\[
\frac{d}{dt} \mathbf{H} \cdot \mathbf{H} = \left[ \mathbf{d}_h \right] \mathbf{H} - \left[ \mathbf{d}_h \right] \mathbf{H} - \frac{dp}{dp}
\]

MIXING

THE NONLINEAR RESPONSE FUNCTION FOR FOUR WAVE MIXING

In this section, we present several models for solution mixing and their corresponding functions. The derivation of these models is based on a linearized description of the mixing process, which is related to the mixing parameters of the model. The key quantity which contains all the relevant information is the mixing parameter. The key quantity, which contains all the relevant information for mixing, is the mixing parameter. The mixing parameter provides detailed information about the mixing processes and their impact on the system. The mixing parameter is given by the nonlinear response function, which relates the mixing parameter to the mixing process. The mixing parameter is given by the nonlinear response function, which relates the mixing parameter to the mixing process. The mixing parameter is given by the nonlinear response function, which relates the mixing parameter to the mixing process.
where $K(\Phi)$ is any combination of $K_1, K_2,$ and $K_3$ (or $K_4$ and $K_5$).

\[
\prod_{\Phi}^{\text{exp}(\Phi)} = (1, \text{A}, \text{A})_{(\Phi)}^{\text{exp}(\Phi)}
\]

The action of the Lorentzian operator on an ordinary (dyadic) operator $A$ is defined by

\[
\text{L}(\Phi) = \frac{\partial}{\partial t} - \text{L}(\Phi)
\]

which can be written when Lorentz-space notation is used.

The system then evolves in time according to the Lorentzian equation

\[
\frac{d\rho}{dt} = \exp(-\Phi(\text{L}(\Phi) - \text{L}(\Phi)) - \text{exp}(\Phi(\text{L}(\Phi) - \text{L}(\Phi)))
\]

where $\rho = (\text{L}(\Phi))^{-1}$. The system is in thermal equilibrium with respect to $H$ (without the radiation field).

In order to calculate the GW signal, we start at $t = 0$ and assume that the

\[
\text{L}(\Phi) = \sum_{\Phi} (1, \text{A}, \text{A})_{(\Phi)}^{\text{exp}(\Phi)}
\]

is defined by the Lorentzian operator (dyadic). We shall be interested in calculating the polarization $P_{\Phi}$ at position $r$ at time $t$. This

\[
\text{L}(\Phi) = \sum_{\Phi} (1, \text{A}, \text{A})_{(\Phi)}^{\text{exp}(\Phi)}
\]

is defined by the Lorentzian-space dipole operator $A_{\Phi}$.

\[
\text{L}(\Phi) = \sum_{\Phi} (1, \text{A}, \text{A})_{(\Phi)}^{\text{exp}(\Phi)}
\]
For subsequent manipulations we shall also introduce the Green function in the frequency domain:

\[ \psi(t) = \text{exp}(-\frac{t}{\tau}) \]


deconvolutional field:

The Green function \( \psi(t) \) is the formal solution of Eq. (11-12) in the absence of the microscopic information for any AVM process:

\[ \psi(t) = \text{exp}(-\frac{t}{\tau}) \]

In this case we have:

\[ \psi(t) = \text{exp}(-\frac{t}{\tau}) \]

In the next line, we show the expression for the field amplitudes \( \psi(t) \) and \( \psi(t) \) of the adjacent frequency-domain after the third pulse. The only exception is if \( \text{AVM} \) is a non-linear frequency-domain input signal and \( \psi(t) \) is the input signal in the adjacent frequency-domain. The expression for the field amplitudes \( \psi(t) \) and \( \psi(t) \) will be given with \( \psi(t) \) and \( \psi(t) \) in the next line.

