$$

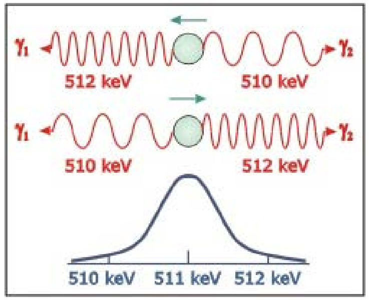


The modulus of the degree of first-order coherence for chaotic light of linewidth parameter $\gamma`$.

❖ Degree of first-order coherence

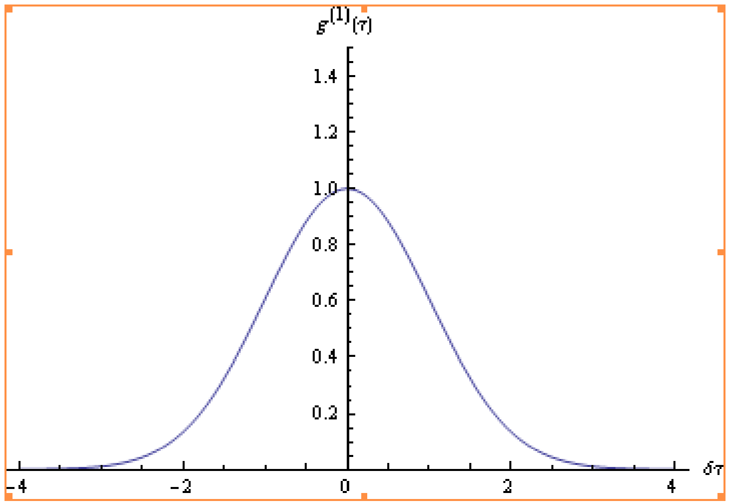
Doppler broadening





$$g^{(1)}(\tau) = e^{-i\omega_0\tau-\frac{1}{2}\delta^2\tau^2}$$

(Debug) Out[6]=



The modulus of the degree of first-order coherence for chaotic light of Gaussian frequency distribution with root-mean-square width δ.