HEOM Gleichungen

$$\dot{\rho}_s(t) = \mathcal{L}_s \rho_s(t) - i \sum_{R,I} \Big([\hat{Q}, \rho_{01}] + [\hat{Q}, \rho_{10}^\dagger] \Big)$$

$$\dot{\rho}_{10} = \mathcal{L}_s \rho_{10} - (\nu_0^I + \nu_0^R)\rho_{10} - iC_0^R \hat{Q}\rho_s(t) + iC_0^I \{\hat{Q}, \rho_s(t)\}$$

$$\begin{aligned}
\dot{\rho}_{01} &= \mathcal{L}_s \rho_{01} - (\nu_0^I + \nu_0^R)\rho_{01} - iC_1^R [\hat{Q}, \rho_s(t)] + iC_1^I \{\hat{Q}, \rho_s(t)\} \\
\dot{\rho}_{20} &= \mathcal{L}_s \rho_{20} - (2\nu_0^R + 2\nu_0^I)\rho_{20} - i2C_0^R [\hat{Q}, \rho_{10}] \\
\dot{\rho}_{11} &= \mathcal{L}_s \rho_{11} - (\nu_0^R + \nu_0^I)\rho_{11} - i(C_0^R \hat{Q}\rho_{01} + C_1^I \{\hat{Q}, \rho_{10}\} + \{\hat{Q}, \rho_{01}\}) \\
&\quad + \sum_{R,I} \Big(- [\hat{Q}, \rho_{21}] + [\hat{Q}, \rho_{12}] \Big) \\
\dot{\rho}_{02} &= \mathcal{L}_s \rho_{02} - (2\nu_0^R + 2\nu_0^I)\rho_{02} - i2C_1^R \Big([\hat{Q}, \rho_{01}] + \hat{Q}, \rho_{01} \Big) \\
&\quad + \sum_{R,I} \Big(- [\hat{Q}, \rho_{03}] + [\hat{Q}, \rho_{12}] \Big)
\end{aligned}$$

Korrelationsfunktionen und Drude-Lorentz-Modell

$$C(t) = \hbar \sum_k g_k^2 \left(C_k^R + iC_k^I \right) e^{-\gamma_k t}$$

$$C(t) = C^R(t) + iC^I(t),$$

$$C^R(t) = \sum_k C_k^R e^{-\gamma_k t}, \quad C^I(t) = \sum_k C_k^I e^{-\gamma_k t}.$$

Drude-Lorentz-Spektraldichte

$$J(\omega) = \frac{4g^2\gamma\omega}{\omega^2 + \gamma^2}.$$

Reale und Imaginäre Teile der Korrelationsfunktion

$$C_k^R = \begin{cases} g^2\gamma \cdot \coth(\beta\gamma/2), & k = 0 \\ \frac{4g^2\gamma\omega_k}{(\nu_k^2 - \gamma^2)}, & k > 0 \end{cases}$$

$$C_k^I = \begin{cases} g^2\gamma, & k = 0 \\ 0, & k > 0 \end{cases}$$

Zusammenhang zwischen Parametern und Frequenzen

$$\omega_k = \frac{2\pi k}{\beta}, \quad \text{für } k > 0.$$

Liouvillian der Systemdynamik

$$\mathcal{L}_s = -i[H, \rho_s].$$

Rekonstruktion von $C(t)$

$$C_k = C_k^R + iC_k^I,$$

$$C(t) = \sum_k C_k e^{-\gamma_k t}.$$

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$$C(t) = \sum_{k=0}^{\infty} c_k e^{-\nu_k t}$$

$$\nu_k = \begin{cases} \gamma & k = 0 \\ \frac{2\pi k}{\beta} & k \geq 1 \end{cases}$$

$$c_k = \begin{cases} \lambda\gamma \left[\cot\left(\frac{\beta\gamma}{2}\right) - i\right] & k = 0 \\ \frac{4\lambda\gamma\nu_k}{\left(\nu_k^2 - \gamma^2\right)\beta} & k \geq 1 \end{cases}$$