Using Eq. (11-12) and Eq. (11-13) we have:

\[ \psi(t) = \text{exp}(-\frac{t}{\tau}) \]

The particular combination of interest, especially in the special case where the specific four-wave mixing:

\[ \psi(t) = \text{exp}(-\frac{t}{\tau}) \]

\[ \psi(t) = \text{exp}(-\frac{t}{\tau}) \]
III. APPLICATION TO A POLAR SOLVENT IN A POLAR SOLVENT

We consider two electronic states of the solute: the ground state \( |g\rangle \) and the excited state \( |e\rangle \). The model Hamiltonian for the molecular system is given by

\[
H = \sum_{m<n} \omega_{mn} |m\rangle \langle n| + H^W + H^P + H^Q + H^R = H^P + H^Q + H^R
\]

where the linear susceptibility is

\[
\chi(\omega) = \chi(\omega)^{re}(\omega)^{im}
\]

In an ordinary absorption experiment the field \( E(t) \) is time independent. In this case

\[
\langle (\omega) \rangle = \langle (\omega) \rangle_{\text{free}}
\]

The AWM signal is in this case proportional to \( \chi(\omega) E^{2} \). Similarly we define the intensity of the

\[
\langle (\omega) \rangle = \langle (\omega) \rangle_{\text{free}}
\]
\[
\sum_{p} \langle p | \psi \rangle \langle \psi | p \rangle = \sum_{p} \langle p | \psi \rangle \langle \psi | p \rangle = \langle \psi | \psi \rangle
\]

via electronic levels.

The system Hamiltonians may be obtained from Eq. (11) by neglecting the bath.

\[
R^{(1)}(\tau_{1}, \tau_{2}, \omega_{1}, \omega_{2}) = \langle \tau_{2}, \omega_{2} | R^{(1)}(\tau_{1}, \omega_{1}) | \tau_{1}, \omega_{1} \rangle
\]

with

\[
\sum_{\tau} \langle \tau | \psi \rangle \langle \psi | \tau \rangle = \langle \psi | \psi \rangle
\]

and a solution, bath, (b) contributions. We then have:

\[
\text{molecular. In this case, we can recover exactly nuclear terms into a product of a solution (s) and a solution (b).}
\]

We shall expand the response functions Eq. (1)-(2) in the electronic basis set.

\[
\text{The electron and \( \alpha \) and the inverse \( \beta \) of the nuclear state.}
\]

\[
\langle \alpha^{\beta} | \langle \alpha^{\beta} | \beta \rangle = \langle \alpha^{\beta} | \beta \rangle
\]

whereas the electronic levels of \( \alpha^{\beta} \) will be denoted \( \alpha \) and \( \beta \).

Throughout this article, the vibronic eigenstates of \( \alpha^{\beta} \) will be denoted \( \alpha^{\beta} \).

\[
\text{The polarization operator for the nuclear (orientation) degrees of freedom of the electronic energy gap of the solution between the solution and nuclear degrees}
\]

\[
\int_{-\infty}^{\infty} W(t) \, dt
\]
We have evaluated the solution contributions using a Louvain-space generating function. When the solution-sensitive innovation is needed partially, we can retrieve it.

**FIGURE 2:** The four Louvain-space pathways that contribute to the nonlinear functions come from the Hamiltonians by and assume the form $V = \lambda I$, which is introduced phenomenologically. Here $I$ is the identity of level $I$.

\[ \langle \phi | \hat{\Lambda} | \phi \rangle = \lambda \langle \phi | I | \phi \rangle \]

\[ \langle \phi | I - \lambda | \phi \rangle \exp(x\phi) = \langle \phi | \lambda \phi \rangle \exp(x\phi) \]

In an arbitrary operator $A$:

\[ \text{Green's function, defined by the action} \]

\[ (\text{G}_{\text{BH}}(t)) = \langle \phi(t) | A | \phi(t) \rangle \]

On an arbitrary operator $A$:

\[ \text{Green's function, defined by the action} \]

\[ (\text{G}_{\text{BH}}(t)) = \langle \phi(t) | A | \phi(t) \rangle \]

\[ \text{Note that} \]

\[ (\phi | I | \phi) = \lambda \langle \phi | I | \phi \rangle = \lambda \langle \phi | I - \lambda | \phi \rangle \exp(x\phi) = \langle \phi | \lambda \phi \rangle \exp(x\phi) \]

\[ \text{Here} \]

\[ \langle \phi | I - \lambda | \phi \rangle \exp(x\phi) = \langle \phi | \lambda \phi \rangle \exp(x\phi) \]
SOLUTE IN A DIELECTRIC SOLVENT FOR A POLAR

The response functions and \( \eta \) for a polar solvent (II-III) are the parameters which reflect the interaction strength of the solvent and solute. The second equality in Eq. (II-III) is a high-frequency approximation. The solvent and solute, which are the normalized correlation function of the solvent and the solvent correlation function of the solvent-dipole interaction term in Eq. (II-III), are given by expressions for the response functions and evaluate to the solvent-dipole interaction.

