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In[•]:= (*Decoherence of a Qubit under Phase Damping*)
(*Objective*)(*Simulate the effect of phase damping on a qubit's density matrix.We observe the decay of the off-diagonal element (coherence).*)

(* ::Section::*)(*Initial State Setup*)
(*Define initial pure state|ψ⟩=(|0⟩+ |1⟩)/√2*)psi = {1, 1} / Sqrt[2];
(*Density matrix ρ(0)= |ψ⟩⟨ψ|*)
rho0 = Outer[Conjugate[#1] * #2 &, psi, psi];

(* ::Section::*)
(*Kraus Operators for Phase Damping*)

KrausOperators[p_] := {{{1, 0}, {0, Sqrt[1 - p]}}, {{0, 0}, {0, Sqrt[p]}}};

(* ::Section::*)
(*Density Matrix Evolution Function*)

RhoT[rho_, p_] := Module[{Ks}, Ks = KrausOperators[p];
   Total[Table[ConjugateTranspose[Ks[[i]]].rho.Ks[[i]], {i, Length[Ks]}]]];

(* ::Section::*)
(*Time Evolution and Coherence Plot*)

(*Parameters*)
γ = 0.5; (*phase damping rate*)
tmax = 10;
dt = 0.1;
times = Range[0, tmax, dt];

(*Compute evolved density matrices*)
rhos = Table[RhoT[rho0, 1 - Exp[-γ * t]], {t, times}];

(*Extract|ρ₁₂(t)|for each time*)
coherences = Abs[#[[1, 2]] & /@ rhos];

(*Plot the coherence decay*)
ListLinePlot[coherences, Frame → True, FrameLabel → {"Time", "|ρ₁₂(t)|"}, PlotLabel → "Decay of Qubit Coherence under Phase Damping", PlotStyle → Red, ImageSize → Large]
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Out[•]=