

# Spontaneous Wave Function Collapse



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## Discrete Processes

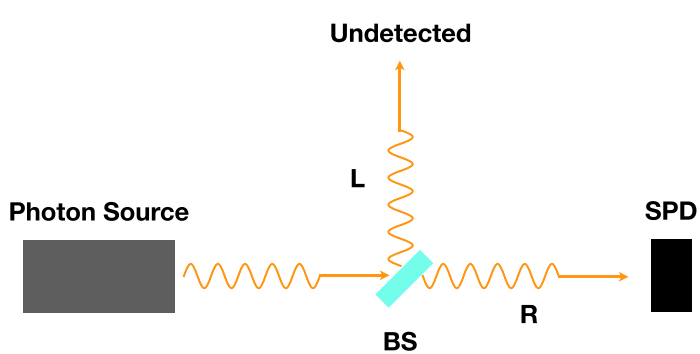
*Infinite-frequency limit*

$$\lambda \rightarrow \infty \quad \alpha \rightarrow 0 \quad \lambda\alpha = 2\gamma = \text{const}$$

$$\frac{d\rho}{dt} = -i[H, \rho] + \lambda(T_\alpha(\rho) - \rho) \quad \longrightarrow \quad \frac{d\rho}{dt} = -i[H, \rho] - \frac{\gamma}{2}[A, [A, \rho]]$$

*Poisson process in time*

*Randomly sharpen the distribution around eigenvalue of A*



$$|c_{R,L}(t + dt)|^2 = L_{R,L}^2(t) |c_{R,L}(t)|^2$$

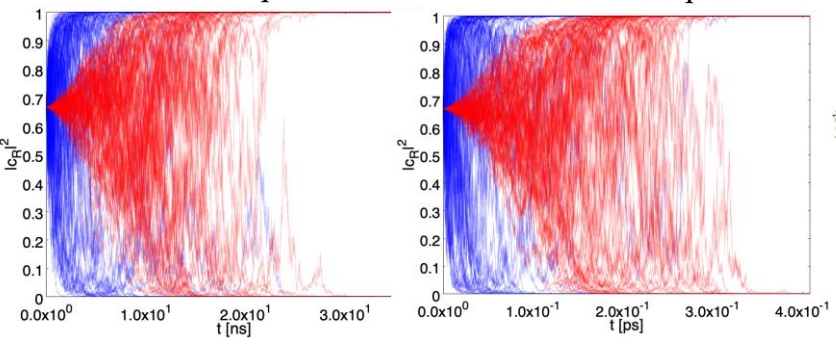
$$L_{R,L}^2(t) = 1 \pm 2a\sqrt{\gamma} |c_{L,R}(t)|^2 dB$$

$$|c_R(0)|^2 = \frac{2}{3}$$

*System-apparatus interaction*  $\hat{H}_I = \frac{d\beta}{dt} f(\hat{R}) \hat{P}$

**Mesoscopic**

**Macroscopic**



## Continuous Processes

*Continuous sharpening process*

$$d|\psi\rangle = \left[ \sqrt{\gamma}(\hat{A} - \langle \hat{A} \rangle_{\psi_t}) \cdot dB - \frac{1}{2}\gamma(\hat{A} - \langle \hat{A} \rangle_{\psi_t})^2 dt \right] |\psi\rangle$$

$$|\psi\rangle = (c_L |\gamma\rangle_L + c_R |\gamma\rangle_R) |D^{(0)}\rangle \rightarrow c_L |\gamma\rangle_L |D^{(0)}\rangle + c_R |\gamma\rangle_R |D^{(+)}\rangle$$

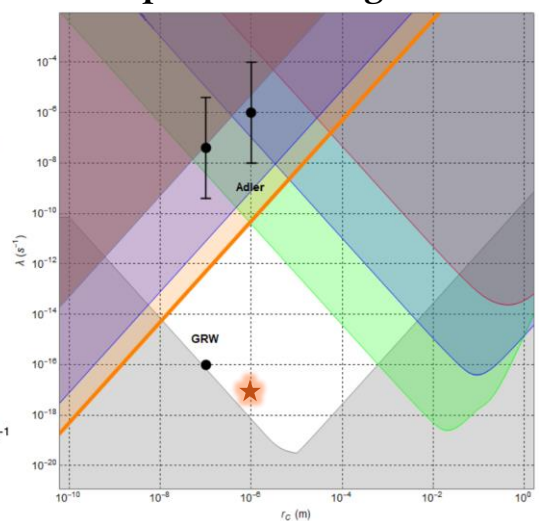
$$\lambda_{\text{micro}} = 10^{-17} \text{s}^{-1} \quad \alpha^{-1/2} = 10^{-4} \text{cm}$$

$$\gamma_{\text{micro}} = \frac{1}{2} 10^{-9} \text{cm}^{-2} \text{s}^{-1}$$

$$\gamma_{\text{meso}} = 10^{20} \gamma_{\text{micro}} = \frac{1}{2} 10^{11} \text{cm}^{-2} \text{s}^{-1}$$

$$\gamma_{\text{macro}} = 10^{23} \gamma_{\text{micro}} = \frac{1}{2} 10^{14} \text{cm}^{-2} \text{s}^{-1}$$

**Current phenomenological bounds**



Bajoni, Nicosini, Rimini, Rodini (2021)

Ghirardi, Nicosini, Rimini (2018) Nicosini, Rimini (1990)

INFN VIP, Donadi et al. (2021)