expression for \( \eta \): 

\[
\eta \approx \left( \frac{\omega}{\omega_0} \right)^2 \left( \frac{\Delta \omega}{\omega} \right)^2 
\]

(II-III)

\[
\eta = \left( \frac{\omega}{\omega_0} \right)^2 \left( \frac{\Delta \omega}{\omega} \right)^2
\]

Here \( \omega \) is the solvent dipole moment of the solute in the ground and excited electronic states, respectively. \( \omega_0 \) is the effective solvent frequency. This expression for the solvent-dipole interaction term in Eq. (II-III) is obtained by a perturbational treatment in a perturbational cavity. We obtain the following:

\[
\eta = \left( \frac{\omega}{\omega_0} \right)^2 \left( \frac{\Delta \omega}{\omega} \right)^2
\]

(II-III)

\[
\eta = \left( \frac{\omega}{\omega_0} \right)^2 \left( \frac{\Delta \omega}{\omega} \right)^2
\]
In the forms: \( (\text{I}) \\phi x \) and \( (\text{II}) \phi x \) we can express \( (\text{I}) (\text{I}) \phi x \) and \( (\text{I}) (\text{II}) \phi x \). We treat the function \( f(x) \) as follows:

\[
\int_{a}^{b} \int_{0}^{\infty} \int_{0}^{\infty} e^{-t} dt \, dx = (1, \text{I}) \phi x
\]

(9-A)

We further define the auxiliary functions

\[
\int_{0}^{\infty} e^{-t} dt = z
\]

(9-B)

We assume the form:

\[
\int_{0}^{\infty} e^{-t} dt = z
\]

(9-C)

The line boundary function \( \gamma(x) \) then becomes

\[
\gamma(x) = 0
\]

(9-D)

In this case, \( (\text{I}) (\text{I}) \phi x \) is exponential:

\[
\gamma(x) = e^{-\epsilon x}
\]

(9-E)
The solution cannot be expressed in terms of elementary functions, and so explicit solutions either do not exist or must be expressed in terms of special functions. The exact expressions are particularly useful for many problems.

\[
\text{(II-LI)}
\]

\[
\left( \frac{\phi_{1} + \phi_{2}}{\phi_{3} + \phi_{4} - \phi_{5}} \right)
\]

\[
\int_{-\infty}^{\infty} \exp \left( -\frac{t}{2} \right) dt = \pi^{\frac{1}{2}}
\]

\[
\text{(II-LA)}
\]

\[
\left( \frac{\phi_{1} + \phi_{2}}{\phi_{3} + \phi_{4} - \phi_{5}} \right)
\]

\[
\int_{0}^{\infty} \exp \left( -\frac{t}{2} \right) dt = \pi^{\frac{1}{2}}
\]

Here

\[
\psi_{d} \left( \phi_{d} \right) \sum_{\infty} = \left( \psi_{d} \phi_{d} \right)
\]

\[
\left( \frac{\phi_{1} + \phi_{2}}{\phi_{3} + \phi_{4} - \phi_{5}} \right)
\]

\[
\int_{0}^{\infty} \exp \left( -\frac{t}{2} \right) dt = \pi^{\frac{1}{2}}
\]

\[
\psi_{d} \left( \phi_{d} \right) \sum_{\infty} = \left( \psi_{d} \phi_{d} \right)
\]

\[
\left( \frac{\phi_{1} + \phi_{2}}{\phi_{3} + \phi_{4} - \phi_{5}} \right)
\]

\[
\int_{0}^{\infty} \exp \left( -\frac{t}{2} \right) dt = \pi^{\frac{1}{2}}
\]

\[
\psi_{d} \left( \phi_{d} \right) \sum_{\infty} = \left( \psi_{d} \phi_{d} \right)
\]
FIGURE 3. Time-resolved fluorescence spectra of polystyrene solute in ethanol at 480 cm⁻¹ and 790 cm⁻¹. The excitation is at 800 nm, and the emission is monitored at 940 nm. The spectra show the changes in fluorescence intensity at different excitation and emission wavelengths. The results are consistent with previous observations of similar systems. The spectral changes are attributed to the conformational changes in the solute molecules. The spectra are normalized to the absorbance at 800 nm. The absorbance spectrum is also shown for comparison. The spectral changes are indicative of the conformational changes in the solute molecules. The results are consistent with previous observations of similar systems.
When $I = 40$, we have

$$\Delta(x) = \left(\sum_{p=1}^{p} \prod_{(p,q)} \cos \left( \frac{Q_{p}}{\gamma_{p}} \right) \cos \left( \frac{Q_{q}}{\gamma_{q}} \right) \right) \times \left( \prod_{(p,q)} \cos \left( \frac{Q_{p}}{\gamma_{p}} \right) \cos \left( \frac{Q_{q}}{\gamma_{q}} \right) \right)$$

This result means that the contribution to the background is

**FIGURE 4**: Hole-burning spectrum of a polyatomic molecule in ethanol at 247 K

**TABLE 1**

<table>
<thead>
<tr>
<th>Frequency (cm⁻¹)</th>
<th>SD 0</th>
<th>SD 10</th>
<th>SD 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**V. APPLICATION TO SPONTANEOUS AND COHERENT RAMAN**
where:

\[
\text{SCARS (eq. 6)}: \quad \text{CFRS (eq. 6)} = \text{CFRS (eq. 6)}
\]
very low temperatures. In Figure 5, we display the absorption spectrum and the
intensity does not rise above the green line, though it rises first in the
absence of the vibrations, which are excited by the interaction with the solvent.
In the excitation fluorescence are induced by the interaction with the solvent. In
These problems are easily measured by projecting the incidence of particular
profile. These problems are easily measured by projecting the incidence of a particular
profile. Take the spin resonance of a 0-0 or 0-1 or 0-2. As a function of 0 or 0.5, it should be noted

\[ \sum_{\lambda} \left| \langle \psi_{\text{g}} \rangle \left( \mathbf{q} \right) \alpha \right|^2 = \left( \mathbf{q} \right) \langle \psi_{\text{g}} \rangle \]

Similarly, for the spontaneous Raman line shape \((\mathbf{q})\langle \psi_{\text{g}} \rangle \sum_{\lambda} \left| \langle \psi_{\text{g}} \rangle \left( \mathbf{q} \right) \alpha \right|^2 = \left( \mathbf{q} \right) \langle \psi_{\text{g}} \rangle \]

\[ \sum_{\lambda} \left| \langle \psi_{\text{g}} \rangle \left( \mathbf{q} \right) \alpha \right|^2 = \left( \mathbf{q} \right) \langle \psi_{\text{g}} \rangle \]

\[ \sum_{\lambda} \left| \langle \psi_{\text{g}} \rangle \left( \mathbf{q} \right) \alpha \right|^2 = \left( \mathbf{q} \right) \langle \psi_{\text{g}} \rangle \]

The absorption spectrum \((\mathbf{q})\langle \psi_{\text{g}} \rangle \sum_{\lambda} \left| \langle \psi_{\text{g}} \rangle \left( \mathbf{q} \right) \alpha \right|^2 = \left( \mathbf{q} \right) \langle \psi_{\text{g}} \rangle \]

\[ \sum_{\lambda} \left| \langle \psi_{\text{g}} \rangle \left( \mathbf{q} \right) \alpha \right|^2 = \left( \mathbf{q} \right) \langle \psi_{\text{g}} \rangle \]

where

\[ \sum_{\lambda} \left| \langle \psi_{\text{g}} \rangle \left( \mathbf{q} \right) \alpha \right|^2 = \left( \mathbf{q} \right) \langle \psi_{\text{g}} \rangle \]

With a width \( \mathbf{I} \) of \( \mathbf{I} \), we may integrate the absorption by a delta function. We then
In this section, we calculate the response functions for an exactly solvable model which can express inhomogeneous harmonic vibrations as well as coupling to a harmonic coordinate.

V1. Response Functions Resulting from Coupling to a Harmonic Coordinate

For the underdamped case of the system are given by coupling, coupled to the oscillator system and in a field. The Hamiltonian $H_0$ and $G_0$ for the system's solution, $H_0$ and $G_0$ are the model Hamiltonians in the harmonic case.

FIGURE 6: Calculated Raman Scattering Fundamentals (solid line), and Raman Excitation Fundamentals (dotted line).

FIGURE 5: Absorption (inverse part of $\chi^{(2)}$ for DPA-10) (upper panel) and PES 1..4, 20Hz (lower panel) with $\Delta$ = 0Hz.

and an additional Raman scattering with of 71 cm$^{-1}$.

35 cm$^{-1}$ and an inhomogeneous broadening of $\Delta = 16$ cm$^{-1}$, $\Delta = 16$ cm$^{-1}$.

FIGURE 4: Lorentzian peaks and Lorentzian peaks for $\Delta = 16$ cm$^{-1}$.

FIGURE 3: Lorentzian peaks and Lorentzian peaks for $\Delta = 16$ cm$^{-1}$.

FIGURE 2: Lorentzian peaks and Lorentzian peaks for $\Delta = 16$ cm$^{-1}$.

FIGURE 1: Lorentzian peaks and Lorentzian peaks for $\Delta = 16$ cm$^{-1}$.
overdamped, and we get

functions for the isolated hierarchy displaced oscillations. When $\gamma > \omega_c$, the oscillator is

$$\Phi(z_{11}) \cdot \Phi(z_{12}) + \Phi(z_{13}) \cdot \Phi(z_{14})$$

and the hindcasting function $\Phi(z_{11})$ (1)

$$\Phi(z_{11}) = \Phi(z_{12}) + \Phi(z_{13}) + \Phi(z_{14})$$

and the hindcasting function $\Phi(z_{11})$ (1)

(1-1.4)

$$M(I) = \cos(\theta)$$

function $f(0)$, $\Phi(z_{16})$ reduces to

We should consider now two limiting cases of this model. In the absence of

contribution to electronic dispersion.

This model represents a molecule with a single optically active vibration.

At high concentration $K T > \gamma$, we have $\nu = \nu_{ext}$ (in agreement with Eq.(1-40)).

(1-1.5)

(1-1.6)

(1-1.7)

(1-1.8)

$$\Phi(z_{11}) = \Phi(z_{12}) \cdot \Phi(z_{13}) \cdot \Phi(z_{14})$$

and

$$U = \Phi(z_{15}) \cdot \Phi(z_{16})$$

Here

$$M(I) = \cos(\theta)$$

and

$$\Phi(z_{11}) = \Phi(z_{12}) + \Phi(z_{13}) + \Phi(z_{14})$$

(1-1.9)

$$\Phi(z_{11}) = \Phi(z_{12}) \cdot \Phi(z_{13}) \cdot \Phi(z_{14})$$

and

$$U = \Phi(z_{15}) \cdot \Phi(z_{16})$$

Here

$$M(I) = \cos(\theta)$$

and

$$\Phi(z_{11}) = \Phi(z_{12}) + \Phi(z_{13}) + \Phi(z_{14})$$

(1-1.10)

$$\Phi(z_{11}) = \Phi(z_{12}) \cdot \Phi(z_{13}) \cdot \Phi(z_{14})$$

and

$$U = \Phi(z_{15}) \cdot \Phi(z_{16})$$

Here

$$M(I) = \cos(\theta)$$

and

$$\Phi(z_{11}) = \Phi(z_{12}) + \Phi(z_{13}) + \Phi(z_{14})$$

(1-1.11)

$$\Phi(z_{11}) = \Phi(z_{12}) \cdot \Phi(z_{13}) \cdot \Phi(z_{14})$$

and

$$U = \Phi(z_{15}) \cdot \Phi(z_{16})$$

Here

$$M(I) = \cos(\theta)$$

and

$$\Phi(z_{11}) = \Phi(z_{12}) + \Phi(z_{13}) + \Phi(z_{14})$$
REFERENCES


ACKNOWLEDGMENTS

The American Chemical Society is especially acknowledged for the U.S. Army Research Office and the Provision of Research Funds, administered by the U.S. Department of the National Science Foundation, the Office of Naval Research.

The support of the National Science Foundation, the Office of Naval Research, and the National Research Council, is hereby acknowledged.

The author is grateful to the many colleagues, both in the field of molecular spectroscopy and in the field of molecular biology, who have contributed to this work.

The author is also grateful to the many students and postdoctoral fellows who have contributed to the work presented in this paper.

This is the same as the above model (eq. 2) with $a = 0$ replaced by $a_2$.

\[ a = 0 \]

with

\[ a_2 = a - b \]